Synopsis Report
on

FIRE DETECTION SYSTEM USING MACHINE LEARNING ALGORITHMS

Submitted as partial fulfillment for the award of

BACHELOR OF TECHNOLOGY

DEGREE

Session 2021-22

in

Information Technology

By:

Prakash Singh 1803213112

Harshit Singh 1803213066

Pragati Gupta 1803213111

Krishna Vishwakarma 1803213084

Under the guidance of:

Dr. Amit Sinha
Head Of Department, IT

DEPARTMENT OF INFORMATION TECHNOLOGY
ABES ENGINEERING COLLEGE, GHAZIABAD

AFFILIATED TO
DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, U.P., LUCKNOW
(Formerly UPTU)

Student's Declaration

We hereby declare that the work being presented in this report entitled **"Fire Detection System using Machine Learning Algorithms"** is an authentic record of our own work carried out under the supervision of **Dr. Amit Sinha, Head of Department, Information Technology.**

The matter embodied in this report has not been submitted by us for the award of any other degree.

Date: 10th November 2021

Signature of student
(Name: Prakash Singh)
(Roll No. 1803213112)
Department: Information Technology

Signature of student
(Name: Harshit Singh)
(Roll No. 1803213066)
Department: Information Technology

Signature of student
(Name: Pragati Gupta)
(Roll No. 1803213111)
Department: Information Technology

Signature of student
(Name: Krishna Vishwakarma)
(Roll No. 1803213084)
Department: Information Technology

This is to certify that the above statement made by the candidate(s) is correct to the best of my knowledge.

Signature of HOD
(Name: Dr. Amit Sinha)
(Information Technology)
Date: 10th November 2021

Signature of Supervisor
(Name: Dr. Amit Sinha)
(Information Technology)
Date: 10th November 2021

Acknowledgement

I would like to express my special thanks of gratitude to my supervisor and HOD (Dr. Amit Sinha) who gave the opportunity to do this wonderful project on the topic (Fire Detection System Using Machine Learning Algorithms) which also helped me in doing alot of research and I came to know about so many new things I am really thankful to them.

Secondly, I would like to thank my parents and friends who helped me a lot in finalizing this project within the limited time frame.

Signature of student

(Name: Prakash Singh)

(Roll No. 1803213112)

Signature of student

(Name: Harshit Singh)

(Roll No. 1803213066)

Signature of student

(Name: Pragati Gupta)

(Roll No. 1803213111)

Signature of student

(Name: Krishna Vishwakarma)

(Roll No. 1803213084)

Table of Contents

List of Figures

List of Tables

List of Abbreviations

Abbreviations	Abbreviation Full Form
NDVT	Neighbors Detection Value Table
WSN	Wireless Sensor Networks
FFNN	Feed Forward Neural Network
GPS	Global Positioning System

Abstract

There are lots of disasters happening in recent times in the world. One of the major disasters which have drawn the most attention is the large area fires, especially forest areas. Forest fires can occur naturally and also sometimes by humans. Forest Fires just does not harm the plants and trees of the forest, but also the animals living in the forest.

It also affects the nearby places where humans live since smoke, carbon dioxide and carbon mono-oxide concentration increases in the atmosphere which can lead to several health problems such as respiratory problems. We can detect the fire by deploying various wireless sensor nodes in the forest areas by which they sense the fire and can inform us, so that we can control the damage to be done by forest fire.

We can increase the efficiency of detection using machine learning techniques on the data collected by various wireless sensor nodes. In this report we will compare some of the machine learning techniques used by researchers with wireless sensor nodes in predicting forest fire

Chapter 1
Introduction

In earlier times fires were detected with the help of watching towers or using satellite images. Paper [8] discussed these approaches. Satellites collect images and send it to the monitoring authority which will decide by seeing images that it is a fire or not. But this approach was very slow as the fire may have spread in the large areas and caused so much damage before the rescue team came. In the watching tower method, there was a man always standing on the tower who would monitor the area and inform if there was fire. This method was also slow because before the man got to know about the fire it may have spread in the inner parts of forest, also it always requires a man who must be present there. Since, we know that some areas, especially forest areas are large so it is practically impossible to put a man in every part of forest from where they can monitor the forest area. So, both these approaches of watching towers and satellite images failed to detect fire as early as possible to reduce the damage done by fire Problems in fire detection:

There were mainly two problems in fire detection as discussed:

(a). Judging criteria for the fire: Threshold is set, if the value is greater than threshold then it is a fire, else not. So, this problem was removed by using machine learning techniques by many researchers.

(b). Connection of nodes: Traditional systems used cables to connect alarm with the detectors. Cable was mainly of copper. But copper wire may be costly or it can suffer from fault in the mid-way. So, this problem was removed using wireless sensor networks.

So, with the advancement in technology researchers find an efficient method to detect forest fire with the help of Wireless Sensor Network. Fire can be detected by deploying sensor nodes in the forest areas by which they inform about the fire. [2] Deploying sensor nodes in the forest area means placing sensors in every part of the forest and mostly in the prone areas where risk of 9 catching fire is more. With the use of wireless sensor networks, now it is easy to detect the fire in large areas as soon as possible.

Chapter 2
Related Work

The basics of project include parameters such as fire causing factors, methodology which are as follows –

2.1 Fire Causing Factors

There are various factors involved when a forest catches fire. The hot and dry weather works as catalysts for fire. Since when there is fire in any region then the temperature of the region will become high due to fire. So, increase in temperature is one of the factors which can help in fire detection events.

But we cannot just depend on temperature to detect fire as the temperature of a region also may increase due to sunlight. So, we can also check the concentration of CO, CO2 gases in that region to detect the fire.

But CO, CO2 gases can also be generated when someone uses the cigarette in that region so it may give false alarm, i.e., false fire event detection. So, to maintain accuracy in predicting the fire event using WSN, researchers in paper [12] presented an approach of setting thresholds on concentration of values. A value is set as a threshold on concentration of CO, CO2. It means that if concentration is greater than the threshold then it is fire, else not.

2.2 Methodology

- In the proposed System monitoring and tracking fires in different areas are done using Wireless Sensor Networks.
- Machine Learning Algorithms are used to detect if there is a fire in a particular area or not.

Chapter 3
Project Objective

In earlier times fires are detected with the help of watching towers or using satellite images. Satellites collect images and send it to the monitoring authority which will decide by seeing images that it is a fire or not. But this approach was very slow as the fire may have spread in the large areas and caused so much damage before the rescue team came. In the watching tower method, there was a man always standing on the tower who would monitor the area and inform if there was fire. This method was also slow because before the man got to know about the fire it may have spread in the inner parts of the area such as forests. Also, it always requires a man who must be present there. Since, we know that forest areas are large so it is practically impossible to put a man in every part of forest from where they can monitor the forest area. So, both these approaches of watching towers and satellite images failed to detect fire as early as possible to reduce the damage done by fire Problems in fire detection.

Chapter 4
Proposed Methodology

Methodology

Dataset is taken from UCI Machine Learning repository; description of dataset is described as below:

- Dataset contains image and video data.
- Image data contains test and train data in image format each having 3 class i.e., default, smoke, fire.
- Test_default has 84 images, test_fire has 57 images, test_smoke has 30 images.
- Train_default has 161 images, train_fire has 274 images, train_smoke has 258 images.
- Video data contains test and train data in video format.
- Test_video contains 3 videos.
- Train_video contains 12 videos consisting of fire with smoke, only fire, only smoke, no fire videos.

4.1 Process Flow

- Loading Dataset.
- Customising (making relevant changes) in the dataset.
- Find the factors (or attributes) which are the most responsible for fire spread.

4.2 Using ML Algorithms

(a). Using Logistic Regression

- train the machine using dataset
- determining accuracy, precision, recall of logistic regression.
- testing the dataset (providing custom input)

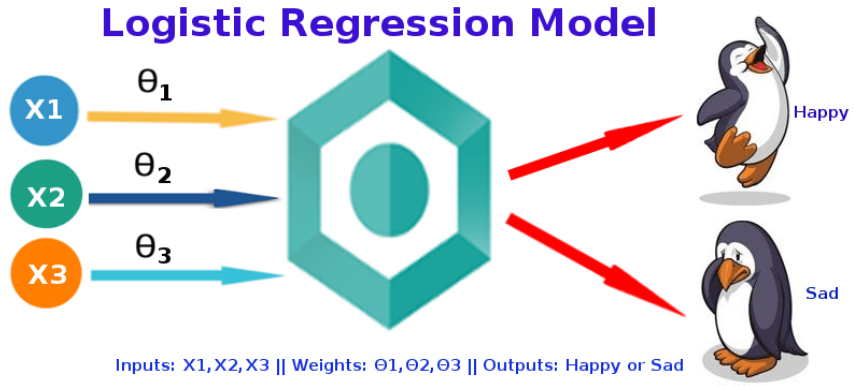

Fig 1: Logistic Regression Model

(b). Using KNN Classification

- train the machine using dataset
- determining error rate and k value
- determining accuracy, precision, recall
- prediction using the test input.

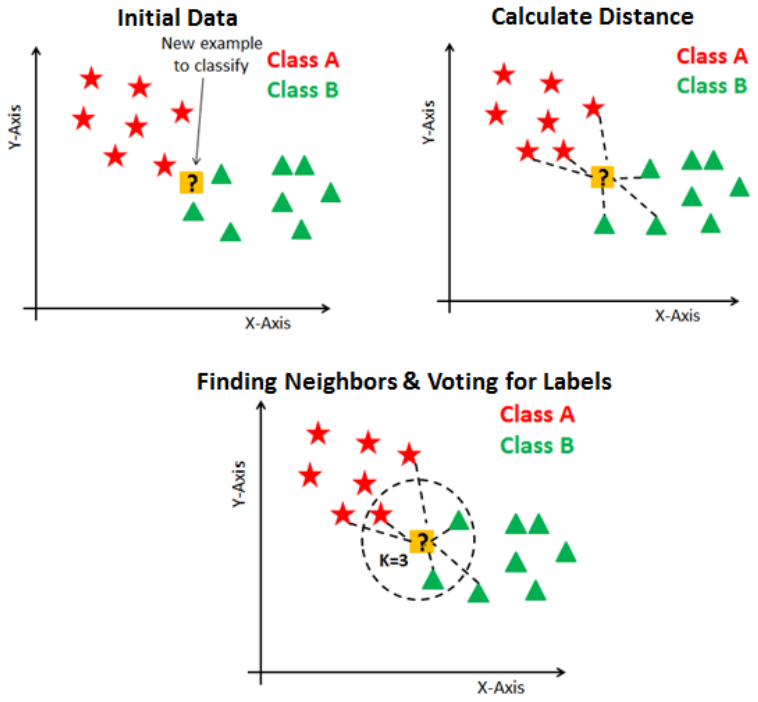

Fig 2: KNN Classification Model

(c). Using SVM

- fit a SVM model to the dataset
- train the machine using dataset
- determining accuracy, precision, recall
- prediction using the test input.

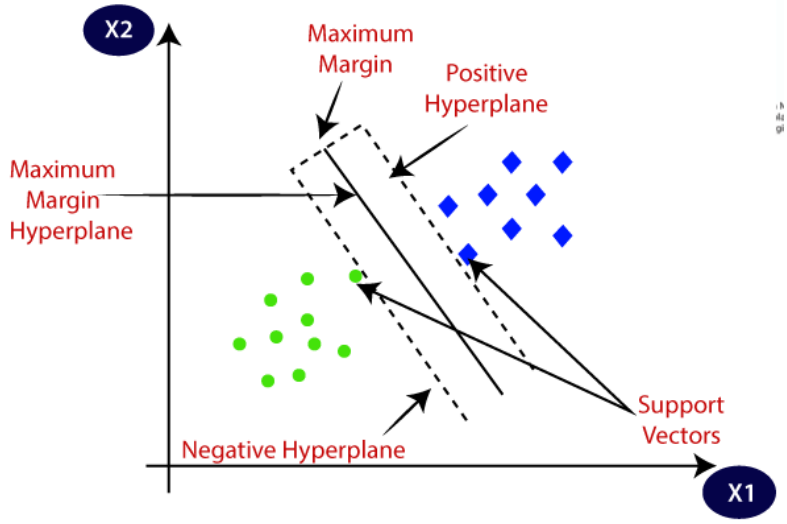

Fig 3: SVM Model

(d). Using Decision Tree

- train the machine using dataset
- determining accuracy, precision, recall
- prediction using the test input.

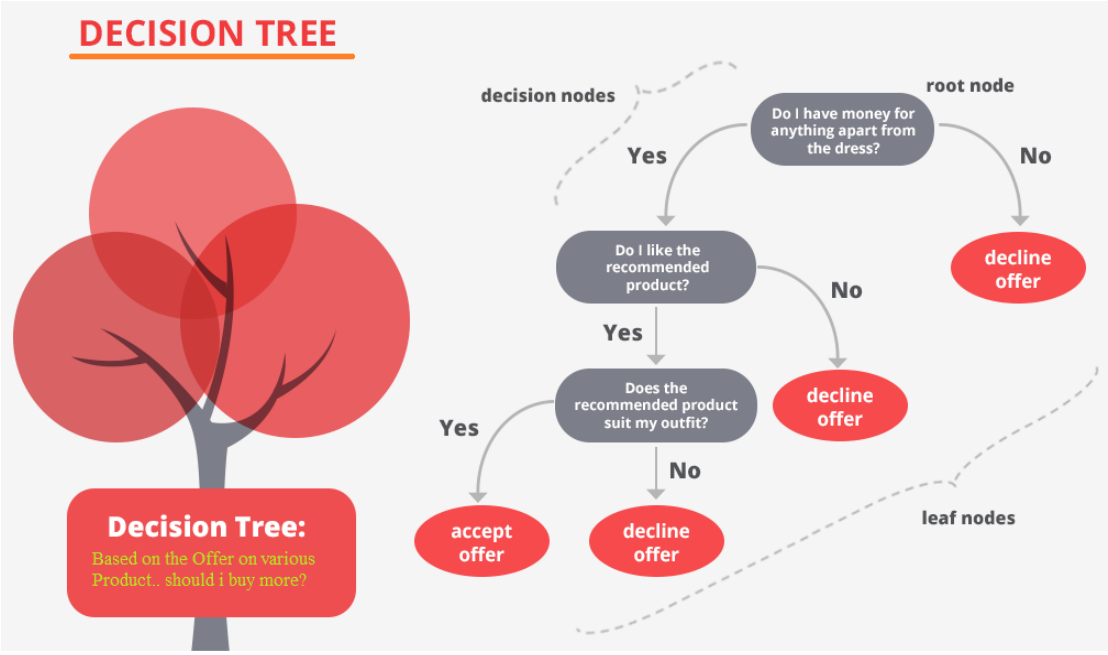

Fig 4: Decision Tree Model

(e). Using Naïve Bayes

- fit a Naive Bayes model to the dataset
- train the machine using dataset
- determining accuracy, precision, recall
- prediction using the test input.

$$P(A|B) = \frac{P(B|A)\ P(A)}{P(B)}$$

using Bayesian probability terminology, the above equation can be written as

$$\text{Posterior} = \frac{\text{prior x likelihood}}{\text{evidence}}$$

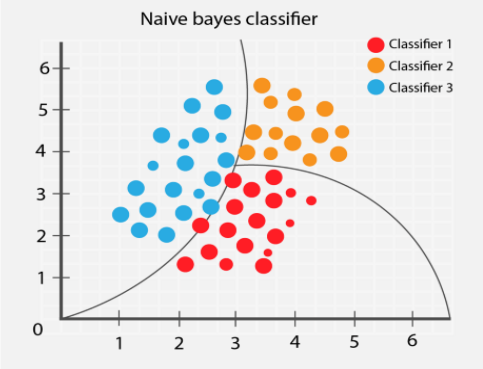

Fig 5: Naïve Bayes Model

(f). Using Random Forest

- fit a random forest model to the dataset
- train the machine using dataset
- make predictions
- determining accuracy, precision, recall
- prediction using the test input.

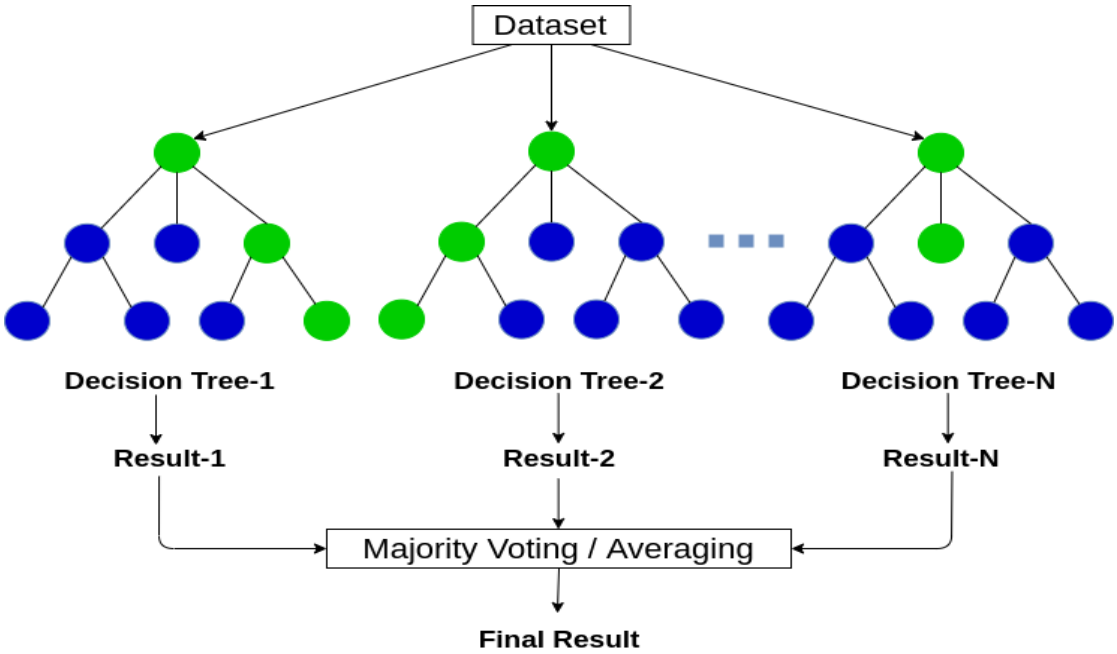

Fig 6: Random Forest Model

Chapter 5
Visualisation of Project Work

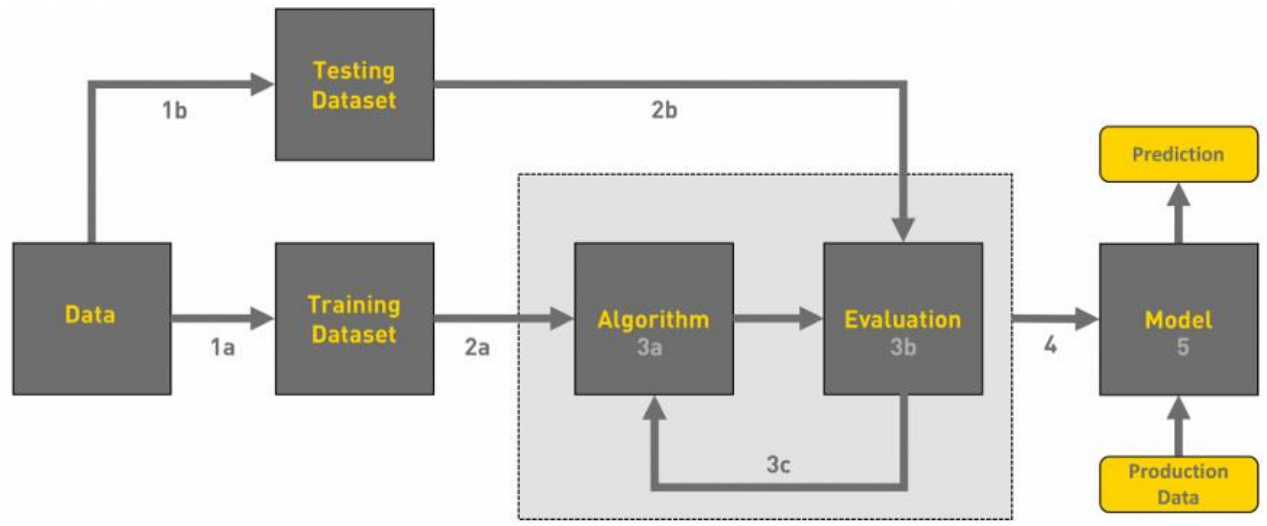

Fig 7: Project Workflow Diagram

- Gathering data
- Data pre-processing
- Researching the model that will be best for the type of data
- Training and testing the model & Evaluation

5.1 Implementation Diagram of Algorithms

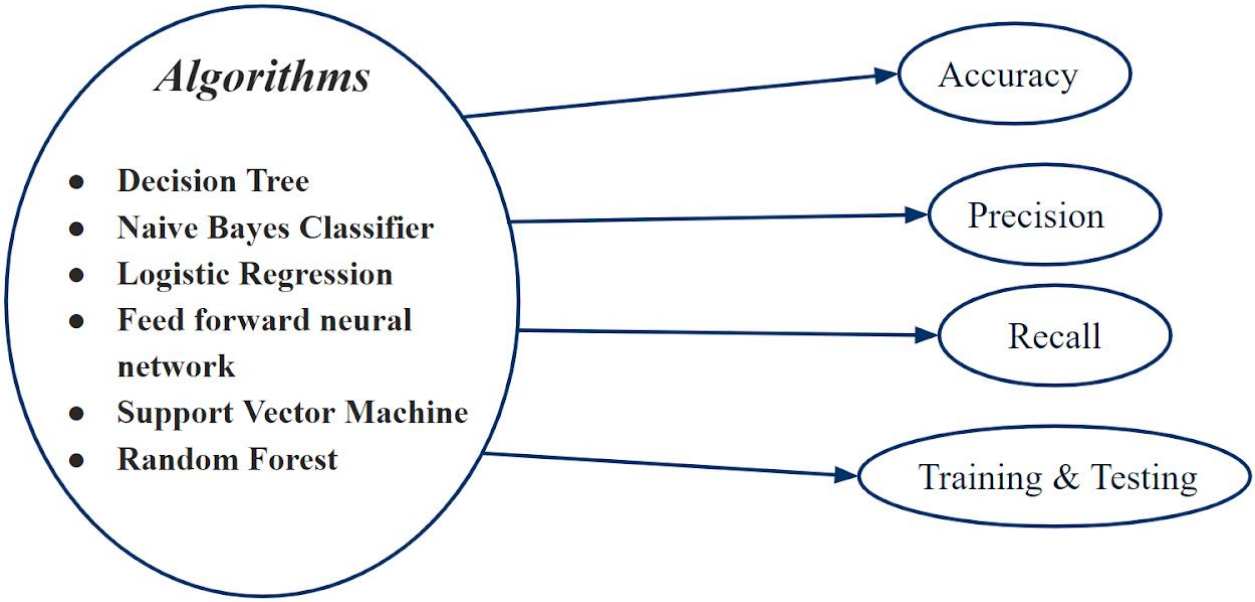

Fig 8: Implementation Diagram

Chapter 6
Results and Discussions

For this purpose, **"Forest-fires.csv"** dataset from UCI machine learning repository was taken and machine learning algorithms were applied to find accuracy of detection. The dataset **"Forest-fires.csv"** contains 517 instances and 13 attributes.

Table 1: Accuracy Analysis of Algorithms

Machine Learning Algorithm	Accuracy
Decision Tree	52.56%
Naïve Bayes Classifier	48.07%
Logistic Regression	55.80%
Support Vector Machine	61.50%
K nearest neighbour	62.82%

Table 2: Process Advantages / Disadvantages

References	**Disadvantages**	**Advantages**
Utilization of AI Techniques for private fire identification in remote sensor organizations.	Risk of delay and bottleneck.	Reduces Fake alarm.
Dispersed Bayesian calculations for shortcoming open-minded occasion locale identification in remote sensor organizations.	Risk of delay due to slow data transmission	Fault tolerant method and high accuracy.
Conveyed occasion identification in remote sensor networks for calamity the board.	False alarm due to faulty nodes.	Low computation overhead due to the decision tree.
Trusted Clustering Based Event Detection for a Disaster Management in Wireless Sensor Network	Increasing no. of nodes can increase complexity.	Reduce False alarms.

Chapter 7
Conclusion and Future Scope

Wireless sensor networks are helpful in detecting events. In the case of forest fire detection wireless network sensor nodes remove the difficulty faced in traditional methods like man standing on a tower and monitoring the environment. Now with the use of WSN we can put sensor nodes in each and every part of forest and mostly in the region where the risk is high. All the data collected by sensor nodes have to be aggregated to reach the result so it is done by using tree based and cluster-based methods.

The machine learning techniques add enhancement to the security of wireless sensor networks. With the use of machine learning techniques, the problem of faulty nodes is minimized. With the use of regression algorithm network lifetime is enhanced and with the use of decision tree algorithm network lifetime is enhanced as well as accuracy. SVM and neural network give better results.

Future Scope

We will be finding a method based on machine learning which will be

- Accurate in prediction
- Fault Tolerant
- Robust

and then finding its space and time complexity and will try to optimise it.

References

[1] M. Bahrepour, N. Meratnia and P. J. M. Havinga, "Use o–f AI Techniques for Residential Fire Detection in Wireless Sensor Networks", AIAI 2009, 2009.

[2] M. Bahrepour, N. Meratnia, M. Poel, Z. Taghikhaki and P. J. Havinga, "Distributed event detection in wireless sensor networks for disaster management", Proc. 2nd Int. Conf. Intell. Netw. Collab. Syst., pp. 507-512, 2010.

[3] G. Wittenburg, N. Dzicngel, C. Wartenburger and J. Schiller, "A system for distributed event detection in wireless sensor networks", Proceedings of the 9th ACM/IEEE International Conference on Information Processing in Sensor Networks, pp. 94-104, 2010.

[4] B. Krishnamachari and S.S. Iyengar, "Distributed Bayesian Algorithms for Fault-Tolerant Event Region Detection in Wireless Sensor Networks", IEEE Trans. Computers, vol. 53, no. 3, Mar. 2004.

[5] M. Bahrepour, N. Meratnia and P. J. M. Havinga, "Automatic Fire Detection: A Survey from Wireless Sensor Network Perspective", 2008.

[6] Karthik, N., & Ananthanarayana, V. S. (2017). Data trust model for event detection in wireless sensor networks using data correlation techniques. In IEEE 4th Conference on Signal Processing, Communications and Networking (In press).

[7] Wu, Q., Cao, J., Zhou, C., Huang, J., Li, Z., Cheng, S. M., ... & Pan, G. (2018). Intelligent Smoke Alarm System with Wireless Sensor Network Using ZigBee. Wireless Communications and Mobile Computing, 2018.

[8] Zaki Ahmad and Abdus Samad, "A Study of Machine Learning in Wireless Sensor Network", International Journal of Computer Networks and Applications (IJCNA), vol. 4, no. 4, August 2017.

[9] Noel Varelaa, Díaz-Martinez, “Wireless sensor network for forest fire detection” The 15th International Conference on Future Networks and Communications (FNC) August 9-12, 2020, Leuven, Belgium

[10] M. O. Oladimeji, M. G. Smiee and S. D. Mieee, A New Approach for Event Detection using k -means Clustering and Neural Networks, pp. 1-5, 2015.

P16

ORIGINALITY REPORT

4%	3%	3%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	towardsdatascience.com Internet Source	1%
2	royallib.com Internet Source	1%
3	D. Arivudainambi, G. Sreekanth, S. Balaji. "Chapter 62 Energy Efficient Sensor Scheduling for Target Coverage in Wireless Sensor Network", Springer Science and Business Media LLC, 2016 Publication	1%
4	connection.ebscohost.com Internet Source	1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		