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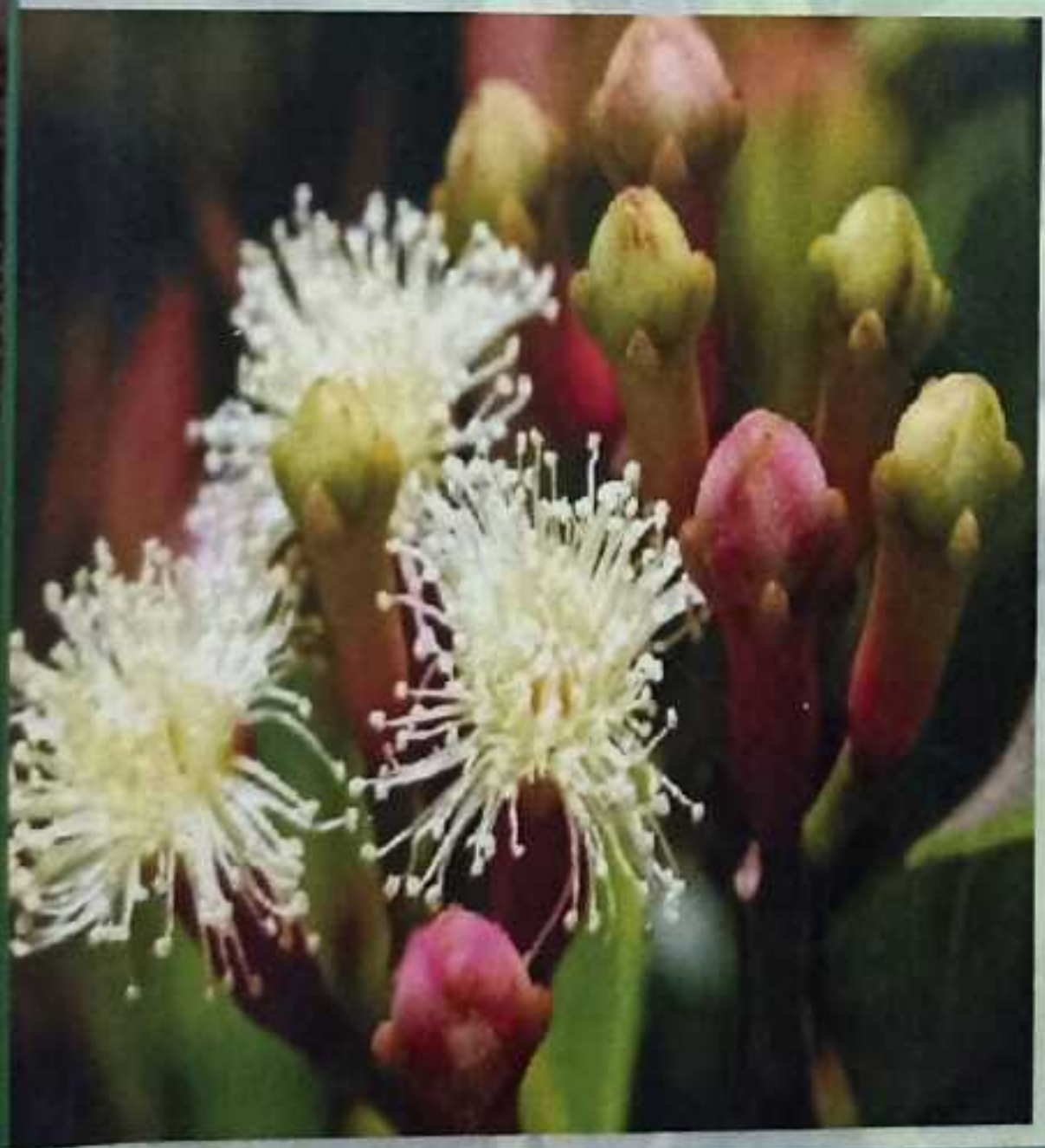
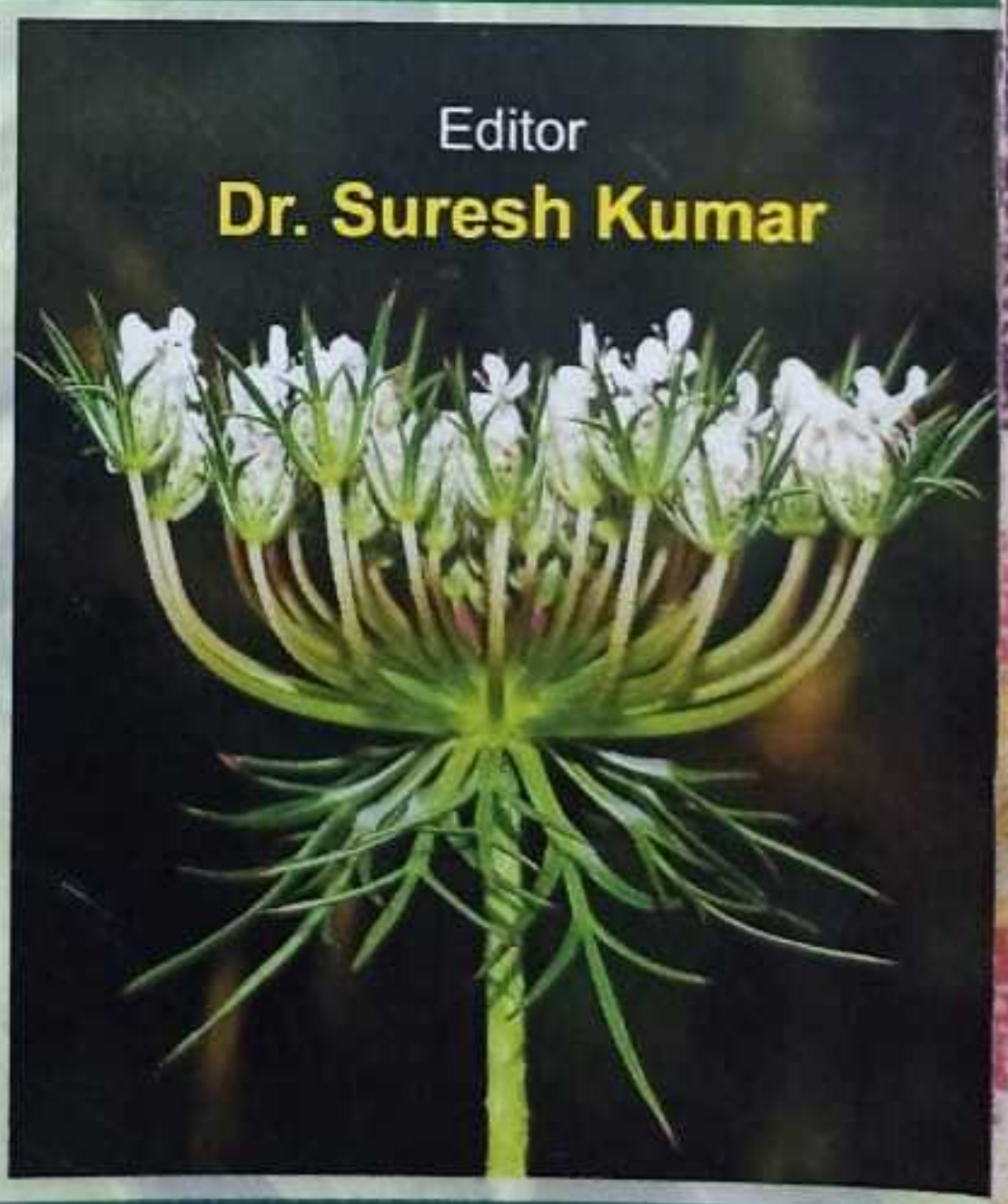
Volume 2





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CONTENTS

CHAPTER 5

Ethnobotany as a Tool to Protect the Interests of Ethnic Group

Kiran Bala

ABSTRACT

Traditional knowledge so called indigenous knowledge terms as the knowledge which come from the local communities and tradition of regional technology areas. It is the technology which has orally passed over generation from person to person. The world intellectual property organization (WIPO) defines traditional knowledge as indigenous cultural and intellectual property. It is very important to analyze the traditional knowledge as intellectual property rights. The protection of traditional knowledge has been a challenging issue for the countries worldwide. India has tribal communities and rich source of forest with forest produce. The forest gives to India an abundant of knowledge about the traditional value of various forest products. But the way intellectual property rights have been designed in modern commerce, traditional knowledge cannot be protected. One of the main reasons is in traditional knowledge there is lack of inventive step. In the recent past years, there have been several cases of bio- piracy of traditional knowledge in India. The foreigner obtaining the patents based on Indian biological materials without acknowledging the sources of their knowledge or without sharing the benefits. Traditional knowledge should be especially protected in developing and underdeveloped countries. Such protection should primarily be with regards to firstly, the recognition of the rights of the original traditional knowledge holders and secondly, the unauthorized

Signaling and Communication in Plants

František Baluška
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Neurotransmitters in Plant Signaling and Communication

Springer

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Contents

Beyond a Neurotransmitter: Physiological Role of Dopamine in Plants

Kiran Bala

Abstract Plant cell produces a wide range of chemical compounds needed for its survival. Mostly secondary metabolite and phytochemicals including neurotransmitters are essential for the reallocation of resources in plants in response to changing environmental factors. Among them, dopamine which is a catecholamine neurotransmitter is found in plants as well as in animals. Many plants species of different families were reported to contain significant amounts of dopamine. It mediates many physiological processes in plants. However, the role of dopamine in plants is poorly documented. They are involved in much aspect of growth, development and their synthesis is regulated by stress condition. Studies have addressed the effect of dopamine on plants as allelochemical that provides defence against herbivore, processes such as nitrogen fixation, flowering and prevention against IAA oxidation, intercellular regulation of ion permeability and photophosphorylation of chloroplast. It has been proposed to be a precursor for various alkaloids benzylisoquinolines like papaverine and morphine or of the hallucinogenic alkaloid. In this chapter current knowledge on role of dopamine in plants are documented. Dopamine, noradrenaline and adrenaline were shown to participate in intercellular regulation of ion permeability and photophosphorylation of chloroplasts. Dopamine is involved in many functions like precursor for various alkaloids, antioxidative, sugar metabolism and coordinates with phytohormones to affect plant growth. In this chapter, current knowledge on role of dopamine in plants is documented.

Abbreviations

ABA	Abscisic acid
BHT	Butylated hydroxytoluene
Cu^{2+}	Copper
DOPA	(3,4-Dihydroxyphenylalanine)

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2020

4

A Smart Solution for Agricultural Practices

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ABSTRACT

Agriculture, being the most important sector for our economy, has a huge impact on the lives of all people in this country in terms of our food, water, clothing and shelter requirements. Most of the agricultural practices are still carried out in a manual way in our country, leading to more work and low yield for the farmers. Hence, this system needs to be upgraded in terms of the use of technology in carrying out various day to day activities like irrigation, soil prediction, weather monitoring etc. and this goal can be achieved by making the agricultural practices "Smart". Smart agriculture can be implemented through the integration of 'Internet of Things' (IoT) in this field. IoT can enable the farmers to remotely access their fields through various sensors/field monitors and carry out all manual tasks automatically without any human intervention. In this paper, we have analyzed the various problems farmers are facing on a daily basis due to manual agricultural practices and how implementing IoT can benefit them. Further, we also propose and study a cost efficient system for implementing this solution to turn traditional agriculture to Smart agriculture.

Keywords: *IoT, Smart Agriculture, Wireless Sensors, Soil Prediction.*

1. INTRODUCTION

Agriculture remains the most important sector of India's economy, contributing 16 percent of the national GDP and providing employment for the 47 percent of the population. It is a basic requirement for humans for their survival in terms of food, clothes, shelter, medicine and a good environment. But most agricultural practices are carried out manually by farmers like irrigation, soil monitoring, crop harvesting and field inspection. This leads to a slow and demanding agricultural system and lower yield of crops due to inefficiency of manual practices. There is a need to automate this system and help the farmers to manage all their work in an efficient and easier way. Such a system can be realized through Internet of Things.

The Internet of Things (IoT) is a system of interconnected computing devices or objects that are provided with unique identifiers and the ability to transfer data to each other over a network without human interaction [2]. IoT is used to create Smart environment systems like Smart Home, Smart -parking etc. using various IoT device sensors and protocols. The physical devices thus used, such as microcontrollers, microprocessors, actuators and sensors, communicate with the Internet using an IoT gateway. It provides the users a network interface with the web using RFID, sensors, global positioning systems (GPS), laser scanners and other information sensing devices [4]. So for any "smart" system, IoT is the solution.

Here, we are going to propose an IoT based Smart Agriculture system that will perform real-time monitoring and automatic controlling of the farmer's field.

2 LITERATURE REVIEW

For agriculture, soil, light and water are important sources of productivity of crops. However, Soil erosion continues to be a major environmental problem with regard to land use in India. [3] has discussed about Soil conservation Issues in India. Authors have focused on Soil degradation in (i) Himalaya region, (ii) Indo-Gangetic Plains (iii) Dry and Arid Regions (iv) Coastal Lands in India. In year 2016, India's total geographical area was 328.73 mha, reporting area was 304.89 mha, and area used for Agriculture Purpose was 264.5 mha. [14] has discussed benefits of ICT in agriculture sector and has presented the path of rural farmers and to replace traditional techniques. In this paper, comparative analysis between the developed system and existing systems is discussed. [4] has focused on various IoT devices which will enable farmers to enhance in food production by 70 percent by the year 2050. Wang et.al. in his paper [16] discussed the communication between machines by static or dynamic means. This paper mainly concentrated on machine to machine communication , sensors and security. Raja et.al. in [11] proposed new methods which can be introduced in the market. Security systems will follow sensor touch reorganization wherein wireless sensor security will be the key of this system. These methods can be implemented in different applications with feasible costing and easy to manage faults but still it is not disseminated in home applications. In this paper authors discussed about python scripting which is used in raspberry PI and Raspbion OS coding, which will capture the motion and send Email and SMS to the assigned system. Alam et.al. in [9], proposed an IoT layer architecture and its frameworks. The system focuses on security reasons and their challenges. Kai et.al. in [12] have discussed about IoT in WBAN networks and integration with smart home and smart hospital. The system is integrated with patient's body and tracks the patient's conditions stage by stage to easily identify the patient's wellness .The system will help health care department to easily and effectively monitor the patient conditions.

3 AUTOMATION USING IOT

Even though agriculture is the main source of income for a vast majority of people in our country, there are many problems which are faced by the farmers on a daily basis leading to bad crop and eventually bad turnover for these people. A few of these problems can be observed in Fig 1.

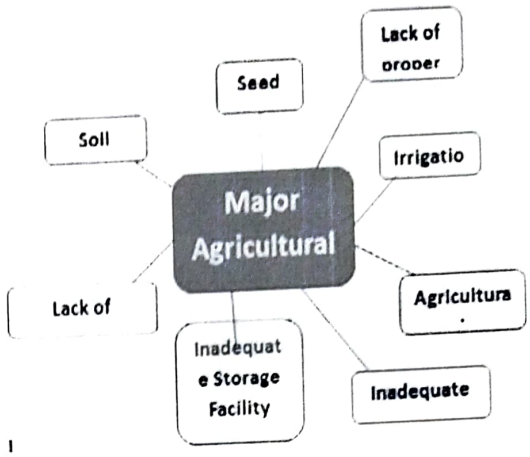

Fig 1: Major Agricultural Problems in India

These problems are often not catered to in the best way possible and hence they result in bad farming practices. There is an immediate need for awareness amongst the farmers and also the Government to make proper use of technology available to them and reduce the risks associated with the various farming activities.

Hence, there is a now a need for "Intelligent agriculture". As visible in the following figure 2, agriculture system can be made

intelligent by deploying some modules for different purposes. An intelligent agriculture system first deploys a platform where the production of crops is maximized, along with an expert service providing platform for integrating IoT with farming practices. Finally, an online trading platform is used to advertise market and sell the crops yield at adequate prices leading to high profits for them.

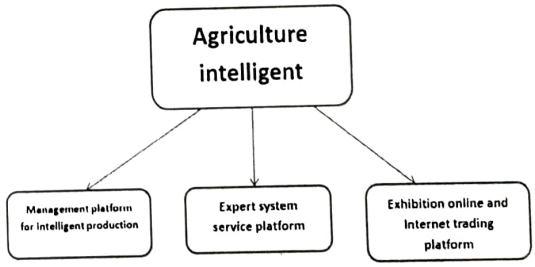

Fig 2: The modules of an agriculture intelligent system

A lot of research and development has been done in the field of IoT to convert agricultural practices "smart" [1]. The Internet of Things (IOT) applications in this sector have brought in many positive changes.

Although there are various challenges like high cost of investment, lack of awareness by farmers, limitations of land, improper use of fertilizers, low production and productivity, lack of proper storage knowledge, limited quality of seeds etc. These challenges can be handled by IoT in a simple and effective manner, helping the farmers on a large scale. By using IoT here, various issues like water and land shortage, storage management, soil prediction etc. can be effectively solved. This new innovation helps to tackle all the above issues and also increases the quantity, quality, cost effectiveness, food safety and sustainability of agricultural production.

Precision agriculture deploys IoT practices in the field of farming in order to ensure optimum growth, health and sustainability. There are many ways in which IoT could be deployed in this field, some of which can be:

1. Soil prediction

In the older farming methods, soil was planted following the traditional approach of selection and sowing. Not choosing the appropriate soil for the intended crops and the actual weather conditions, leads to bad crop growth and losses in the turnover eventually. IoT can greatly help in predicting the soil by studying the climate of growth and the kind of crops required on the field. Data collected over a period of time can be accessed from over the cloud and used to predict what kind of soil would lead to maximum crop growth in the region.

2. Weather monitoring

Climate is a crucial aspect for agricultural crop growth and so there is a need to keep track of the surrounding weather conditions, according to which the soil, water level and crop types can be updated without relying on the imprecise meteorology predictions or manually checking the field for rains. Smart agriculture deploys various sensors across the farmer's field to collect data from the environment and stores it over a cloud. This data can then be used to study the weather conditions and select appropriate crops, soil and irrigation needs of the farm.

3. Greenhouse monitoring

Since Greenhouse monitoring requires manual intervention for keeping track of the irrigation process, temperature, light and humidity, IoT technology could be deployed for automating majority of this process [16]. Such a system can monitor the greenhouse atmosphere and alter the surrounding conditions accordingly, to form an automated greenhouse environment for the crops. The Greenhouse can be segregated into multiple areas that are managed through a base station. Sensor nodes are placed in these measurement areas to collect relevant information, which is then passed onto the controlling sensors to control or change the in house environment parameters.

4. Livestock monitoring

Monitoring the hundreds of livestock on a farm can be a tedious process with keeping track of their location as well as looking out for any health issues. This process is an important function to be taken care of, in order to carry out the proper management and growth of farming itself. Sensors can be attached to the livestock to track their location, grazing patterns, bodily functions etc, which are then sent over to the cloud, from where the farmers can monitor and take appropriate steps to maintain their animals.

5. Smart tractors

Smart farming is evolving to use more Artificial Intelligent hardware for agricultural purposes. The tractors on a farm are important for carrying out various tasks on the field based on the kind of equipment used. AI powered tractors can highly reduce the manual labour involved with farming by introducing driverless tractors involving minimum human intervention. Inclusion of technologies like GPS, camera and IoT connectivity would enable these machines to be autonomous to a large extent and diminish active human control required.

6. Drones

Surveillance of the farm field is one of the most valuable information for precision programme. Any kind of problems can be detected early and taken care of, before they lead to more serious issues. But the traditional approach using helicopters etc. does not guarantee accurate data collection across very large fields and hence smart farming uses drones – unmanned aerial devices, with sensors and inbuilt digital cameras, giving the farmers a better view and more accurate representation of their fields. These drones can be used at on-demand basis and are easy to use and deploy providing real time data with low investment. They are also a safe and reliable solution to farm management.

All these applications can develop a Smart agriculture system by automating these activities being carried out on a daily basis by the farmers.

4. PROPOSED SOLUTION

In our proposed system, we are going to sense the agricultural parameters remotely and then control the system to perform various activities by maintaining co2, soil moisture, light and temperature with the help of sensors. As a result, we are going to increase the yield of organic farming.

For example, in order to perform Smart irrigation, the first step will be to initialize the co2, soil moisture, temperature and light sensors. Then we shall set the threshold value individually for each type of sensors. The sensors will monitor the atmospheric conditions and the values thus obtained shall be compared with the threshold value internally. If the sensed value is less than the threshold value, the motor will be set to 'off' automatically, without any human interruption since the soil humidity value is correct for the plant. If the sensed value is high as compared to the threshold value, then the motor is set to 'on' and the plant is watered automatically without human interruption. This methodology is depicted in Fig 3. Hence, the soil is kept at an adequate moisture level always and the yield of the plant is increased.

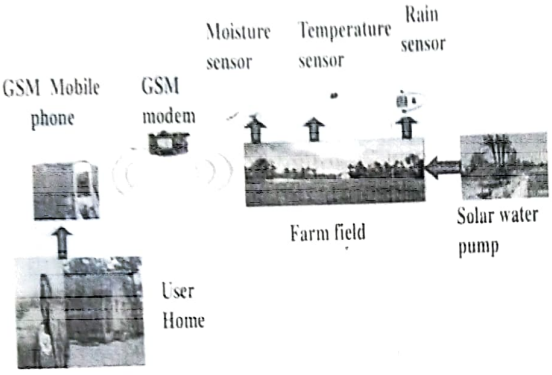

Fig 3: E farming irrigation system using IoT

In our framework, observing and controlling the agricultural field will be done through various sensors, like soil dampness sensor, PIR sensor, pH sensor and water stream sensor (Fig 4). Here the data is transmitted through the Internet which is prepared by PIC16877 Microcontroller. These sensors will monitor the field every day and update the status automatically to the farmers.

The working of this proposed system is as follows:

1. The system consists of soil moisture detecting sensor which senses and measures the moisture level in the soil.
2. The PIR sensor determines the structures with high recurrence formation.
3. The ph sensor and water stream sensor is utilized to streamline the manure utilization.
4. The information of the water level will be updated through the water siphon which is turned on at the field.

5G network will be defined with slicing IoT network technology with quality, speed and storage in developing service. Apart from that, radio/access level carriers must work to reduce device cost, energy consumption and increased reliability, coverage and spectrum efficiency. This is the key point that can implement the system in the entire field. Since costing will be low we can easily implement the system in entire field and the system can update the details on the go in the field. This intelligent system tells about a field whether it is ready to harvest or not since the system is equipped with sensors which will monitor the field every day and update the status. The system has been integrated with a modem which can also be integrated with the output device.

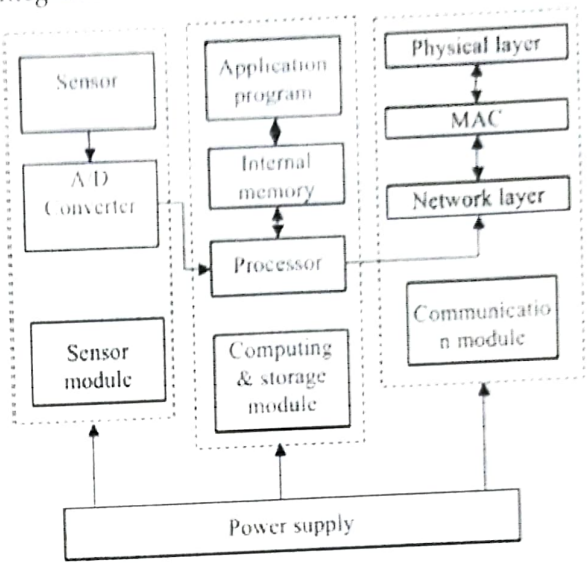

Fig 4: Structure of sensor nodes

Although, IOT is the emerging technology in the developing world but the security of the devices is still questionable. We also need to deploy a new technology that provides high security from any kind of security attack. In our system, we shall implement an advanced 'wheat stone' algorithm to encrypt the data sensed from the devices which is then stored on the cloud. The key is shared with the receiver so that the receiver can decrypt the sensed data from the cloud but no third party can intercept the data on the cloud storage system. The proposed system is thus made safer when compared to the existing system.

5. CONCLUSION

The importance of agriculture in a developing nation, like India, is high and incorporating the concepts of Internet of Things in this field can result in increase of agricultural yield to a large extent. Smart farming solutions like soil moisture monitoring can ease the problems faced by farmers in the current manual setup. We have proposed a Smart solution for agriculture which shall monitor and control the

various atmospheric conditions and then transfer this data through microcontrollers to the farmers. This data shall also be stored on the cloud in encrypted form to avoid any security threats. Although there are limitations of cost, resources, knowledge and technicalities in putting up these concepts in practice, the overall benefits and ease of work for the farmers shall result in high yields and hence deployment of IoT in farming should be done in the majority of regions in our country. The Government needs to encourage farmers and provide loans to utilize these solutions since unless the real time proof for smart agriculture is not made available, farmers shall not be ready to invest in huge amounts for this system.

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7

Advances in Carbon Nanomaterial-Based Green Nanocomposites

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Abstract

Nanotechnology is one of the most remarkable scientific and industrial developments of the twenty-first century. But, many of the currently involved materials and processes in these techniques requires non-renewable resources which creates hazardous wastes. Thus, there is an urgent need of processes involving the combination of green chemistry with nanotechnology. Recently, green nanocomposites have been utilized in industrial applications due to their biodegradability, renewability, and their low cost. Carbon nanomaterials possess unique characteristics, such as remarkable electrical conductivity, large surface area, excellent mechanical strength etc. Thus, these materials pose a great potential for application in various environmental fields. The present article describes green and efficient carbon nanomaterial-based nanocomposites for diverse applications.

Keywords: Nanotechnology, green nanocomposites, carbon-based nanomaterials

7.1 Introduction

Nanocomposites (NCs) are materials which are prepared by the incorporation of nanoparticles into a matrix of standard materials in which properties of both can be used for the synthesis of materials having good mechanical strength, thermal, and chemical properties [1]. Green NCs are widely researched for the preparation of ecofriendly products with

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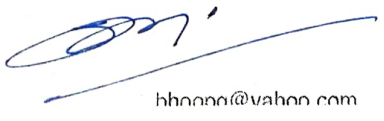

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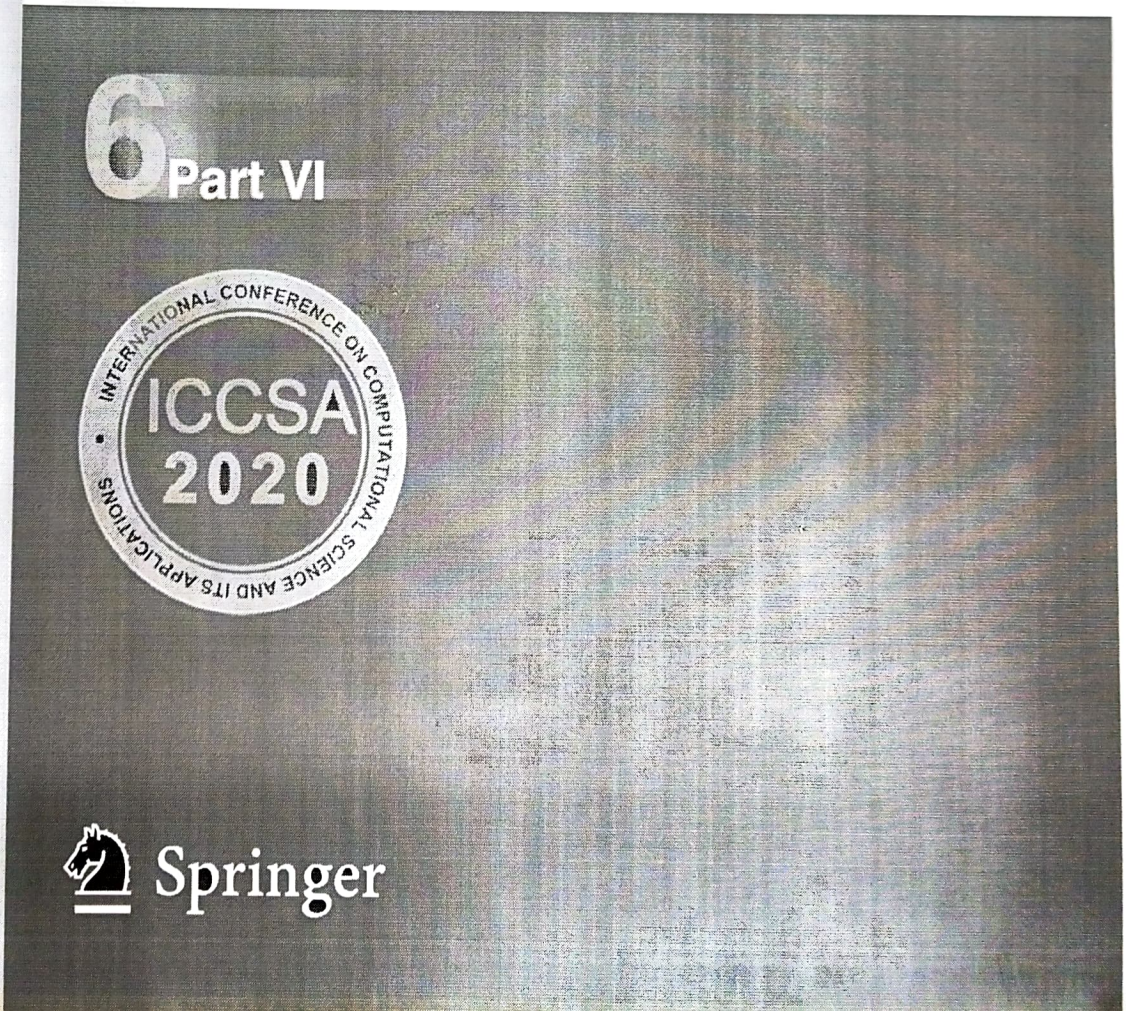

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Contents – Part VI

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Entropy Based Machine Learning Models for Software Bug Severity Assessment in Cross Project Context

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Abstract. There can be noise and uncertainty in the bug reports data as the bugs are reported by a heterogeneous group of users working across different countries. Bug description is an essential attribute that helps to predict other bug attributes, such as severity, priority, and time fixes. We need to consider the noise and confusion present in the text of the bug report, as it can impact the output of different machine learning techniques. Shannon entropy has been used in this paper to calculate summary uncertainty about the bug. Bug severity attribute tells about the type of impact the bug has on the functionality of the software. Correct bug severity estimation allows scheduling and repair bugs and hence help in resource and effort utilization. To predict the severity of the bug we need software project historical data to train the classifier. These training data are not always available in particular for new software projects. The solution which is called cross project prediction is to use the training data from other projects. Using bug priority, summary weight and summary entropy, we have proposed cross project bug severity assessment models. Results for proposed summary entropy based approach for bug severity prediction in cross project context show improved performance of the Accuracy and F-measure up to 70.23% and 93.72% respectively across all the machine learning techniques over existing work.

1 Introduction

In software development life cycle, bug reporting and fixing is a continuous and iterative activity [1]. A large number of bugs are reported on bug tracking systems by different users, developers and staff members located at different geographical locations in a distributed environment. Bug severity is one of the most important bug attributes which tells about its extent of impact on the functionality of the software. Bug severity is labeled in seven classes from 1 to 7, namely "Blocker", "Critical", "Major", "Normal", "Minor", "Trivial" and "Enhancement". The automated bug severity prediction is useful in resource allocation and bug fix scheduling. It also assists the priority assignment for the bug. Bug severity prediction needs training data, i.e. the history of

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the software to train the classifier. But it is not easy to get such data always as some projects may be new with very less of no history of bug data. In such situation, we can use history of bug data from other software projects for training purpose [2, 4–6]. Bugs are reported by users with different levels of understanding and knowledge about the software working which may result in noise and uncertainty in different bug attributes entered. This noise and uncertainty present in training data may degrade the performance of automated bug severity assessment and hence need to be considered during prediction process. Bug summary attribute (the brief description of the bug) has been used for bug severity prediction in this paper. No attempt has been made in literature to consider uncertainty in bug summary in cross project context for bug severity prediction. The contribution of this paper is cross project severity prediction models based on summary entropy in addition to priority and summary weight using "k-Nearest Neighbors (k-NN)", "Support Vector Machine (SVM)", and "Naïve Bayes (NB)". The proposed models result in improved performance when compared with summary based cross project bug severity assessment models [6].

The remaining paper is structured as follows: Sect. 2 describes the review of related work. Section 3 contains the brief of bug reports and its pre-processing. Section 4 deals with data collection and model building required to perform the analysis. Results have been documented in Sect. 5. The conclusion of the paper has given in Sect. 6.

2 Related Work

Bug severity prediction helps in assigning bug priority, fix time prediction and resources allocation. Many bug summary based severity assessment models have been proposed in literature [7–12]. Different authors compared the performance of different machine learning techniques for bug severity assessment [19–21].

An attempt has been made to propose bug summary based cross project severity prediction models using "SVM", "NB" and "k-NN" [6]. Authors also identified the best training candidates for a project. Bug summary based cross project priority prediction models have been proposed by [2, 4] using "SVM", "NB", "k-NN" and "NNET".

Entropy based measure has been used to predict the bugs lying dormant in the software [14, 15]. Recently entropy based measures have been used to handle the uncertainty during the prediction of priority and severity of the reported bug [3, 13].

To our knowledge, no work has been done for considering the uncertainty and noise present in bug summary data that can affect the performance of prediction models in cross project context. In this paper, we have measured the uncertainty in bug summary by using entropy based measures for cross project severity prediction. In addition to summary entropy, we have considered bug priority and summary weight to assess bug severity in cross project context. We have compared our proposed summary entropy based cross project bug severity assessment models with [6] and found improvement in the performance of the classifiers.

3 Bug Reports and Pre-processing

A bug report contains the information about bug in the form of different attributes reported by the users and the developers use this information to fix the bug. In this section we have discussed different bug attributes and two derived attributes summary weight and summary entropy used in bug severity prediction.

We have taken bug priority and two derived bug attributes: summary weight [4] and summary entropy to predict severity in cross project context.

Bug priority and severity are categorical attributes, whereas summary weight and summary entropy are continuous attributes. Bug priority determines the importance of a bug in the presence of others. Bugs are prioritized by P1 level, i.e. the most important to P5 level, i.e. the least important.

Bug severity tells about the extent of bug's impact on software functionality. Eclipse project define the seven levels of severity, namely "Blocker", "Critical", "Major", "Normal", "Minor", "Trivial" and "Enhancement". Throughout this analysis, we have not included bugs with "Normal" and "Enhancement" severity levels because "Normal" is the default standard stated in the reports submitted, and "Enhancement" does not reflect actual bug reports. The severity weights and levels as mentioned in Table 1 (IEEE std 92, 1989) have been defined by IEEE Standard Classification Levels [16]. "Blocker" and "Critical" are most severe severity levels, "Major" is medium severity level and "Minor", "Trivial" are minor severity levels.

Table 1. Severity levels categories [16]

From the IEEE Standard Severity Classification Levels	Severity Weight	Severity Level
Blocker, Critical	10	Most Severe
Major	3	Medium
Minor, Trivial	1	Minor

Summary weight attribute is extracted from the bug summary provided by the numerous users. We pre-processed the bug summary in RapidMiner tool [18] to compute the summary weight of a reported bug, with the steps of text mining: "Tokenization", "Stop Word Removal", "Stemming to base stem", "Feature Reduction" and "Info Gain" [6].

We assume that the bug reports, i.e. different bug attributes, reported in software bug repositories are trustworthy during bug triaging process. In reality, the bug reports data is not trustworthy in terms of various aspects like integrity, authenticity and trusted origin as the bugs are reported by users who may or may not have proper knowledge of the software. It may result in uncertainty in reported bug data. Without proper handling of these uncertainties in different bug attributes, the performance of learning strategies used for different bug attributes prediction can be significantly reduced.

The validation of cross project is a key concern in empirical software engineering where we train the classifiers with historical data of projects other than the testing projects. In literature, researchers have made attempts for cross project bug summary based severity assessment [6]. But no attempt has been made to handle uncertainty in bug summary in cross project context for bug severity assessment.

We have proposed summary entropy based measure to build the classifier for bug severity prediction to handle uncertainty in cross project context. We have calculated the summary entropy for model building using Shannon's entropy [17]. Shannon's entropy, S is defined as:

$$S = -p_i \log_2 p_i$$

In the case of summary entropy, p is calculated as:

$$p_i = \frac{total\ number\ of\ occurences\ of\ terms\ in\ i^{th}\ bug\ report}{total\ number\ of\ terms}$$

To rationalize the effect of the severity, we multiplied entropy with 10 for "Blocker" and "Critical" severity level bugs, 3 for "Major" severity level bugs and 1 for "Minor" and "Trivial" severity level bugs as given in Table 1 [16].

The cross project bug severity model has been shown in Fig. 1.

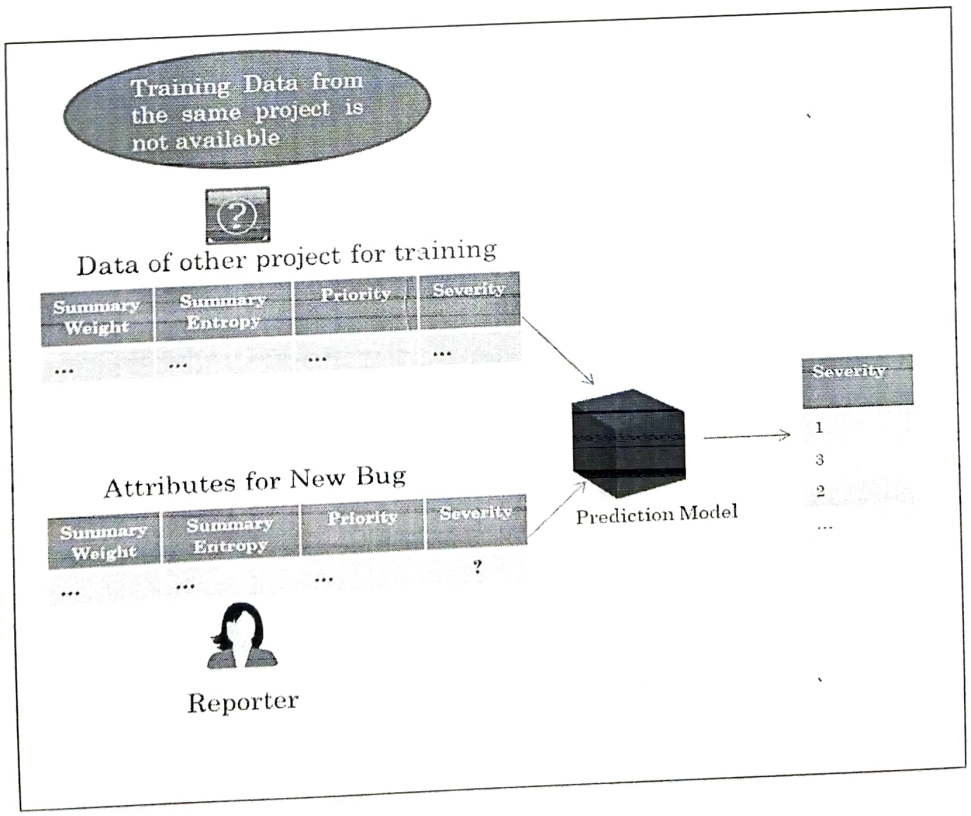

Fig. 1. Cross project bug severity prediction

4 Methodology

In this section, we briefly described the data collection and model building for summary entropy based cross project bug severity assessment.

4.1 Data Collection

The empirical validation has been conducted on different products, namely "CDTDebug (CD)", "EclipseDebug (Deb)", "EclipseJDTUI (TUI)", "EclipseSWT (SWT)", "EclipseUI (UI)", "IDEPlatform (IDE)", and "JDTUI (TUI2)" of Eclipse project (http://bugs.eclipse.org/bugs/) to assess cross project bug severity. Table 2 shows the severity level wise number of bug reports across different products.

Table 2. Severity wise Bug Reports in Eclipse Projects [6]

Projects	1 (Blocker)	2 (Critical)	3 (Major)	4 (Minor)	5 (Trivial)	Total
CD	25	25	122	53	8	233
Deb	23	97	213	72	39	444
TUI	23	81	282	281	81	748
SWT	71	161	298	64	36	630
UI	28	124	401	327	109	989
IDE	23	75	267	148	85	598
TUI2	1	24	118	204	56	403

4.2 Model Building and Experimental Setup

We have developed summary entropy based models using different classifiers, namely "k-NN", "SVM" and "NB" for cross project bug severity assessment by taking priority and summary weight. The empirical evaluation has been validated on 7 products of the Eclipse project. Number of cross fold validations is taken as 10 with stratified sampling for different classification techniques. We have validated our proposed approach and compared it with state of art [6] using performance measures, namely Accuracy and F-measure.

The experimental setup of severity prediction in cross project context developed in RapidMiner tool [18] has been shown in Fig. 2.

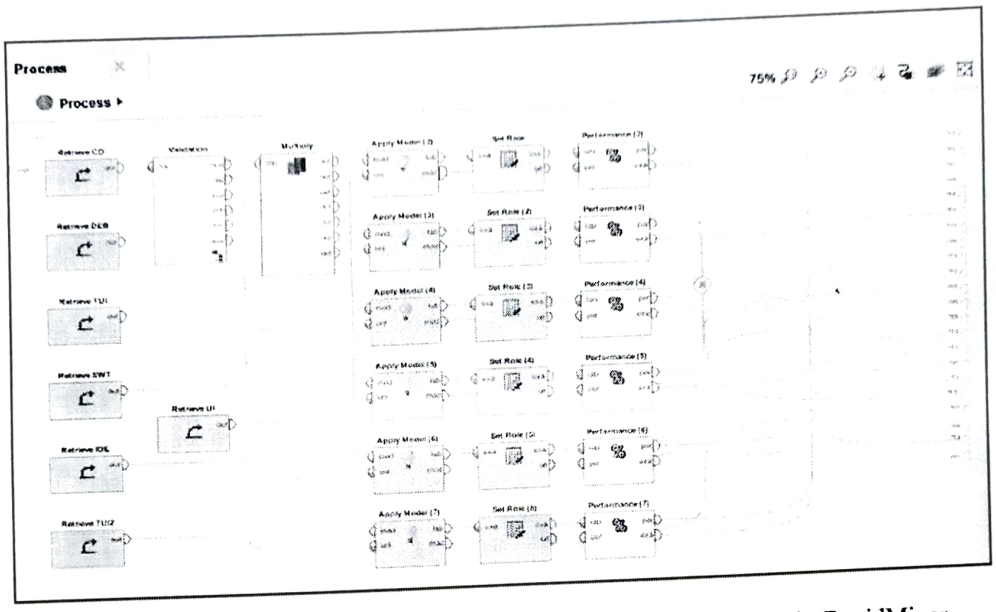

Fig. 2. Experimental Setup for Cross project bug severity prediction in RapidMiner

The parameter values used for tuning the classifier parameters, namely "k-Nearest Neighbor (k-NN)", "Support Vector Machine (SVM)" and "Naïve Bayes (NB)" have been shown in Table 3.

Table 3. Parameters Optimized for different Classifiers

Classifier	Parameters
NB	laplace_correction
k-NN	k
SVM	C (cost)
	G (gamma)

Using "Optimize Parameters (Grid)" operator in the RapidMiner tool, we obtained optimal parameter values. Table 4 shows the parameters optimized for each classifier.

Table 4. Optimal Parameter Values for Eclipse products

Eclipse products	NB	k-NN	SVM	
	laplace_correction	k	C	G
CD	False	8	1	1
Deb	False	8	1	1
TUI	False	13	3	3
SWT	True	2	2	2
UI	True	6	4	4
IDE	True	20	1	1
TUI2	True	4	3	3

5 Results and Discussion

We have proposed summary entropy based models using different classifiers, namely, "k-Nearest Neighbors (k-NN)", "Support Vector Machine (SVM)" and "Naive Bayes (NB)" for cross project bug severity prediction. We have compared the proposed entropy based approach with Singh et al. [6]. We have taken the same datasets and techniques as taken by the authors in [6] to predict bug severity. Singh et al. [6] considered the F-measure performance of different classifiers only for "Major" severity class, since fewer bug reports for other severity class than the "Major" severity class. This results in low performance for these severity classes. In order to compare with state of art literature [6] we have also considered the F-measure performance for "Major" severity class. Tables 5, 6 and 7 show the F-measure performance for "Major" severity class for different classifiers, namely "k-NN", "SVM" and "NB" respectively. Tables 8, 9 and 10 show the Accuracy of different classifiers, namely "k-NN", "SVM" and "NB" for different testing projects. Across Tables 5, 6, 7, 8, 9 and 10 '–' indicates that no analysis was performed on this particular combination of testing and training dataset, since the training and testing data sets are similar.

Table 5. k-NN F-measure (%) for "Major" severity class

Training Projects	Testing Projects						
	CD	Deb	TUI	SWT	UI	IDE	TUI2
CD	–	93.63	55.65	51.54	49.00	77.15	69.70
Deb	96.27	–	49.39	33.10	33.33	64.45	89.06
TUI	91.21	89.54	–	88.16	91.20	93.72	71.67
SWT	61.87	53.69	86.21	–	90.25	91.04	31.40
UI	64.19	58.94	95.04	96.71	–	95.72	38.57
IDE	96.77	90.00	88.56	87.97	86.90	–	62.88
TUI2	91.27	97.25	54.88	27.71	40.95	58.71	–

Table 6. SVM F-measure (%) for "Major" severity class

Training Projects	Testing Projects						
	CD	Deb	TUI	SWT	UI	IDE	TUI2
CD	–	90.64	58.29	54.95	53.38	80.07	62.03
Deb	95.90	–	54.54	36.43	35.09	65.71	96.27
TUI	66.97	65.84	–	96.08	95.45	96.45	52.50
SWT	58.62	50.64	89.71	–	90.51	89.73	33.07
UI	43.86	23.26	97.39	98.50	–	97.21	22.94
IDE	87.60	84.34	91.79	94.35	90.73	–	57.30
TUI2	96.69	98.84	59.52	39.45	39.57	69.74	–

Table 7. NB F-measure (%) for "Major" severity class

Training Projects	Testing Projects						
	CD	Deb	TUI	SWT	UI	IDE	TUI2
CD	–	95.57	73.18	51.49	62.23	77.61	69.70
Deb	94.87	–	87.38	69.87	77.53	88.11	92.51
TUI	56.08	80.57	–	89.08	92.70	92.65	66.66
SWT	39.64	51.09	76.01	–	83.61	73.57	43.27
UI	41.32	67.15	95.43	92.77	–	89.34	50.42
IDE	71.43	89.04	96.27	85.90	91.63	–	77.39
TUI2	88.51	96.08	84.29	63.65	78.43	89.65	–

Table 8. k-NN accuracy (%) for different testing candidates

Training projects	Testing projects						
	CD	Deb	TUI	SWT	UI	IDE	TUI2
CD	–	68.24	57.35	39.37	51.16	62.04	63.52
Deb	80.69	–	50.27	31.11	37.92	54.85	80.89
TUI	76.82	76.58	–	72.70	78.97	77.42	64.52
SWT	46.78	49.32	73.26	–	76.95	74.58	27.05
UI	53.65	51.58	82.62	80.32	–	79.10	33.75
IDE	78.97	78.15	78.61	73.65	76.44	–	61.04
TUI2	72.53	82.43	54.14	24.44	45.20	50.84	–

Table 9. SVM accuracy (%) for different testing candidates

Training projects	Testing projects						
	CD	Deb	TUI	SWT	UI	IDE	TUI2
CD	–	67.34	58.56	42.54	53.49	65.22	55.33
Deb	81.55	–	58.69	34.44	47.02	56.86	83.37
TUI	57.94	56.98	–	78.57	81.70	78.76	50.12
SWT	46.78	47.52	80.08	–	80.08	76.25	33.75
UI	39.91	25.45	83.16	81.59	–	79.93	21.59
IDE	69.96	73.20	80.61	79.05	78.67	–	55.83
TUI2	73.39	83.78	55.35	38.73	45.40	61.20	–

Table 10. NB accuracy (%) for different testing candidates

Training projects	Testing projects						
	CD	Deb	TUI	SWT	UI	IDE	TUI2
CD	–	70.43	66.22	41.49	58.70	62.41	65.25
Deb	80.26	–	76.34	57.94	68.86	71.24	81.89
TUI	45.49	69.82	–	73.81	80.79	75.92	66.00
SWT	31.33	47.75	67.78	–	74.52	61.37	40.69
UI	33.05	57.66	82.22	77.46	–	76.42	49.63
IDE	55.79	77.48	81.15	72.06	79.17	–	72.95
TUI2	66.09	82.43	69.12	53.33	64.41	75.59	–

We have designed 7 cases for 7 training projects given below.

Case 1: F-measure of Major Severity Level and Accuracy improvement over Singh et al. (2017) for training project CD

The proposed approach improved the F-measure performance by 29.73%, 1.98%, 15.56% and 25.16% for testing projects "Deb", "TUI", "IDE" and "TUI2" respectively for KNN classifier. For SVM the F-measure performance improved by 20.70%, 2.70%, 12.26% and 62.03% for testing projects "Deb", "TUI", "IDE" and "TUI2" respectively. For testing projects "Deb", "TUI", "SWT", "UI", "IDE" and "TUI2", the F-measure performance improve by 62.24%, 64.29%, 35.16%, 52.01%, 64.47% and 25.16% respectively for NB classifier.

The entropy based proposed approach improved the Accuracy performance by 20.94%, 20.45%, 11.12%, 17.56% and 33% for testing projects "Deb", "TUI", "UI", "IDE" and "TUI2" respectively for KNN classifier. For SVM the Accuracy performance improved by 19.37%, 21.13%, 13.05%, 20.57% and 26.3% for testing projects "Deb", "TUI", "UI", "IDE" and "TUI2" respectively. For testing projects "Deb", "TUI", "SWT", "UI", "IDE" and "TUI2", the F-measure performance improved by 46.78%, 50.04%, 25.93%, 39.89%, 45.35% and 46.64% respectively for NB classifier.

Case 2: F-measure of Major Severity Level and Accuracy improvement over Singh et al. (2017) for training project Deb

In case of KNN and SVM classifiers, F-measure performance improved by 34.27%, 3.60%, 44.21% and 30.97%, 1.44%, 93.59% for testing projects "CD", "IDE" and "TUI2" respectively. Our approach improved the F-measure performance by 60.62%, 81.49%, 60.63%, 68.18%, 83% and 82.20% for testing projects "CD", "TUI", "SWT", "UI", "IDE" and "TUI2" respectively for NB classifier.

The proposed approach improved the Accuracy performance by 37.34%, 13.24%, 10.54% and 53.35% for testing projects "CD", "TUI", "IDE" and "TUI2" respectively for KNN classifier. For SVM the Accuracy performance improved by 28.33%, 21.93%, 6.58%, 12.21% and 55.08% for testing projects "CD", "TUI", "UI", "IDE" and "TUI2" respectively. For testing projects "CD", "TUI", "SWT", "UI", "IDE" and "TUI2", the Accuracy performance improved by 59.23%, 65.78%, 42.38%, 56.32%, 60.37% and 70.23% respectively for NB classifier.

Case 3: F-measure of Major Severity Level and Accuracy improvement over Singh et al. (2017) for training project TUI

In case of KNN and SVM classifiers, the proposed approach improved the F-measure performance by 25.64%, 24.93%, 29.41%, 30.64%, 93.72%, 28.29% and 12.39%, 12.01%, 41.82%, 42.43%, 42.83%, 49.81% for testing projects "CD", "Deb", "SWT", "UI", "IDE" and "TUI2" respectively. For testing projects "CD", "Deb", "SWT", "UI", "IDE" and "TUI2", the F-measure performance improved by 35.03%, 67.71%, 80.08%, 86.44%, 83.50% and 51.65% respectively for NB classifier.

The entropy based proposed approach improved the Accuracy performance by 28.32%, 30.41%, 31.59%, 26.49%, 37.62% and 4.22% for testing projects "CD", "Deb", "SWT", "UI", "IDE" and "TUI2" respectively for KNN classifier. For SVM the Accuracy performance improved by 21.03%, 17.57%, 37.62%, 39.74%, 37.62 and 13.15% for testing projects "CD", "Deb", "SWT", "UI", "IDE" and "TUI2" respectively. For testing projects "CD", "Deb", "SWT", "UI", "IDE" and "TUI2", the Accuracy performance improved by 33.04%, 57.43%, 59.68%, 67.95%, 65.22% and 47.14% respectively for NB classifier.

Case 4: F-measure of Major Severity Level and Accuracy improvement over Singh et al. (2017) for training project SWT

We observed that the F-measure performance of our approach has improved by 34.05%, 36.03% and 70.76% for testing projects "TUI", "UI" and "IDE" respectively in case of KNN classifier. In case of SVM, the F-measure performance improved by 28.99%, 28.33%, 25.33% and 32.41% for testing projects "TUI", "UI", "IDE" and "TUI2" respectively. For testing projects "CD", "Deb", "TUI", "UI", "IDE" and "TUI2", the F-measure performance improved by 18.39%, 38.41%, 69.26%, 76.40%, 61.45% and 27.67% respectively for NB classifier.

In case of KNN classifier, our approach improved the Accuracy performance by 1.29%, 7.2%, 38.23%, 39.94%, 34.11% and 0.5% for testing projects "CD", "Deb", "TUI", "UI", "IDE" and "TUI2 respectively. In case of Accuracy values of SVM classifier, our approach improved by 43.05%, 40.04%, 31.06% and 4.72% for testing projects "TUI", "UI", "IDE" and "TUI2" respectively. In case of NB classifier, for testing projects "CD", "Deb", "TUI", "UI", "IDE" and "TUI2", the Accuracy performance improved by 16.74%, 38.29%, 55.35%, 61.68%, 47.49% and 28.53% respectively.

Case 5: F-measure of Major Severity Level and Accuracy improvement over Singh et al. (2017) for training project UI

The proposed approach improved the F-measure performance by 34.25%, 35.41% and 39.41% for testing projects "TUI", "SWT" and "IDE" respectively for KNN classifier. For SVM the F-measure performance improved by 43.52%, 41.21 and 39.82% testing projects "TUI", "SWT" and "IDE" respectively. For testing projects "CD", "Deb", "TUI", "SWT", "IDE" and "TUI2", the F-measure performance improved by 19.18%, 49.22%, 89.42%, 79.73%, 79.94% and 30.30% respectively for NB classifier.

The entropy based proposed approach improved the Accuracy performance by 2.15%, 5.18%, 29.28%, 36.99%, and 35.96% for testing projects "CD", "Deb", "TUI", "SWT" and "IDE" respectively for KNN classifier. For SVM the Accuracy performance improved by 46.26%, 37.15% and 36.45% for testing projects "TUI", "SWT"

and "IDE" respectively. For testing projects "CD", "Deb", "TUI", "SWT", "IDE" and "TUI2", the F-measure performance improved by 20.6%, 43.7%, 68.05%, 66.03%, 64.38% and 35.49% respectively for NB classifier.

Case 6: F-measure of Major Severity Level and Accuracy improvement over Singh et al. (2017) for training project IDE

In case of KNN, F-measure performance improved by 33.85%, 25.89%, 34.95% and 25.98%, 30.19% and 93.59% for testing projects "CD", "Deb", "TUI", "SWT", "UI" and "TUI2" respectively. For SVM, F-measure performance improved by 25.80%, 22.64%, 33.81%, 32.49%, 29.54% and 56.57% for testing projects "CD", "Deb", "TUI", "SWT", "UI" and "TUI2" respectively. The F-measure performance improved by 52.06%, 72.88%, 83.97%, 73.12%, 86.38% and 62.14% for testing projects "CD", "Deb", "TUI", "SWT", "UI" and "TUI2" respectively for NB classifier.

In case of KNN, the Accuracy performance improved by 33.05%, 31.53%, 41.71%, 29.68%, 35.69% and 30.77% for testing projects "CD", "Deb", "TUI", "SWT", "UI" and "TUI2" respectively. For SVM the Accuracy performance improved by 18.89%, 26.58%, 44.38%, 31.75%, 38.53% and 27.05% for testing projects "CD", "Deb", "TUI", "SWT", "UI" and "TUI2" respectively. For testing projects "CD", "Deb", "TUI", "SWT", "UI" and "TUI2", the Accuracy performance improved by 41.2%, 66.44%, 68.05%, 56.98%, 67.44% and 59.05% respectively for NB classifier.

Case 7: F-measure of Major Severity Level and Accuracy improvement over Singh et al. (2017) for training project TUI2

In case of F-measure performance of KNN classifier, our approach improved by 23.90% and 36.35% for testing projects "CD" and "Deb" respectively. In case of SVM, the F-measure performance improved by 51.90%, 54.56%, 22.80% and 66.83% for testing projects "CD", "Deb", "TUI" and "IDE" respectively. For testing projects "CD", "Deb", "TUI", "SWT", "UI" and "IDE", the F-measure performance improved by 70.98%, 82.83%, 71.43%, 47.40%, 71.29% and 78.46% respectively for NB.

The entropy based proposed approach improved the Accuracy performance by 21.89%, 39.86% and 10.87% for testing projects "CD", "Deb" and "IDE" respectively for KNN classifier. For SVM the Accuracy performance improved by 51.07%, 67.56%, 18.18%, 28.73%, 11.83 and 36.45% for testing projects "CD", "Deb", "TUI", "SWT", "UI" and "IDE" respectively. For testing projects "CD", "Deb", "TUI", "SWT", "UI" and "IDE", the F-measure performance improved by 55.36%, 62.16%, 46.53%, 37.46%, 40.04% and 57.53% respectively for NB.

Out of 42 cases, i.e. 7 training datasets * 6 testing datasets, the classifiers "k-NN", "SVM" and "NB" perform better in 27, 30 and 42 cases respectively in terms of F-measure performance for Major severity class in comparison with Singh et al. [6]. For Accuracy comparison the classifiers k-NN, SVM and NB perform better in 35, 35 and 42 cases respectively.

Figures 3, 4 and 5 show the F-measure performance comparison of "k-NN", "SVM" and "NB" techniques for proposed summary entropy based cross project severity prediction with Singh et al. [6].

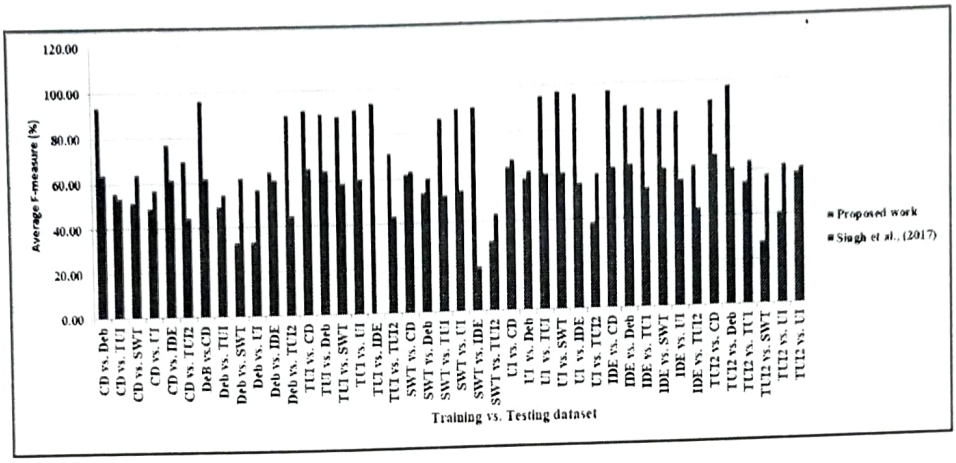

Fig. 3. k-NN F-measure comparison for "Major" severity level

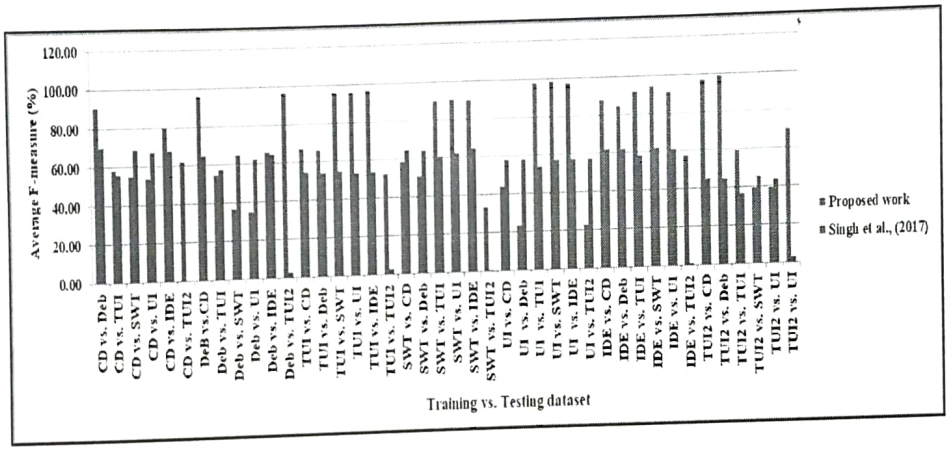

Fig. 4. SVM F-measure comparison for "Major" severity level

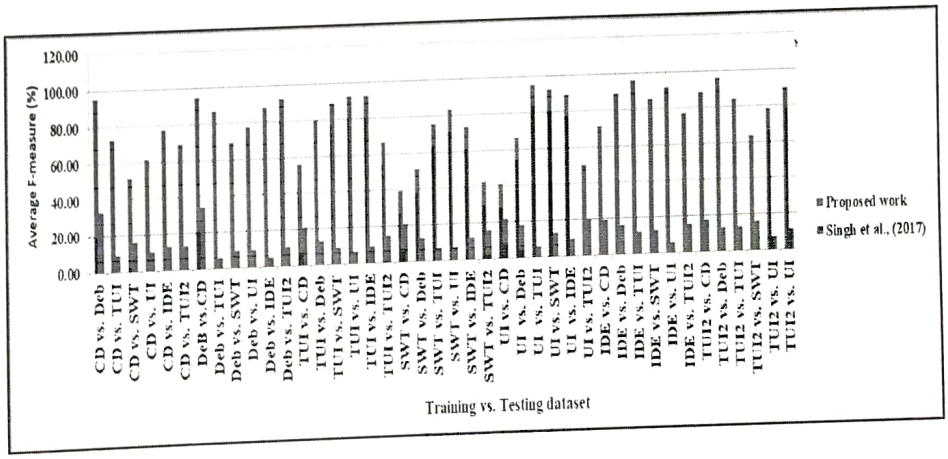

Fig. 5. NB F-measure comparison for "Major" severity level

The Accuracy comparison of the proposed entropy approach with Singh et al. [6] using k-NN, SVM and NB techniques for cross project severity prediction has been shown in Fig. 6, 7 and 8.

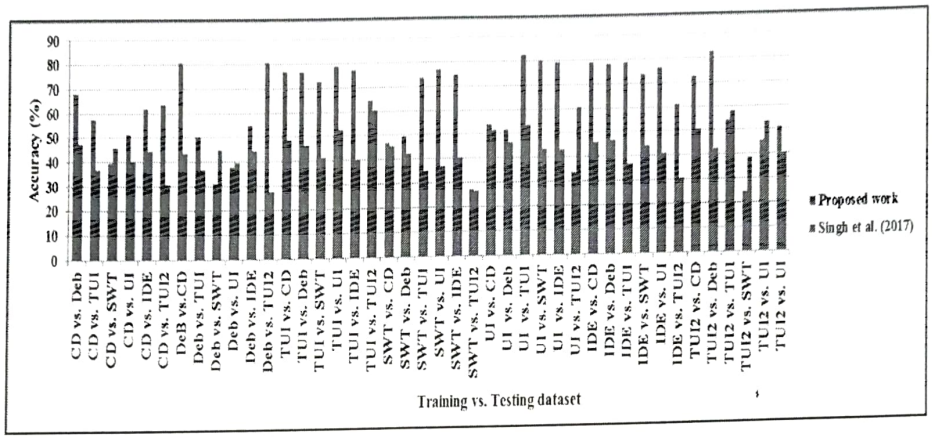

Fig. 6. k-NN accuracy comparison (proposed work vs. Singh et al. (2017))

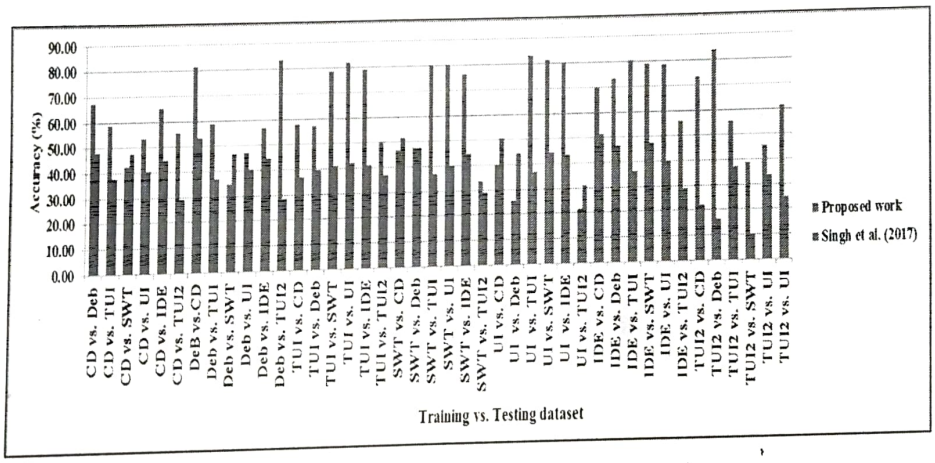

Fig. 7. SVM accuracy comparison (proposed work vs. Singh et al. (2017))

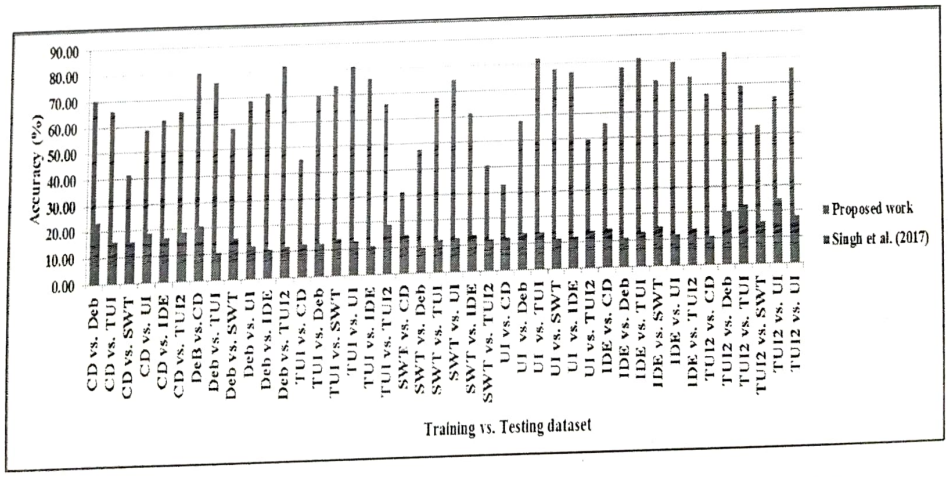

Fig. 8. NB accuracy comparison (proposed work vs. Singh et al. (2017))

6 Conclusion

In this paper, we have proposed an approach using bug priority, summary entropy and summary weight for cross project bug severity prediction. For taking care of uncertainty in bug summary attribute, we have derived an attribute termed as summary entropy using Shannon entropy. Summary weight is also derived by taking the sum of weights of summary terms using information gain criteria. We have used machine learning techniques, namely "k-Nearest Neighbors", "Support Vector Machine" and "Naïve Bayes" to build the classifiers. The empirical evaluation has been validated on seven products of Eclipse project. The built-in classifiers based on these techniques predicted the severity of bug reports in cross project context with significant Accuracy and F-measure. We have also optimized the parameters by using Grid Search. Our proposed approach outperform with the work available in the literature [6]. The proposed approach improved the F-measure for "k-NN", "SVM", "NB", by 1.98% to 93.72%, 1.44% to 93.59% and 18.39% to 89.42% respectively across all the 42 cases for cross project bug severity prediction in comparison with [6]. Our entropy based proposed approach improved the Accuracy from 0.5% to 53.35% for k-NN, 4.72% to 67.56% for SVM and 16.74% to 70.23% for NB across all the 42 cases. NB outperforms for bug severity prediction across all the 42 cases in terms of both F-measure and Accuracy performance. More analysis in the field of summary entropy based metric models may be performed in the future with other projects data. We can measure various forms of entropy and test the built in classifier with more techniques and data sets.

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Contents

Chapter 20
Predicting the Fix Time of a Reported Bug using Radoop: A Big Data Approach

Madhu Kumari, Meera Sharma, Sameer Anand, and V. B. Singh

20.1 Introduction

When it comes to big data, it is clear that the data is produced at an astronomical rate. In fact, 90% of the world's data were created in the last two years. The term "Big Data" can be defined as data that becomes too large to be processed using traditional methods. The volume of data that can be considered as large data is constantly changing, and new tools are continually being developed to deal with this massive data. It completely changes our world and shows no signs of transit that will disappear at any time in the near future. To understand this vast amount of data, it is often defined by five V's: Velocity, Volume, Value, Variety, and Veracity.

Velocity is the speed at which large amount of data is generated, collected, and analyzed. Every day, emails, twitter messages, photos, and videos are increasing around the world at lightning speed. Data is increased every second of a day. Big data technology now allows us to analyze data as it is generated without having to put it into the database. A large number of bug reports are reported on different bug tracking systems at a higher speed. From different geographical locations, researchers collected and analyzed this big data of bug reports.

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Volume refers to the large amount of data that is generated each second from social media, mobile phones, cars, credit cards, photos, videos, etc. In fact, such data have become so big that we cannot store and analyze it using traditional database technologies. Facebook has 10 billion messages, clicked the "Like" button for 4.5 billion times, and uploaded more than 350 million new images every day. It is clear that the collection and analysis of such data is a huge engineering challenge. A large number of bug reports are reported on different bug tracking systems every day.

Value refers to the worth of the data being extracted. Having endless amounts of data is one thing, but it is useless unless it can be converted into value. Although there is a clear correlation between data and ideas, this does not always mean having value in big data. The most important part of the development of the big data plan is to understand the costs and benefits of data collection and analysis to ensure that the resulting data can be monetized. The bug reports data has the value of being extracted and analyzed for different bug attributes prediction [9–14] and bug fix time prediction [1–4, 7, 8].

Variety is defined as the different types of data we can use. Today's data is very different from previous data. We no longer only have structured data (names, phone numbers, addresses, financial statements, etc.), which is great for spreadsheets. Today's data are not organized. In fact, 80% of the world's data fall into this category, including images, video sequences, social-network updates, and more. Big data technology now allows the use of structured and unstructured data that is collected, stored, and used simultaneously. Bug reports on bug tracking systems consist of a collection of attributes. Some textual attributes such as patch, summary, and long description are unstructured attributes. Some attributes such as bug-id, platform, cc-list, assignee, operating system, hardware, component, reporter, resolution, product, status, severity, priority [23] are structured attributes. It means that bug reports deal with both types of unstructured and structured attributes.

Veracity denotes uncertainty and distortion in data. The data which is mined should be meaningful for the problem being analyzed. Veracity is the biggest challenge when comparing with volume and velocity. Various bug attributes are filed by the reporter of bugs during bug reporting on bug repository. Based on these attributes different prediction models have been proposed to improve the software quality. During bug reporting high irregular pattern has been observed. Bug repository size increases at a high rate with irregularities and uncertainty.

For bug-related analysis like software quality measurement [16] and development effort coordination in bug triaging [17], bug fix time plays an important role. It assists in software quality improvement. It also assists in resource allocation and release time management. "If bugs in a file take a relatively long time to be fixed, the file may have some structural problems that make it difficult to make changes" [16].

In this paper, we have applied an extension called Radoop to enable the integration of RapidMiner with Hadoop to handle big bug report datasets. We have used Hive-based Naïve Bayes (NB) and Spark-based Decision Tree (DT) machine learning techniques in RapidMiner open source software [6] for bug fix time prediction of a reported bug. The experimental analysis is validated on 1,23,849 bug reports of Eclipse and 67,178 bug reports of Mozilla projects. The results show that Decision

Tree performs better than Naïve Bayes for both the projects in terms of accuracy. The proposed approach shows improved accuracy in comparison with the work mentioned in [20] for fix time prediction.

The rest of the paper has been divided into four sections: Sect. 20.2 discusses description of datasets, bug attributes, and model building. Section 20.3 describes the results and discusses the results. Section 20.4 presents related work. Conclusion and future research directions have been given in Sect. 20.5.

20.2 Data Collection and Model Building

In this section, we have described the data collection and model building.

20.2.1 Data Collection

We have considered seven independent bug attributes, namely, product, component, number of comments, operating system, priority, severity, and hardware. Product, component, operating system, priority, severity, and hardware are nominal attributes, whereas the number of comments is a continuous attribute. The bug attributes have been described in Table 20.1 [15].

We have calculated the time to fix a bug by subtracting bug opened date from last resolved date.

Bug fix time = Last_resolved date − Bug_open date.

"The bugs which are reported by different users are assigned to different developers. The bugs take a reasonable amount of time in fixing" [22]. These bugs are having an open status till they get fixed.

To validate our proposed approach, we have considered datasets of Eclipse [21] and Mozilla [5] open source projects. "We have considered bug reports of resolution 'fixed', 'works for me' and status 'verified', 'resolved' and 'closed'. Only these bug reports contain meaningful and static information" [22]. In this paper, we have taken different independent attributes such as product, component, number of comments, operating system, priority, severity, and hardware to predict bug fix time.

"We observed a large variation in bug fix time, which can affect the results. We have drawn a distribution graph shown in Fig. 20.1 for number of bugs versus fix time and found that the maximum number of bugs is having the fix time of 0-99 days across both the datasets" [22].

We classified the bug fix time in three ranges, i.e., 0–32 days (Bug fix time1), 33–65 days (Bug fix time2), and 66–99 days (Bug fix time3) for our study.

Table 20.2 shows the bug reports of Eclipse and Mozilla projects for the observed time periods.

Table 20.1 Description of different bug attributes

Bug attribute	Short description
Bug-Id	This represents a unique numeric id for the bug
Resolution	This describes what happened to this bug, e.g., fixed, Worksforme, etc.
Status	It determines the current state (New, Verified, Resolved, etc.) of bug
Severity	Severity of a bug gives its impact on the software or its components. It is divided into seven levels: Blocker (1) to Enhancement (7)
Priority	Bug priority determines the importance of a bug in the presence of others. It ranges from P1 (most important) to P5 (least important)
Number of comments	Number of different comments on a bug that have been given by different users
CC count	When a change is done in a bug during fixing, e-mail is sent to different concerned people. The number of such people indicates the value of the CC Count field
Summary	A brief text about the bug
Component	It refers to the subdivision of the product in which bug lies
OS	It refers to different operating systems in relation to which bug was filed
Product	Bugs are categorized into Products and Components, where a Product has one or more Components in it
Hardware	The computing environment in which the bug has been detected

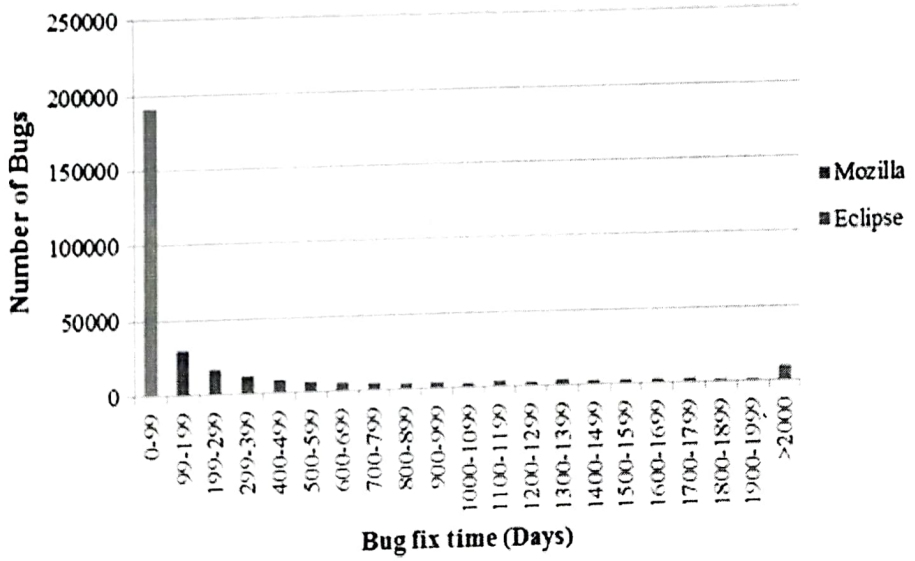

Fig. 20.1 Distribution of bugs in different fix time range

Table 20.2 Number of bug reports of Eclipse and Mozilla projects

Projects	Number of bugs	Observation period
Eclipse	1,23,849	Oct. 2001–May 2015
Mozilla	67,178	July 1998–Nov. 2017

20.2.2 Model Building

RapidMiner Radoop is a user-friendly graphical interface and client software in the Hadoop cluster for handling and analyzing large amounts of data. It can be installed on a RapidMiner Studio and/or RapidMiner server, and provides a platform for storing data and running computations in a Hadoop cluster. RapidMiner Radoop runs on any Java-enabled platform. It is a code-free environment for advanced analytics processes in which the computations come down to Hadoop cluster. It works directly in Hadoop so that the value of data is unlocked in a variety of machine learning applications [6] (Fig. 20.2).

In this paper, we have applied an extension called Radoop: RapidMiner with Hadoop to handle big bug report datasets. This extension provides an additional operator for RapidMiner and communicates with the Hadoop cluster to run the job. The Radoop process starts by adding the Radoop Nest meta-operator. It contains general group settings (such as Hadoop's master node IP address), and all other Radoop operators can only be used within this meta-operators. We have used some of the data analysis features of Hive and Mahout because they are highly optimized [18]. We have used Hive-based Naïve Bayes and Spark-based Decision Tree machine learning techniques to predict bug fix time.

We have downloaded the Cloudera Quickstart VM (version 5.13) from the Cloudera website [19] and connected it with RapidMiner Radoop. Figure 20.3 shows the connection of Cloudera Hadoop with RapidMiner Radoop.

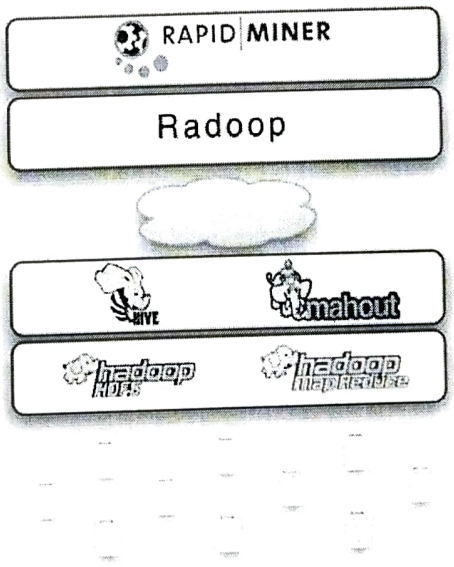

Fig. 20.2 An architecture of the RapidMiner with Hadoop integration (Radoop) [18]

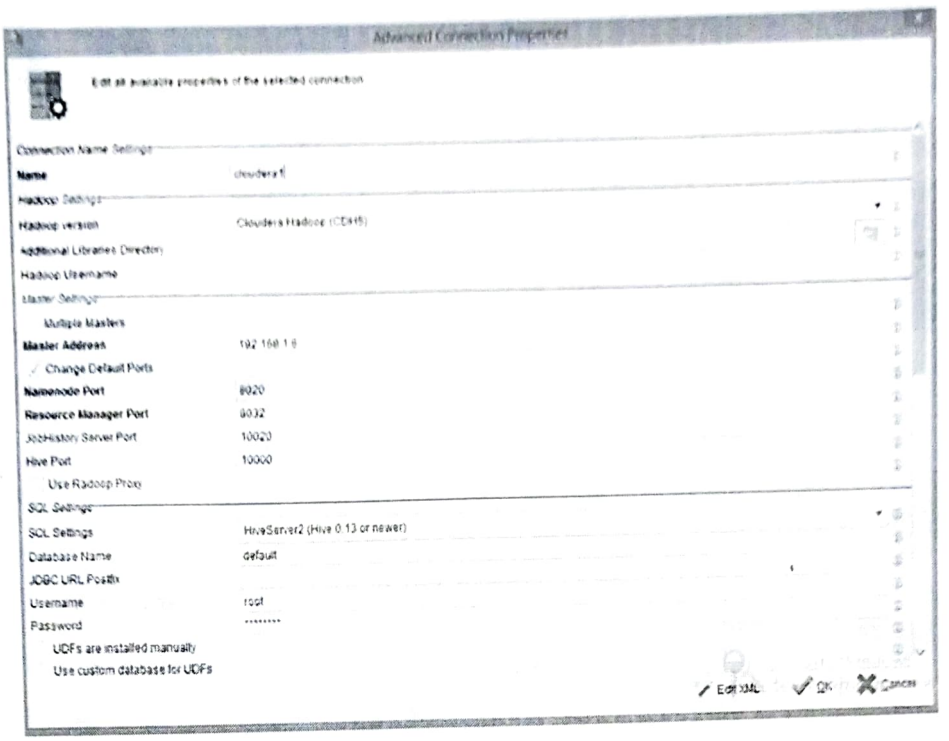

Fig. 20.3 Connection of RapidMiner Radoop with Cloudera Hadoop

We have extracted the data of Eclipse project and saved it into CVS format. After that we uploaded that data into Hive database as shown in Fig. 20.4.

Figure 20.5 shows the main process Radoop Nest. This is the main operator for running processes on Hadoop.

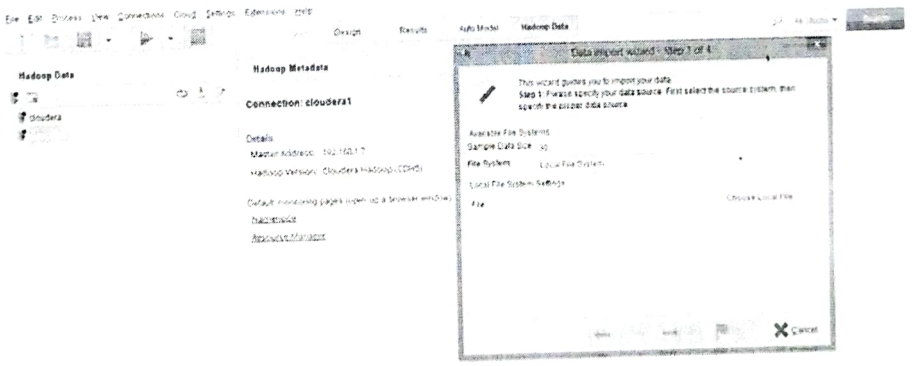

Fig. 20.4 Data upload into Hive database

Fig. 20.5 Radoop nest process in Radoop

Figure 20.6 shows the subprocess within Radoop Nest, which consists of Retrieve, Set Role, and Validation operators. Hive-based Retrieve operator retrieves a Hive table for analysis. Set Role operator can be used to change the attribute role. The

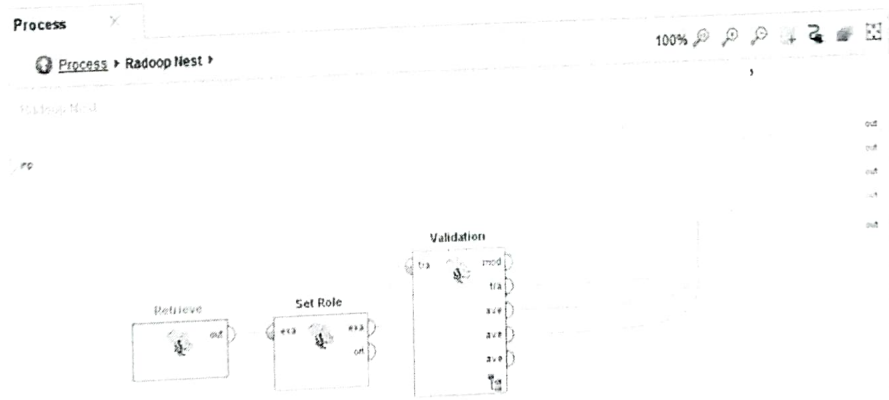

Fig. 20.6 Subprocess of Radoop nest in Radoop

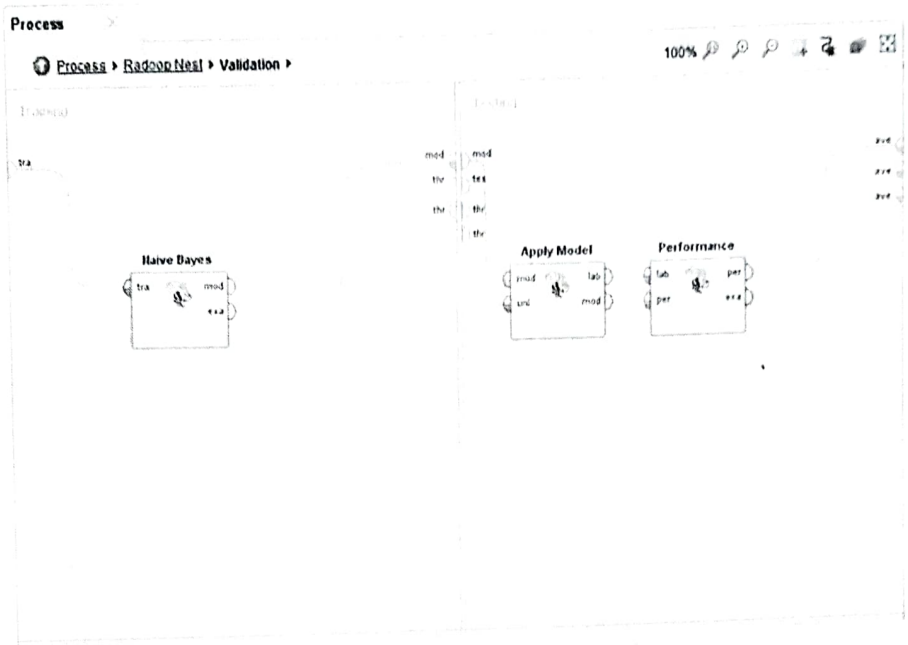

Fig. 20.7 Subprocess of validation operator in Radoop

example set has been randomly split into training and testing sets by using Validation operator.

Figure 20.7 shows the subprocess within Validation operator which builds the Naïve Bayes classification model.

20.3 Results and Discussion

In this section, we have presented and discussed the results in terms of performance measure accuracy.

Bug fix time prediction accuracy of Naïve Bayes and Decision Tree for Eclipse and Mozilla projects has been shown in Table 20.3. In case of Eclipse project, the accuracy is 72.57% for Naïve Bayes and 74.18% for Decision Tree. In case of Mozilla project, the accuracy is 71.95% for Naïve Bayes and 73.17% for Decision Tree.

The results show that Decision Tree performs better than Naïve Bayes for both the Eclipse and Mozilla projects in terms of accuracy.

Table 20.3 Accuracy for Bug fix time prediction

Projects	Accuracy (%)	
	NB	DT
Eclipse	72.57	74.18
Mozilla	71.95	73.17

We have also compared our proposed approach with the state-of-the-art approach as mentioned in Panjer [20]. The author has used 0-R, 1-R, Naive Bayesian Networks (NB), C4.5 Decision Trees (C4.5 DT), and Logistic Regression (LR) to perform data mining and analysis of the constructed datasets for predicting bug lifetimes. The author achieved prediction accuracy 29.10%, 31.00%, 31.90%, 32.50%, and 34.90% for 0-R, 1-R, NB, C4.5 DT, and LR algorithm, respectively. Our proposed approach achieved bug fix time prediction accuracy 72.57% for Naïve Bayes and 74.18% for Decision Tree. The comparisons of the proposed approach with the Panjer [20] have been shown in Figs. 20.8 and 20.9. We observed that the proposed approach improves the accuracy significantly.

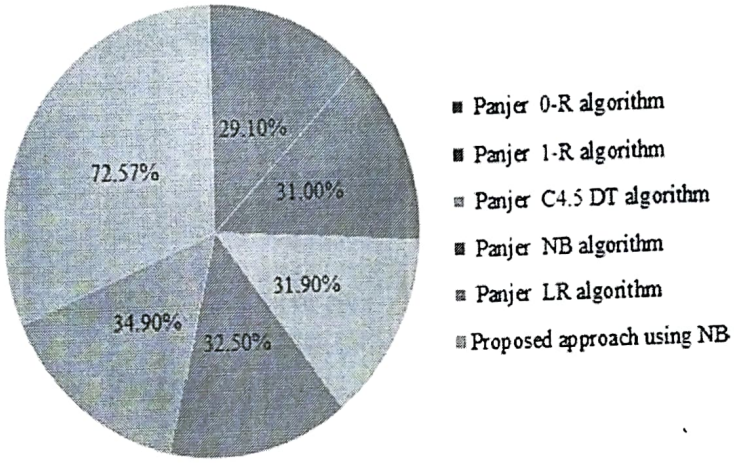

Fig. 20.8 Eclipse project Radoop (NB) accuracy comparison with Panjer [20]

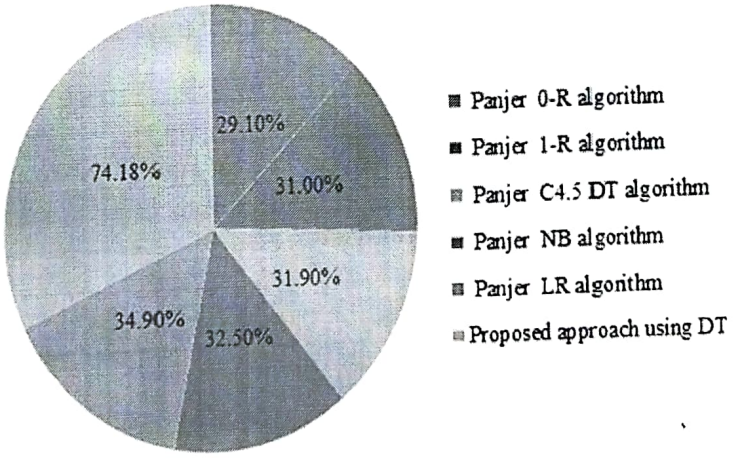

Fig. 20.9 Eclipse project Radoop (DT) accuracy comparison with Panjer [20]

20.4 Related Work

Researchers have contributed a significant contribution in the development of bug fix time prediction models. An attempt has been done for 72,482 bug reports of Linux software [1]. The authors observed that the people, who have participated in the range from 1 to 8 users, corrected 95% bug reports. The study shows that during bug fixing 92% developers have a linear relationship with bug fix time. The proposed model improved the result in terms of R^2. In [2], the authors test the prediction performance of previously used models by using regression models. The previously used models' predictive performance lies in the range of 30–49%. No correlation was found between bug-fix likelihood, the reputation of the developer who opens the bug, and bug fix time. A model has been proposed to determine how much time a bug will take to get fixed by using different bug attributes [3]. The authors observed that the performance measure accuracy improved if developers and comments are included. In [4], the authors study the tendencies of bug fix time pattern in Mozilla and Apache datasets [4]. Result shows that bugs of priority levels 5 and 4 take more than 100 days to get fixed. Bugs of the priority level 2 take less than 80 days to get fixed and bugs of the priority level 1 or 3 are fixed in less than 30 days. An attempt has been made to focus on the delays incurred by developers during bug fixing [7]. In [8], the authors identify and filter the outliers from the bug fix time distribution [8]. Filtering outliers resulted in improvement of prediction accuracy.

To handle the increasing volume of software bug repositories, we need to use big data approach. We have used Radoop to predict bug fix time of Eclipse and Mozilla projects bug reports.

20.5 Conclusion

In this paper, we have taken seven independent attributes, namely, product, component, number of comments, operating system, priority, severity, and hardware to predict bug fix time using big data approach. As the bug repository data keeps on increasing and growing in the form of big data, we need a big data approach to handle big bug reports' datasets. We have applied an extension called Radoop to enable the integration of RapidMiner with Hadoop. The experimental analysis has validated on 1,23,849 bug reports of Eclipse and 67,178 bug reports of Mozilla projects. We have used Hive-based Naïve Bayes and Spark-based Decision Tree machine learning techniques to predict bug fix time of a reported bug. We observed that Decision Tree performs better than Naïve Bayes for both the projects, Eclipse and Mozilla in terms of accuracy. We have also compared our proposed approach with the state-of-the-art work proposed by Panjer [20] for bug fix time prediction. The proposed approach shows improved accuracy. In future, the study can be extended on more open source and closed source projects.

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विषय-सूची

2 गुरु घासीदास

GURU GHASIDAS (1756–1850)

मनीष कुमार

भारतीय चिंतन की एक अविरल एवं निरन्तर परंपरा रही है। प्रत्येक चिंतक अपने समय, देशकाल का शिशु होता है। ऐसे ही एक जनवादी विचारक थे - गुरु घासीदास। घासीदास के विचारों का प्रस्फुटन सतनाम आंदोलन द्वारा दृष्टिगोचर हुआ है। ज्ञात हो कि इस आंदोलन का वैचारिक पिता महात्मा बुद्ध को माना जाता है जबकि संत कबीर एवं गुरु नानक देव ने इस आंदोलन को विस्तृत आयाम प्रदान किया था। सतनाम का अभिप्राय ही होता है एक क्रांति, जिसमें "सच्चाई" को आधार माना जाता है। गुरु घासीदास ने इस आंदोलन में (सात) 'सप्त सिद्धांत' की अवधारणा रखी है। इस आंदोलन का ध्येय रहा है समाज में जाति, वर्ग, वर्ण के आधार पर व्याप्त असमानता को समाप्त करना एवं प्रत्येक मनुष्य को समान मान-सम्मान प्रदान करना। वंचित समाज से सम्बन्ध रखने के कारण गुरु घासीदास को एवं उनके आंदोलन को प्रारंभ में उपेक्षा की नजर से देखा गया था। लेकिन उन्नीसवीं सदी के प्रारंभ में (1820–1830 ई.) उन्होंने अंग्रेजी शासन के खिलाफ जोरदार आंदोलन के माध्यम से अपनी उपयोगिता एवं प्रासंगिकता को साबित किया था। आज का छत्तीसगढ़ राज्य उनका कार्यक्षेत्र रहा था।

गुरु घासीदास पर लोहिया का कथन बिल्कुल सटीक और प्रासंगिक प्रतीत होता है। एक ऐसा मानव जिसने समाज के अंतिम पायदान पर खड़े लोगों के लिए अपना जीवन समर्पित कर दिया। घोर अभाव में जीवन व्यतीत करने वाला एक अदने से व्यक्ति ने अपने कर्म और समाजसेवा के द्वारा एक महान समाज सुधारक बनने का गौरव हासिल किया। यह दूसरी बात है कि हमारी वर्ण-व्यवस्था में निचली जाति का होने के कारण उन्हें उनका समुचित अधिकार, सम्मान तथा श्रेय मिलने में सदियां लग गईं। गुरु घासीदास ने अपने मन, वचन और कर्म से समाज में एकता, भाईचारा तथा समरसता का संदेश दिया। गुरु घासीदास की सत्य के प्रति गहरी आस्था थी। उन्होंने समाज के लोगों को सात्विक जीवन जीने की प्रेरणा दी। वे आजीवन सत्य के उपासक, साधक रहे। अपनी तपस्या से प्राप्त ज्ञान और भक्ति का उपयोग उन्होंने मानवता की सेवा कार्य में किया।

यह भारतीय चिंतन प्रणाली की विडम्बना ही कही जाएगी कि इसने गुरु घासीदास जैसे मौलिक चिंतक को समुचित स्थान और सम्मान प्रदान नहीं किया। अब जबकि भारतीय चिंतन में उपाश्रित वर्ग को न्याय प्रदान करने की पहल की जा रही है, ऐसे में बाबा गुरु घासीदास की प्रासंगिकता और भी व्यापक और स्वीकार्य होनी चाहिए। उनके संदेश

Toni Morrison:
A Study in Techniques

Vipan Kumar

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CONTENT

FOREWARD

African American literature has constantly documented the struggles of African Americans with race and (anti-black) racism, African heritage, slavery and freedom, political agency and social assimilationas well as the spectres of history and modernity. The African American writers have regularly wrestled with the critical and commercial expectations that guided, compromised or contradicted their own agendas as creative writers or as proclaimed agents of social change. Toni Morrison intends to reveal the complexities and contradictions of African American literature by paying attention to race, gender, class and culture. Her craftsmanship and thorough probing into the lives of African Americans catapulted her into international stardom. Her techniques are an honest effort to aestheticize her artistry of fiction. Her narrative technique correlates ideas and emotions around which her characters mature and bloom. For Morrison, the understanding of the lives of AfricanAmericans is prerequisite to her commitment as an African American writer. Undoubtedly she has attempted at refiguring the nature of African American literary canon. She was conferred on Nobel Prize for Literature in 1993.

The book by Dr. Vipan Kumar offers stimulating discussions on Morrison's aesthetic sensibility and scrutinizes her astute way of delivering the content. Toni Morrison published her first novel in 1970 and soon crowned the momentum for her epic power, narrative web, and poetic imagery, richly flawless depiction of African Americans and wonderful richness and vitality of her language. Broad spectrums of critical approaches to Toni Morrison's fiction are by no means mutually exclusive of one another or exhaustive of all possibilities. One of the possibilities is to make a critical study of the interrelationship of race, gender and class in the novels of Toni Morrison. I do believe that the book will prove to be an odyssey into the fictional world of Toni

Morrison. She considers her writing a way of thinking, a process. She is highly concerned and dedicated to her own people with her aesthetic responsibility to oppression and marginalisation of (African American) black people.

I can safely conclude that this study will be of immense value to the readers in getting novel critical insights into Morrison's mind and fictional art. The author's endeavour is a valuable contribution to the canon of African American literature and I am pretty sure that this book documents the author's efflorescence of sensitivity, awareness and acumen for the historical conditions of African Americans. The widely talked about techniques—stream of consciousness, narrative technique, historiography— are inseparably dominant in all the novels of Toni Morrison. Interestingly, this book by Dr. Vipan Kumar will prove to be an avid testimony of Morrison's narrative techniques.

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To Late. Dr. (Prof.) S.K. Garg (former Principal of R.K.S.D., Kaithal, Haryana) whose contribution to my thinking is unlimited, and for whose affection and support, always indispensible, I owe a debt beyond measure.

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My thanks also to Signorina Publications.

(Dr.Vipan Kumar)

CHAPTER I

INTRODUCTION

"She was our conscious. Our seer. Our truth teller".—
Oprah Winfrey

Literature mirrors the society and all litterateurs speak the spirit of time which is an accretion of all the political, social, cultural and religious characteristics of a particular age. Great fiction transcends time and space and enjoys universal response, yet every major work of art and literature is rooted in the soil of a culture and is held, with pride, as one in its finest efflorescence. It is by this measure that *King Lear* is English, *Madam Bovary* is French, *War and Peace* is Russian, *Faust* is German, *The Serpent and the Rope* is Indian and *Invisible Man* is African American literature. In fact, a novel is initially a sociological document and in the final appeal it is a cultural asset. It gives glimpses of the dialectics of society and self. Percy Lubbock, in his book *The Craft of Fiction* writes: "A novel is a picture of life, and life is well-known to us; let us first of all 'realize' it, and then using our taste, let us judge whether it is true, vivid convincing-like life, in fact" (9).

It may be argued that by 'picture of life' the writer here does not necessarily mean picture of man's social life. The novel may give us pictures of man's inner life, his soul, his spirit, his feelings, his emotions, his intellectual and philosophical awareness. In fact, Thomas Hardy wrote that "novelists of social minutiae" with their "photographic consciousness" (119) presented only life garniture and not life. Hardy has continually emphasized the transcendental end of art. But since the very mode of human existence is a social one, so even in man's inmost being we can glimpse the society in which he lives in flesh and blood in relationship with other

individuals and various social institutions. A true, vivid, and convincing picture of life will, therefore, show man organically rooted in society with such dimensions as soul, spirit, intellectual, philosophical and transcendental awareness, etc. as the efflorescence of that organic body. In a sonnet entitled *The Novelist*, W.H. Auden says that "the novelist has to stay all the time in a real world while he is writing his novels" (147). Waller Besant gives the authorial experience of pride place among the laws of fiction.

Henry James, one of the great practitioners of the art of fiction, says that something important with regard to the historical authenticity of life is depicted in novel. He writes in his famous essay *The Art of Fiction*:

> ... the *novel* is history. That is the only general description (which does it justice) that we may give of the novel. But history also is allowed to present life; it is not, any more than painting, expected to apologize. The subject-matter of fiction is stored up likewise in documents and records, and if it will not give itself away, as they say in California, it must speak with assurance, with the tone of historian (37).

All forms of authentic experience and especially fiction must have a preference to human experience and consciousness if they are to have permanent value (Dhawan 11). Fielding, the father of English novel, embodied in the English novel a significant streak of socio-political concern. This element of socio-political concern has, since then, struck deep roots and produced many great works of genius. Beginning with the novels of Daniel Defoe and Fielding, realistic novels earned merit and struck roots. Gradually novel found acceptance as an adequate medium of expression to withstand the demands of the time, where the majority of problems raised in bristling multitude by contemporary social and political developments could be discussed, analyzed and interpreted. The

novelists of the time also allocated much space in their works to the representation of the currents and cross-currents of the contemporary socio-economic and political reawakening. Whereas Dickens, Disraeli, Kingsley and Gaskell kept themselves abreast of the social and political developments of the period, they were primarily concerned with description, and analysis of the conditions of England. Kipling, Chresterton and Orwell portrayed graphically the socio-political ferment of the era.

Enduring fiction forges itself in the smithy of reality. African American fiction has also held a mirror up to US social life and down the decades it has explored the varied facets of US society. This flexibility inspired African American writers to figure the themes of gruesome poverty, social change, and crisis of identity, emerging experiences, alienation and anarchy on the screen of African American novel. African American fiction reflects a perfect blending of the individual's inter-reaction with external reality offering a rich repository for the novelists to choose material for artistic creation from African American customs, tradition and its socio-political set-up. The growth and evolution of African American fiction has thus encompassed the whole gamut of experience from the historical to the social, and the psychological as it is iambically related to the environment wherein it takes birth. The craft of African American fiction is imbued with the novelist's genius to reflect the society in its verisimilitude. Interpersonal as well as intrapersonal relationships of people in a society, their problems could find suitable expression in the novel as "novel is the readiest and the most acceptable way of embodying experiences and ideas in the context of our time" (Dhawan 6). This elasticity attracted African American writers particularly those involved in activities of social reforms.

By African American literature, I mean writing about blacks by African American writers with a black consciousness. The form

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Contents

DISABLED GLOBALIZATION

EMPLOYMENT REALITIES

Pankaj Lakhera

Human society is marked by inequality. It may be in terms of economic condition, social status or political power. Inequality leads to discrimination, suppression and marginalization of a specific section in any society. Marginalization refers to a situation where a section or class in a society does not get its due share and feels alienated and deprived. The reasons behind marginalization and suppression may be a poor economic condition, caste prejudice, racial discrimination, linguistic identity, ethnicity etc. But, the most powerful reason for it may be a disability.

Disability may be defined as a hindrance faced by a person while doing some work due to physical or mental impairment. Such impairment may be in the form of the loss of a limb, sensory impairment or mental retardation. The long-term impact of disability is not limited to just physical impairment, but also to challenges in social, psychological, educational and vocational fields (Bhatt, 1963: 66).

Disability may be of different types. The Rights of Persons with Disabilities act of 2016 mentions 21 types of benchmark disabilities which are as follows:

1.Blindness, 2. Low-vision, 3. Leprosy Cured persons, 4.Hearing Impairment (deaf and hard of hearing), 5. Locomotors Disability, 6. Dwarfism, 7. Intellectual Disability, 8. Mental Illness, 9. Autism Spectrum Disorder, 10. Cerebral Palsy, 11. Muscular Dystrophy, 12. Chronic Neurological conditions, 13.Specific Learning Disabilities, 14. Multiple Sclerosis, 15. Speech and Language disability, 16. Thalassemia, 17. Haemophilia, 18. Sickle Cell Disease, 19. Multiple Disabilities including deaf-blindness, 20. Acid Attack victim, 21. Parkinson's disease. (The Rights of Persons with Disabilities Bill 2016 (GOI))

However, here we may consider only those disabilities which are mentioned in the disability bill of 1995. Based on benchmark disabilities mentioned in the bill of 1995, the disabled population in India as per the 2011 census is:

Disabled Population by Types of Disability in India: 2011

Total	26,810,557	14,986,202	11,824,355
In Seeing	5,032,463	2,638,516	2,393,947
In Hearing	5,071,007	2,677,544	2,393,463
In Speech	1,998,535	1,122,896	875,639
In Movement	5,436,604	3,370,374	2,066,230
Mental Retardation	1,505,624	870,708	634,916
Mental Illness	722,826	415,732	307,094
Any Other	4,927,011	2,727,828	2,199,183
Multiple Disability	2,116,487	1,162,604	953,883

(Source: C series census of India 2011)

The question of the hour is what is the impact of globalization in India on persons with disabilities especially in the context of employment? Is it leading to inclusive employment or is pushing these persons to the margins of the society?

The word globalization is one of the most popular and important terms of the present century. It has both positive and negative consequences. It is treated as a subject of debate in the academic literature in social sciences.

It pertains to economic interdependence of different countries leading to more and more free trade all over the world. For a common person, it means increasing privatization of services, opening up of the economy and technological advancement. In economic perspective, it involves huge capital investment by the MNCs, big financial exchanges by private players, increasing competition among various firms, loosening of regulations on economic activities, a big surge in global trade and more emphasis on economic efficiency. Globalization also symbolizes the rapid spread of information through modern means of communication such as TV and internet, the fast development of transportation, growing employment opportunities in various sectors, rising living standard for the emerging middle class, availability of electronic goods and automobiles at a cheaper price.

According to Peter Marber, globalization involves the cross-border interaction whether economic, social or cultural, leading to human progress (Marber, 2015: World Policy Journal). It is only due to globalization and economic liberalization that India is said to have become one of the fastest-growing economy with a forex reserve touching Dollar three Billion.

But, everything is not rosy in the present scenario of globalization and economic liberalization. Common man is just impressed by the presence of big companies, handsome pay packages, availability of consumer goods, good transportation and telecommunication services. But, this is only one side of the picture. The deeper analysis of globalization presents a categorically different situation. The situation of unequal competition, unjust trade rules, trade imbalance between centre and periphery, exploitation of labour class, instability in job prospects, no social security for workers, frequent economic crisis, cut in welfare services, environmental degradation, rising consumerism and materialism and above all, the decline of the sovereignty of the state.

Globalization implies implementation of the structural adjustment programs (saps). It means the cut in government expenditure. It badly

affects sectors like health and education. It results in the reduction of subsidies and the privatization of essential services. As the MNCs buy the state-owned companies, many workers lose their jobs. Not only that, services like transport and power supply become more expensive. (Sengupta, 2003: *Social Scientist* Vol. 31)

The net result of the saps is rising unemployment, constant inflation, rise in food prices and the withdrawal of subsidies from public services. Moreover, it also challenges our sovereignty since the parliament has no control over the day to day functioning of foreign companies. (Sengupta, 2003: *Social Scientist* Vol. 31)

Employment situation prior to liberalization:

We cannot understand the impact of globalization on the employment scenario of persons with a disability unless we compare the pre-liberalization period in terms of employment with the period of globalization. In the pre-liberalization period, India adopted a development strategy with a mixed economy based upon planning with a predominance of public sector. The main thrust of the state was to have control over all key sectors of the economy with an instrument of state planning. The objective of development at that time was to establish a socialistic society. That is to bridge the gap between the rich and poor.

This policy resulted in a big rise in public employment and social security for a common person. The industrial resolutions of 1948 and 1956 as well established state monopoly over all the key industries such as coal, iron and steel, minerals, shipbuilding, manufacture of aircraft, telephone and telegraph equipment, railways, defence, Nuclear Energy, Space Technology etc. (Gill, 1985: 6). Not only this, all the basic facilities such as health, education, public transport, power and water supply and public distribution system were in government hands. That was the time when the public sector was the major employer of most of the people including persons with disabilities.

In countries like India, it is the public sector which is a major employer of persons with disabilities. It employs different categories through the agency of reservation in jobs. The public or government employment in the Indian context is not only a means of livelihood but also an agent of social security. The government employees have a fixed tenure. They cannot be removed easily. They enjoy all types of facilities including leaves, increments and timely promotion. They get social security cover in the form of a medical facility, life insurance, provident fund and retirement pension. Moreover, they have the labour laws providing them security. In a nutshell, government job in India is a guarantee for a healthy and safe life. On the contrary, the private sector is quite hesitant to provide most of the above-said facilities.

If we see the pre-liberalization scenario of employment of persons with disabilities in India, we find that in 1977, a provision was made through an executive order that all the three categories of the disabled would be given 1 per cent of reservation each, which would be computed based on total number of vacancies in any department. But, this provision was accompanied with the clause that reservation can be given only on identified posts. This policy also mentions the carry forward of jobs and exchange of jobs. Initially, the reservation was confined to class C and class D jobs. But, later it was extended to class B and class A posts also. The persons with disabilities act of 1995 further consolidated these provisions. (Sarin, 2009: 228-229)

Employability of persons with disabilities and its consciousness started taking roots during the decade of 1980s. And that is only when the organizations like the National Federation of the Blind resorted to mass struggle for employment. One example of this was a big agitation of persons with disabilities in front of parliament on March 16, 1980, in which police resorted to lathi-charge on these persons. This incident drew the attention of the general public, mass media and international organizations to the problem of acute unemployment of disabled in India. Consequently, the year 1981 was declared as the international year for the disabled by the United Nations Organization. In the decade of 1980s, the level of

education and professional training among the disabled was not so high. So, the workforce which was prepared at that time was basically for low-level jobs. The emphasis at that time was on the class C and class D vacancies. The reservation was also at that time was in group C and group D posts. The special recruitment drive for the disabled in 1987 is worth mentioning here. In this drive, a lot of persons with disabilities were recruited on the posts of lower division clerks and school teachers. (Rungta, 2016: personal interview)

The success in getting group C and group D jobs led to more struggle for group A and group B post since 1987. Consequently, there was an order of central government that priority should be given to disabled in the selection of candidates for these categories. In 1993, a landmark judgment of supreme court came wherein it was ordered that disabled including the blind should be allowed to sit in civil services exam. If she/he qualifies in that, she/he should be given employment in group A or group B post. The government should also consider reservation in these categories. But, despite this and persons with disabilities Act of 1995, no reservation was given in group A and group B posts up to 2005. Again, a struggle for the same was started and the success could be achieved up to 2007 and 2008. It must be kept in mind that whatever had been achieved after 1991 was not due to the impact of globalization but it was basically due to the disability Act of 1995 and sincere efforts of disability organizations. Thus, we find that in the pre-liberalization period, the chances of employment for disabled persons were quite optimistic. Since most of the economy was in the public sector, it was bound to employ the agency of reservation. (Rungta, 2016: personal interview)

Declining employment in the era of globalization

In July 1991, India adopted the policy of economic liberalization, privatization and globalization. The policy was a response to grim economic situation. The external debt reached an alarming point that India was on the brink of repayment default. The uncertain political situation further worsened the situation. Not only this, the fall of the socialist block

in Eastern Europe including the Soviet Union took away the glamour from socialist ideology. Moreover, the neo-colonial forces became keen to integrate India into the world's capitalist economy. (Gupta, 1992)

The assumptions behind the new economic policy was that system of controls and licenses had discouraged the efficient growth of the industry, created a vested interest in ever-increasing bureaucracy. The public sector controlled by Political patronage, managed by ill-trained and corrupt bureaucracy and run by inefficient and irresponsible workforce was eating into public resources. (Gupta, 1992)

It was in this background that there came the liberalization package starting from July 1991. The first step of this was the devaluation of the rupee. This was followed by removal of industrial licensing for most products, raising of foreign equity limits in industries, the abolition of MRTP clearances, disinvestment of government holding in the public sector, reduction in the number of product and reserved for the small sectors, automatic permission for foreign technology agreements in high priority industries, automatic clearance for import of capital goods for export-oriented units, liberalization of policy regarding industrial location, concessions in taxes etc. (Gupta, 1992)

Globalization means that the economic policies of a nation are not limited to their national interest only. Globalization leads to automation which is part of economic policy and technological advancement. So, employment prospects are depending upon these policies. Under the process of globalization, the companies have become transnational and are engaged in cut-throat competition. In such a situation, they adopt the method of cost-cutting to remain in the market. For cost-cutting, they not only resort to new techniques but also tend to reduce their workforce. Due to this technological advancement, the opportunities for employment at the lower level are going down both in public and in the private sector. These tendencies result in a reduction in the actual workforce. there is no doubt that if the workforce, in general, is declining, the employment of physically challenged is also declining. Moreover, there may be an increase in

employment in the private sector, but public employment declines. (Rungta, 2016: personal interview). The table below shows these trends:

Growth of workforce, 1981-2001 census

(Fig. in lakh)

Census Year	Total Population		Total number of Workers (main +marginal workers)		% of workforce in population		% increase in work-force in 1981-1991 & 2001	
	India	Delhi	India	Delhi	India	Delhi	India	Delhi
1981	6851.85	62.20	2446.04	20.02	35.70	32.19	-	-
1991	8463.05	94.21	3141.30	29.80	37.12	31.63	28.42	48.85
2001	10270.15	137.83*	4025.12	45.27*	39.19	32.84	28.14	51.91

* Provisional

(source: Employment Handbook 2016)

We may easily visualize that the population in India as well as in Delhi increased substantially between 1981 to 2001, but the workforce did not increase at the same pace. It declined at the national level, but it increased marginally in Delhi. Even the increase in Delhi may be attributed to the migration of workers from neighbouring states.

Moreover, studying the data as provided by special employment exchanges for the period between 1990 to 2013 regarding the placement of physically challenged persons, we find that there is hardly any increase in the ratio of employment being provided to such persons in the country. The table below shows this trend:

Figures for special exchange for physically handicapped

(in thousands)

Year	Placement				
	Blind	Deaf and dumb	Orthopaedics	Total	Women**

	All employment exchanges *				
1990	0.3	0.2	3.4	3.9	
1991	0.3	0.3	4.0	4.6	
1992	0.2	0.2	3.9	4.3	
1993	0.2	0.2	4.0	4.5	
1994	0.2	0.1	4.2	4.5	
1995	0.2	0.2	3.3	3.7	
1996	0.2	0.2	3.4	3.9	
1997	0.4	0.3	3.8	4.5	
1998	0.3	0.2	3.2	3.6	0.5
1999	0.2	0.2	3.8	4.2	0.9
2000	0.2		3.0	3.3	0.7
2001	0.2		3.1	3.5	0.7
2002	0.4	0.3	2.7	3.4	0.7
2003	0.4	0.4	3.1	3.9	1.0
2004	0.2	0.3	2.9	3.4	0.8
2005	0.3	0.3	2.6	3.2	0.7
2006	0.4	0.3	2.6	3.4	0.6
2007	0.4	0.3	2.6	3.4	0.7
2008	0.3	0.3	3.1	3.7	0.8
2009	0.3	0.2	2.8	3.5	0.8
2010	0.3	0.2	2.6	3.2	0.8
2011	0.3	0.2	2.8	3.3	0.7
2012	0.2	0.1	1.8	2.1	0.5
2013	0.2	0.1	1.6	1.9	0.4

(source: Employment Handbook 2016)

Globalization has an adverse impact upon the employment of the disabled, especially in the public sector. For the all-India working-age population in 1999-2000, 62.5% of the working-age population reported being employed, which is 24.9 percentage points higher than the employment rate for those with disabilities (37.6 %) in 2002.

The employment of the disabled persons in India fell from 42.7 per cent in 1991 to 37.6 per cent in 2002 due to the shrinking of the public sector, where these persons were employed most (Mitra and Sambamoorthi, 2006: 199-203).

Globalization, liberalization and privatization of economy during the decade of 1990s has helped in the growth of highly skilled jobs in Information Technology, Automobile Industry or other service sectors of the economy. But, it has failed to create jobs for the unskilled poor workers, because Public Investment in areas of the economy which generates jobs for the Millions of unskilled labour force lagged behind the requirements of expanding Indian Labour Market. This tendency is more acute in the case of persons with disabilities (Bhambhri, 2005: 17).

In the era of globalization and economic liberalization, getting 3 per cent reservation in government employment is very challenging. It is full of all types of hurdles right from tedious paperwork to pursue the officers, going to the courts and even agitating on the roads (Rungta, 2016: personal interview). Reservation in government jobs has been implemented either with the help of judicial pronouncements or through the agitations done by disability organizations. The government itself admits that out of 3 per cent, only 1.2 per cent of reservation has been given. Out of this reservation, 60 per cent has been given to locomotors disabled, 25 per cent to hearing impaired and only 15 per cent has been assigned to blind (Rungta, 2016: personal interview).

So, globalization is affecting the employment of disabled persons. The low level jobs are shrinking due to technological advancement and the tendency of cost-cutting. The high-level jobs are increasing slightly. But, only the people, who are well educated and are from well to do families are taking advantage of these opportunities. But now, even high-level jobs are not secured. Government is adopting the policy of contractulization and outsourcing. So, the employment opportunities for disabled are decreasing in the age of globalization leading to their marginalization.

Employment scenario, in private sector, in the era of globalization

The persons with disabilities bill of 1995 provides for 3 per cent reservation in public sectors in jobs for persons with disabilities. There is also a provision for providing an incentive to private firms who employ 5 per cent disabled people in their total workforce. But still, there is acute unemployment prevailing among persons with disabilities. Even the private sector, with a high growth rate, could not provide enough employment to these persons. Apex bodies such as CII, FICCI and ASSOCHAM still do not have policies relating to the employment of disabled people. A study was conducted in 1999 by the National Centre for Promotion of Employment for Disabled People, Delhi, to identify the current practices of Indian industry with regard to the employment of disabled people. A sample of 100 corporate houses was chosen, by including all the corporate houses listed in the 'Super 100 ranking of the corporate sector' by 'Business India'. 23 companies in the sample were public sector companies while 67 were the private sector companies and 14 were multinational companies. Of the 100 companies to whom the questions were sent, only 70 responded. The total number of employees in these companies was 7,96,363 of which 3160 were disabled persons' consisting of 0.4% of the employees. Among the companies who responded, 50 (71.43%) companies had employed disabled persons belonging to different categories of disabilities. (Abidi, 1997) The table below shows this trend:

Types of disability among disabled employees

Types of disability	Percentage of total disabled employees
Visual impairment	9.87%
Loco-motor impairment	70.57%
Speech and hearing impairment	8.26%
Mental retardation	0.66%
Other disabilities	1.87%

Disabled persons as a percentage of the workforce in different companies

Types of company	% of disabled persons employed
Public sector companies	0.54% of the total workforce
Private sector Indian companies	0.28% of the total workforce
Multinational companies	0.05% of the total workforce

No company in the sample employed disabled persons above 2% level, way below 5% level to claim the incentives guaranteed to them if they employ disabled persons. Disabled people with loco-motor disability was the group most commonly employed, probably because they are less severely disabled, and people with mental retardation are rarely employed, probably due to the stigma attached to mental retardation. It has also been found that persons with disabilities, who are employed, have a mild degree of disability which is not a big hindrance in doing any job. (Abidi, 1997)

Another issue regarding the employment of persons with disabilities in the private sector in the era of globalization is the lack of education and proper skills among these persons which is very essential for a market economy. The private sector may give job only to those workers who are well educated, trained and have good communication skills. It has been found that the disabled persons who belong to a well to do family may easily access education, technological advancement and other facilities. But, those who are not so fortunate or who live in rural areas cannot have the same. It must be kept in mind that in the countries like India, there is a direct relation between disability and poverty and most of the persons with disabilities belong to poor section of our society who are not suitable for modern skilled employment.

Thus, privatization of economy has opened highly skilled new job avenues for disabled persons. But, these avenues are available for only those with higher education and adequate training. Most of the training programs do not match with the requirements of the modern skilled jobs and most of the persons with disabilities are from poor families.

Employment and social security

One may argue that in the era of globalization and economic liberalization, private employment is rising which is benefiting a lot of people. But, does it ensure social security for the workers or particularly those with disabilities?

The pre-1991 reform period in India is quite different in terms of the development strategy and its impact on the labour regime. The era was marked by the policy of a mixed economy with a prevalence of the public sector. Since most of the working force was engaged in the organized public sector at that time, they were automatically given all the benefits.

In that period, the government of India also supported the trade union movement and came out with various labour laws for the protection of workers. Apart from benefiting the general workers, these laws have been quite important for workers belonging to weaker sections of society such as persons with disabilities.

The important labour laws made by the government of India from time to time are —

1. Minimum wages Act 1948
2. Payment of bonus Act 1965
3. Provident fund Act 1952
4. Union Act 1926
5. Compensation Act 1923
6. Contract labor Act 1973

All such acts insured the safety of the workers in both the public as well as the private sector units. Whenever the workers felt any dissatisfaction with

the authorities, they came out with trade union activities, strikes, lockouts etc. (Singh, 2016)

The post-liberalization period saw a U-turn in the development policy of the government. The period is marked by the main features of globalization such as the free flow of capital, free flow of labour and free flow of technology. The number of public sector undertakings is decreasing constantly. The government wants to disinvest the units, downsize the staff and privatize most of the sectors in the economy. The emphasis is now on inviting the foreign direct investment at a large scale.

The major shortcoming of the various labour acts in India is that they only cover the labour of the formal sector. The labour in agriculture, as well as the informal sector, is not covered by them.

Thus, various labour laws are applicable only in the organized sector. Even in the formal sector, a number of workers can fall outside the preview of the laws due to the nature of the work they perform. If the workers in the private sector units are given full benefits, it will reduce the profits of the investors. So, the prevalent practice is to minimize the coverage of the labour law without making any change in that. (Singh, 2016)

Often, the workers in private sector industrial units are not given permanent jobs. They are hired on a contract basis. Their employers thus have the full freedom to hire and fire the workers. These workers cannot have the other job-related benefits such as bonus, provident fund, medical facility, insurance, pension and other retirement benefits. the workers with disabilities are either not taken by private sector units or even if they are taken, they do not enjoy any social security as they also work on a contract basis.

Suggestions and Conclusion

The above discussion reveals that the process of globalization and economic liberalization is adversely affecting the employment scenario of persons with disabilities. If they do not get adequate employment, their inclusion in mainstream society would be quite difficult and they would

remain marginalized. But, what are the ways to face the challenges put forward by globalization and privatization?

The process of globalization and economic liberalization is irrevetsible. We cannot go back to the pre-liberalization period of the state-controlled economy. But, globalization and liberalization should have a human face as said by Dr. Manmohan Singh. It means promoting balanced social and economic development, responsible macroeconomic policies with a strong emphasis on agriculture, employment and viable social safety net. "The development process should be in tandem with an emphasis on the creation of job opportunities. If this policy is followed honestly, it would lead to inclusive growth, involving all sections of society." (Singh, 2004)

It is a fact that public sector would not be able to absorb all unemployed disabled persons. The reservation should indeed be properly given. But no government can employ all needy persons. Hence, the disabled persons should be trained in such a manner that they will be able to compete in open market with other able-bodied persons.

The government has to introduce some measures which would enable the persons with disabilities to meet the challenges of globalization. For instance, in the Rights of Persons with Disabilities Bill of 2016, there is a provision for skill development for disabled and also facilitating their self-employment. Not only this, reservation in public establishment has been increased to 4 per cent in place of 3 per cent. There are provisions to give incentive to private firms who employ these persons. But, one must admit that legislation may only give rights in theory, it cannot employ practice. No legislation can say that if people trained in management or information technology are required in job market, those persons should be given employment only on the basis of disability who even do not qualified for a class D post.

In order to prepare the persons with disabilities for job market, they should be given education and vocational training needed for job market. The jargon of inclusive education can make a quantitative increase, but it may not lead to qualitative education. The workforce prepared by such

education would be unemployable. They would again become a liability for the society. Although integrated education must be there, special schools cannot be eliminated altogether. In the disability bill of 2016, it is up to the parents whether they want to send their disabled child to an integrated education school or to a special school.

Economic freedom and capacity is the key to get equal status in any society. The employment of the disabled has changed the attitude of society towards the disabled. Nobody can manifest discrimination against a disabled person if he is employed and earning his living respectfully. We must adopt a multi prone approach to change the attitude of society. First of all, the disabled workers must set an example of sincerity and best performance. They should try to work better than able-bodied workers. The working performance of outstanding disabled persons has earned respect for other persons with disabilities in society. Attitudes should be changed by demonstrative value. The talk about one sincere disabled person leads to the change in attitude of people to other disabled persons also. All these measures would bring the persons with disabilities in mainstream society and would bring their marginalization to an end.

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प्राथमिक

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पर्यटन भूगोल

Syllabi	Mapping in Book
इकाई–1 पर्यटन की परिभाषा; पर्यटन को प्रभावित करने वाले कारक– ऐतिहासिक कारक, प्राकृतिक कारक, सामाजिक कारक, सांस्कृतिक कारक, आर्थिक कारक; तीर्थयात्राओं के लिए प्रेरक कारक– अवकाश, मनोरंजन; पर्यटन के तत्व; एक उद्योग के रूप में पर्यटन	**इकाई 1** : पर्यटन के मूल आधार **(पृष्ठ 3–35)**
इकाई–2 पर्यटन का भूगोल : इसकी स्थानिक आत्मीयता; क्षेत्रीय और स्थानीय आयाम– भौतिक आयाम, सांस्कृतिक आयाम, ऐतिहासिक आयाम, आर्थिक आयाम; पर्यटन के प्रकार– सांस्कृतिक पर्यटन, पारिस्थितिकी पर्यटन, नृजातीय पर्यटन, तटीय पर्यटन, साहसिक पर्यटन, राष्ट्रीय और अंतरराष्ट्रीय पर्यटन, वैश्वीकरण और पर्यटन	**इकाई 2** : पर्यटन का भूगोल **(पृष्ठ 37–86)**
इकाई–3 भारतीय पर्यटन; पर्यटन के आकर्षण के क्षेत्रीय आयाम– अवस्थिति आयाम, भौतिक आयाम, सामाजिक सांस्कृतिक आयाम, ऐतिहासिक आयाम, आर्थिक आयाम, आधुनिक आकर्षण; पर्यटन का विकास– पंचवर्षीय योजना और पर्यटन का विकास, 1982 की पर्यटन नीति, राष्ट्रीय पर्यटन नीति 2002, पर्यटन के विकास का मूल्यांकन; पर्यटन का संवर्धन– पर्यटन संवर्धन, पर्यटन संवर्धक के उद्देश्य, भारत में पर्यटन के संवर्धक, भारत में पर्यटन संवर्धन के महत्वपूर्ण कार्यक्रम, भारत में पर्यटन संवर्धन के नवीनतम कार्यक्रम	**इकाई 3** : भारतीय पर्यटन **(पृष्ठ 87–140)**
इकाई–4 परिचय : बुनियादी ढांचा और सहायक प्रणाली, पर्यटन में बुनियादी ढांचे और सहायक प्रणाली का महत्व, बुनियादी ढांचा, सहायक प्रणाली, अन्य सुविधाएं; पर्यटन सर्किट – लघु और दीर्घ अवधि, लघु अवधि पर्यटन सर्किट, दीर्घ अवधि पर्यटन सर्किट, भारत सरकार के पर्यटन मंत्रालय द्वारा पहचाने गए थीम आधारित पर्यटन सर्किट, भारत के कुछ प्रसिद्ध पर्यटन सर्किट; एजेंसियां और मध्यवर्ती– अंतरराष्ट्रीय पर्यटन संगठन, भारत में सरकारी पर्यटन संगठन, भारतीय पर्यटन में निजी निकाय, पर्यटन मध्यस्थ; भारतीय होटल उद्योग	**इकाई 4** : आधारभूत ढांचा और सहायक प्रणाली **(पृष्ठ 141–181)**
इकाई–5 परिचय : पर्यटन के प्रभाव– पर्यटन के भौतिक प्रभाव, पर्यटन के आर्थिक प्रभाव, पर्यटन के सामाजिक और अनुभूति–संबंधी प्रभाव; पर्यटन के सकारात्मक और नकारात्मक प्रभाव; पर्यावरणीय कानून और पर्यटन; पर्यटन के वर्तमान रुझान, स्थानिक प्रतिरूप और हाल में हुए बदलाव– पर्यटन के वर्तमान रुझान, पर्यटन के स्थानिक प्रतिरूप, पर्यटन के क्षेत्र में वर्तमान में आए परिवर्तन; पर्यटन में विदेशी पूंजी की भूमिका; पर्यटन पर वैश्वीकरण का प्रभाव	**इकाई 5** : पर्यटन के प्रभाव **(पृष्ठ 183–215)**

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नौटंकी

❑ प्रतिभा राणा

'नौटंकी' उत्तर प्रदेश में मनोरंजन का प्रमुख माध्यम रही है। इस कला का उद्‌भव भी इसी प्रदेश में हुआ है विशेषकर ब्रज और बुदेलखंड क्षेत्र में इसने विशेष लोकप्रियता पायी। प्राचीन समय से ही नौटंकी कला ने आम जनता में अपनी पैठ बनायी हुई थी इसीलिए सामान्य जन जो दिन में तो काम पर लगा रहता लेकिन रात को सब थकान भूलकर नौटंकी के माध्यम से ही मनोरंजन करता था। उत्तर प्रदेश में हाथरस, मथुरा, इटावा और कानपुर में नौटंकी कला ने विकसित होकर, लोक नाट्य के रूप में शोहरत पायी। यहाँ दो व्यक्तियों का उल्लेख अनिवार्य है– पहला नाम हाथरस से पं. नथाराम शर्मा 'गौड़' और दूसरा कानपुर से श्री कृष्ण पहलवान का है। इन दोनों ने नौटंकी को लोकप्रिय बनाने में अपना सम्पूर्ण जीवन लगा दिया। इन्हीं के प्रयासों की बदौलत इस शैली ने देश से बाहर भी नाम कमाया है। इनकी 'श्री श्याम प्रैस' हाथरस और 'श्री कृष्ण प्रैस' कानपुर के माध्यम से नौटंकी नाटक लिखित रूप में, कम कीमत पर आम जनता और कलाकारों को उपलब्ध कराये गये। इसके अलावा कानपुर की पहली महिला कलाकार मानी जाने वाली गुलाबबाई ने नौटंकी प्रस्तुतिकरण में नये प्रयोग किये। इस कला में उनके अप्रतिम योगदान के लिए भारत सरकार द्वारा उन्हें 'पद्‌मश्री' सम्मान से नवाजा भी गया है।

ऐसा नहीं कि भारत में नौटंकी कला मात्र मनोरंजन का जरिया ही रही बल्कि नवजागरण काल में तो यह कला जनजागृति और चेतना का माध्यम भी बनी। इसी कारण स्वतन्त्रता से पहले नौटंकी के विषय अधिकतर देश के हालात या प्रेरणा देने वाले तत्कालीन नायकों पर केन्द्रित रहते थे, जैसे–

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Dr. Preeti Sachar

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Archaeological Evidence of Śiva

L.B. Swarankar

Prehistoric Age

India happens to be the sacred land of the gods and goddesses, where, from the time immemorial, several deities had been adored, while some of them disappeared from the Indian religious horizon, as rapidly as they had mushroomed, but some of them were relegated to oblivion with the passage of time becoming redundant. Still, there had been certain deities, who after appearing over the Indian religious horizons never lost their importance and continue here even to the present times, facing all the political, socio-religious and other viscosities. Lord Śiva comes under the last category, because his following never disappeared from the Indian scene after he attained the position of adoration and worship. Besides the ancient Indian literature, even the archeological evidence is quite vocal on the subject for the presence of Śiva has been found in the Harappan culture commonly known as the Harappan civilization which is believed to be the pre-Vedic. The name of the pre-Vedic proto-type of Śiva is not known to us, but Rudra continued to be the principal name of Śiva. The Harappan sites in the country as well as those in Pakistan have the evidence of the presence of Śiva in human as well in the symbolic form. A seal from Harappa displays a horned deity seated cross legged in the forest, stretching his arms upto the knees, which has been interpreted to represent Śiva, in the form of Paśupati, surrounded by the wild life. The inscription over the seal has not been satisfactorily deciphered yet. But the deity is supposed to be the proto-type of Śiva. Even the pre-Harappan sites like Namazga, Kuli and Zhob in Afghanistan and Baluchistan, have yielded terracotta images of Śiva and yonī besides a large number of bulls. This establishes the antiquity of the worship of Śiva in the Indian sub-continent. In so far as the historical sites are concerned, enough of evidence has been forth coming in the form of terracotta artefacts, manifesting worship of Śiva from Ahicchatra, Kausambi, Rajghat and many others.

Vedic and Post Vedic Age

While dealing with the presence of Śiva in the ancient Indian literature, one has to refer to the *Ṛgveda*, wherein Rudra, the violent form of Śiva had been more popular. Indeed, Rudra was the Vedic counterpart of Śiva and the Vedic and Brahmanic characterization of Rudra enunciates as many as a hundred names of the god i.e. Satarudriya in *Śukla-yujurveda*. The glimpses of the presence of Rudra/ Śiva in the *Ṛgveda* are given hereunder:

(i) May Rudra, the lord of cosmic vitality, the vital breath, and divine speech, the all pervading winds send us rains and make us happy.

(ii) O, Resplendent Rudra, men glorify you with hymns. So that you may cherish, their noble deeds, the spiritually awakened sages, in one accord lift up their voice to praise you first and men possessing vital energy also sing forth your praises.

(ii) O Excellent, charitable Rudra you make the enemies to cry, holding all the weapons. O Illustration Maruts.When you being present in the *yajna* drink the *soma* juice, you get fully conscious of your functions.

Yajurdeva

Ruda has been eulogized with a hundred names in the *Satarudiya Saṁhitā* of the *Śukla-yajurveda* of Vajesnehi School. In the *Taittiriya Saṁhitā* of the *Kṛṣṇa-yajurveda*, he has been conceived as having a thousand fold virility. Chapter 16 of the *Yajurveda* conceives Rudra in a variety of forms.

Brahmanical Literature

The adoration of Śiva in the form of Rudra continued during the period of the Brahmanical literature.

Upanisadic Literature

The *Upaniṣads*, besides the Brahmanical have their own importance while dealing with the various aspects of Śiva.

Epics

The epics of Valmiki *Rāmāyaṇa* as well as the *Mahābhārata* besides the *Upaniṣads* have their own importance in the ancient Sanskrit literature and Śiva is conspicuously found present in both these texts. In *Mahābhārata*, Śiva enjoys a prominent place. He is adored in the two exclusive poems in which he is eulogized as Śiva Mahādeva.

Puranas

The *purāṇas* have added immensely to the development of the personality of Śiva. In these texts, many episodes from the Vedic and the post-Vedic literature have been included and further elaborated, highlighting, the benevolent, heroic and the *urga* forms of Śiva. The Puranic literature is so vast that it would be rather impossible to bring in all the important details in the present narration, but still an effort has been made to highlight the presence of Śiva in some of the *purāṇas* in various forms. Another aspect that cannot be lost sight of in this connection that appeared on the Indian religious horizons is the development of iconographic features of the deity with his spouse, which added to the grace of representing Śiva in various forms in the Indian plastic art.

(i) *Agni-purāṇa* (Ch. 53) brings out the essential features of the phallic emblem of Śiva including the mode of sculpturing it and its dimensions besides the measurement of the *pīthas*. The next

Chapter describes the merit of worshipping the phallic emblem made of different substances and other related details.

ii) *Bhaviṣya-purāṇa* (Ch. 85) highlights an episode in which Kṛṣṇa, once went to the Mānsarōvara lake where he meditated Śiva for 12 years. The next Chapter provides a graphic account of the gods who called Kṛṣṇa during his stay at Kailāśa. This event of Kṛṣṇa's visit to Himalaya for the purpose of performing *tapas* (penance) for Śiva has also been found in the *Vayaviya-saṁhitā* of the *Śiva-purāṇa*.

iii) *Brahma-purāṇa* (Ch. 34) narrates the episode of Śiva's destruction of the sacrifice of Dakṣa in considerable detail. According to this account, Sati went to the sacrifice of her father, uninvited, much against the wishes of her husband where she was humiliated for arriving without the invitation. Even Śiva was abused by Dakṣa, as a result of which Sati ended her life in the fire altar of *yajña*. The concluding part of the Chapter relates to the birth performance *tapas* for getting Śiva as her husband. In Chapter-36, Śiva's marriage with Pārvatī is described.

Chapters 205-206, describe the battle between Bāṇāsura and Kṛṣṇa and ultimate marriage of Uṣā- the daughter of Bāṇāsura, with Aniruddha, the grandson of Kṛṣṇa after a battle between Śiva and Kṛṣṇa. The same episode has been included in the *Śiva-purāṇa* as well.

(iv) *Devī Bhāgavata-purāṇa*, [3(51)] narrates how Śiva eulogizes the goddess alongwith Brahma and other gods, calling her the universal mother. According to the Chapter 17 of this *Purāṇa*, Viṣṇū once cursed Lakṣmī that she would never stick to one place and shall always remain on the move being unstable. After the curse, Lakṣmī left Vaikuṇtha and came to stay at the confluence of the rivers Yamunā and the Tamasā in the form of a mare. She spent all her time in the devotion of Śiva having five faces, ten arms and with Pārvatī as his spouse. She spent thousands of years in her meditation. Thereafter, Śiva and Pārvatī appeared before her and Lakṣmī apprised them of her misfortune because of the curse of Viṣṇū. She then prayed to the divine couple to rid her of the curse. Śiva then pronounced that she would be free of the curse after giving birth to a son. Lakṣmī then pointed out that she could not have a son without Viṣṇū, her husband. Śiva then promised that he would send Viṣṇū in the form of a horse and a son named Ekavtra would be born to her and she would be relieved of the curse.

Harivaṁsa Purāṇa (Ch. 188) contains the story of Bāṇāsura who desired to be a son of Śiva and Pārvatī and for this he performed severe *tapas* which pleased the divine couple who granted him his desired wish. Thereafter, Bāṇāsura resided at Sonipat which was protected by Śiva. In the meantime, Uṣā the daughter of Bāṇāsura fell in love with Anirudha, the son of Pradyumna and grandson of kṛṣṇa. Uṣā's maid servant abducted Anirudha from Dvārakā and was brought him stealthily to the capital of Bāṇāsura, where both of them married secretly. Knowing the presence of Aniruḍha in his palace, Bāṇāsura became furious and began a war in which Kṛṣṇa and other Yadavas also joined since Bāṇāsura had been declared as the son of Śiva, the latter also joined the war. A great battle was fought between Śiva and Kṛṣṇa in which deadly weapons were used. The conflict ended at the intervention of Brahma, after which Śiva returned to Kailāśa and Uṣā was formally married to Aniruḍha. But Bāṇāsura was deprived of all his arms except the two natural ones in his fight with Kṛṣṇa.

(vi) *Kūrma-purāṇa* (9.50-51) describes Śiva having three eyes, one of which is in the forehead. He is the lord of the *Bhūtas* having the matted locks of hair and holds a trident. Brahmā and Viṣṇū also describe him as Mahādeva manifested as a great Yogī, having effulgent splendorequal to that

of the ten million Suns put together. He has also been described as devouring the sky as it were, with a thousand crores of months and possessed of a thousand heads and an equal number of feet, having the sun, the moon and the fire as his eyes. The trident bearing lord appears holding the *pināka* in the hand dressed in the tiger's skin, using a snake to serve as a sacred thread and uttering sounds as deep as the rumbling of the clouds.

(vii) The word *liṅga* in *Liṅga-purāṇa* has been used in several ways, the most important and the fundamental meaning of which could be a mark or a symbol. Even in respect of the meaning of the marks distinguishing one sex from the other is further derived from the primary meaning. In its usage all over the Sanskrit literature, this primary meaning has already been kept in view even when applied to a form of Śiva. It is thus the primary meaning that is predominately kept in view as visualized from occurrence in different places in the *Vāyu, Liṅga* and *Śiva-purāṇas*. Chapter 3 of the *Liṅga-purāṇa* is important as much as it projects the meaning in which the *liṅga* is used in connection with Śiva. The word *liṅga* is used here in the sense of a visible symbol. The absolute form, which is beyond all the visible forms, is therefore called a *lingo* (that which has no visible symbol) and as the basis of any later manifestations of a visible form (*liṅga*).

Silpasastras and Tantric Literature

With the advent of the *purāṇas* over the Indian historical horizon, there has been a boost in the popularity of Śiva and his images were conceived (besides the Śivaliṅga) in *ugra, saumya* and benevolent forms. With the development of the concept of Śiva in forms, several types of images of the god had to be made and for that purpose detailed iconographical features had to be developed. Therefore, for the study of the detailed iconography of Śiva, some *Śilpaśāstras* had been composed which defined the various forms of Śiva, with many heads, hands and eyes, etc. A few examples of these projections are given here under:

The Heads

(i) **Single Headed Śiva:** Most of the images of Śiva are presented with single head as would evident from the following.

(a) *Mānsāra* describes Sadāśiva to have a single head with three eyes and *jatāmukuṭa.*

(b) *Aṁsubhedagama* describes Paśupata to have a single head and three eyes. The same text also prescribes a single head for the Ardhanārīśvara form of Śiva. *Uttrakamikāgama* also describes Candraśekhara form of Śiva to have a single head. There are several other such cases described in the texts sometimes the *mukhaliṅga* also has the single head of Śiva curves over it.

(ii) **Two Headed Śiva:** Textual reference to the god having two heads are rarely found but in the representation of art of the god in Ardhanārīśvara form has been found sculpted in the ceiling of the Markula Devi temple at Udaipur in district Chamba of Himachal Pradesh. Here the deity besides the two male and a female part of the body has also two heads, a male and a female joined at the shoulders. The male head wears the *jatāmukuṭa* while the head of the female is adorned with an ordinary crown.

(iii) **Three Headed Śiva:** The earliest reference to the three headed Śiva in the texts is rarely found, but the earliest representation of the deity in this form is found over a seal from Mohenjodaro, projecting a three-headed god wearing, the horned headdress, seated cross-legged over a throne, surrounded by the wild life.

Karaṇagama and *Rūpamaṇḍana* lay down that there should be three faces with a Mukhaliṅga and if so there should be no face at the back; one of the wooden panel found at Dandinulliq in Khotan represents three faced Śiva, seated over a bull mount. The face in the centre is placid while the right one is feminine and the one to the proper left is terrific. The image of Martanda Bhairava preserved in the Rajashahi Museum has three faces. *Uttrakamikagama* prescribes three faces for Trimurti form of Śiva. Śiva with three faces has been found from several sites in the country.

(iv) **Four Headed Śiva:** *Karaṇagama* lays down that the number of the faces of Mukhaliṅga should be four facing the four quarters. It further specifies that the number of faces on Mukhaliṅga should be determined on the basis of the openings available in a particular shrine. Thus, for a temple or a shrine having four openings, there should be four faces drawn over *liṅga* each one of which should face each one of the openings. *Rūpamaṇḍana* prescribes that the western face of Śiva should be white, the northern red, the southern black and terrific and the eastern face should be of the colour of fire. One of the earliest stone *liṅga* with four faces sculpted on all the four sides was discovered from Bhita. Caturmukhaliṅgas are also found during the Kuṣāṇa period. Four faces of Śiva are also found projected over the sculptures of Śiva in stone, etc.

(v) **Five Headed Śiva:** The five faces of Śiva stand for the five *tattvas* viz.: *Sadyojāta*, *Vāmdadeva*, *Aghōra*, *Tatpuruṣa* and *Īṣāṇa*, which are believed to be beyond the comprehension of even the great *yogis*. *Karaṇagama* refers to the five faces of Śiva. A unique collection of five faced liṅga is preserved in the Mathura Museum which dates back to the Kuṣāṇa period. *Samarāṅgaṇasūtradhāra* also refer to the five faces of Śiva with two, four, eight, eighteen, twenty, a hundred or even a thousand arms with fifteen eyes. Each head is studded with a skull. *Aparājitaprccha* attributes five heads to the Sadāśiva form of Śiva.

(vi) **Eight Headed Śiva:** In *Mahābhārata* Śiva has been conceived to be as sadanana or having six heads.

(vii) **Eight Headed Śiva:** The *Viṣṇudhramōttara* prescribes eight heads of Śiva in a form of Umā-mahēśvaramurti and each one of the eight heads is said to be adorned with a *jatābhāra* and a crescent.

(viii) **Twenty-five Headed Śiva:** *Mānsāra* prescribes twenty-five heads of Śiva in his Mahāsadāśiva form. An image of the god from Vaithisvarankoyil at Tanjore of Tamil Nadu has been referred to by Gopinatha Rao, in which twenty-five heads have been shown in different tiers in arithmetical progression. The top tier has a single head, the next below has three and further next five and so on till the last tier has nine heads. The heads on the border triangles are adorned with *jatāmukuṭas*.

(ix) **Thousand Headed Śiva:** Some of the texts eulogize the lord with a thousand heads, arms and feet but the projection of such types of the lord has yet to be found.

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3·4·4

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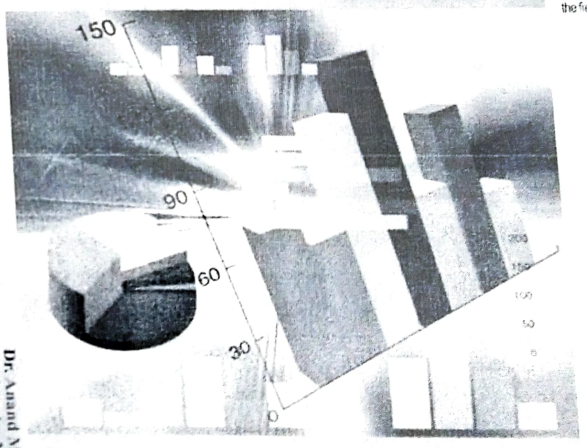

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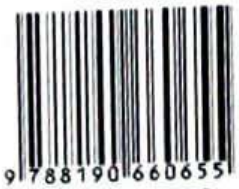

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EXPERIMENT 10

DETERMINATION OF THE TEMPERATURE COEFFICIENT OF RESISTANCE BY PLATINUM RESISTANCE THERMOMETER

Structure

10.1 INTRODUCTION

From your +2 classes you may recall that the resistance of metal depends on its temperature, hence it is a common practice to use metal wire as a temperature measuring device (temperature sensor). Platinum is one of the best materials for this sensor because its resistance varies linearly with its temperature over a wide range of temperatures. Due to its very high melting point, it can be used to sense high temperatures. Moreover, being noble metal, it is chemically inert and is stable in any environment.

Resistance of a wire can be measured by different techniques. If resistance were large, you could use a multimeter and read the value of resistance directly. However, in this experiment you will use a platinum wire, whose resistance is small. In such a case you will use Carey Foster bridge. You have learnt about it in your previous laboratory course.

From your +2 classes you also know that the resistance of a metallic wire is given by