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# Wireless Sensor Network Assited Coal Fire Detection and Prevention with J48 and Naïve Bayes Classification Algorithm

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***Abstract*—** Thermal coal, non-renewable resources for energy, accounts for 40 percentage of theworld's electricity production. Coal fire occurs in their storage areas emit greenhouse gases like carbon dioxide, methane and other toxic substance which leads to global warming. Also Coal fire in coal warehouse leads to economic loss, loss of human lives. The greenhouse gases and toxic substances have to be detected and neutralized at a fast rate to prevent the fire accidents. Wireless Sensor Network contributes well in early detection of changes in environment condition of coal warehouse. The main objectives of this proposed system is early detection of excess temperature, humidity, gases in coal warehouse and to store the values in Secure Digital card and classify the dataset using J48 and Naïve Bayes algorithm by using Weka explorer to calculate the efficiency, TP rate, FP rate, Precision, Recall, ROC curve, F-measure.

***Keywords*—** Interfacing Sensors, Coal Fire Data, TP rate, FP rate, Precision, Recall, ROC curve, F-measure.

## I. INTRODUCTION

### *A. Fire in Coal Warehouse*

The coal storage area is almost closed having more than one entry/exit point.Sometimes the entry/exit is more than one. But due to poor ventilation and air flow different gases can be accumulated inside the area and they can create suffocation, explosions or fire as explained byZeshanAslam Khan et.al[1]. In coal warehouse heat generated in the environment are allowed to accumulate inside it and the accumulated temperature ignites the coal this process is called spontaneous combustion, where this is the main cause of losing good quality of coal as explored by M.Syed Mohamed et.al [2].Hence, there is a need for detection and monitoring of coal fires in coal warehouse in order to control them effectively. These uncontrolled coal fires occur in all coal warehouse pose multiple threats to environmentbecause they emit greenhouse gases like carbondioxide (CO2), methane (CH4), mercury(Hg), carbon monoxide (CO), and other toxic substances as listed byM.Syed Mohamed et.al[2].

### *B. WSN assisted Coal fire monitoring unit.*

Coal monitoring unit comprises of three sensors they are Temperature, Humidity, Gas Sensors. Temperature sensor is used to collect the temperatures in Coal Storage area. The temperature sensor has three pins, they are (GND, SIGNAL, +V).Humidity Sensor determines the amount of water Vapor present in an environment. There are four pins available in humidity sensor, they are VDD (Power supply), Serial data out, NC (not connected), GND (Ground).The gas sensor used to measure amount of oxygen level in the coal warehouse environment. It has three pins, they are Vcc, GND, Output. These Sensors will get connected with the Intel Galileo board through jumper wires. Values which displays in Serial monitor will be stored in SD card. These values will classify using J48 and Naïve Bayes algorithm in order to avoid Fire accidents in coal warehouse.

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## II. CLASSIFICATION ALGORITHMS

### *A. J48 Algorithm.*

J48 is decision tree algorithm and it is a extension of C4.5, Which is used to construct the model classification process. In decision tree the internal node of the tree denotes a test on attribute branch represents the outcome of the test, leaf node holds the class label and the top most node is the root node. The decision tree algorithm has few base classes the first one is if all the samples in the list belong to the same class. It simply creates a leaf node for the decision tree .The second one is if none of the features provide any information gain, C4.5 creates a decision node Create a tree using the expected value of the class. Finally the third one is if the Instance of previously-unseen class encountered then C4.5 creates a decision node higher up the tree using the expected value [10].

### *B. Naïve Bayes Algorithm.*

Naive Bayes is a practical learning algorithm works based on probability. It is supervised learning algorithm which is highly scalable and suitable for high dimensional data. It works based on Bayes Theorem with strong independence of Naive assumptions. Naive Bayes can combine prior knowledge with observed data. The main advantage of Naive Bayes algorithm is fast to train and classify data and it is insensitive to irreverent features of data set. It can handle real, discrete and stream data well [12].

### *C. Weka Tool.*

WEKA stands for Waikato Environmental of knowledge Analysis. It is a popularsoftware in machine learning, WEKA written in language java. WEKA accepts dataset either in ARFF format or CSV format. WEKA is used calculate the no

of instances in the given data set, Efficiency, Elapsed time, Precision, Recall, F-Measure, ROC curve.

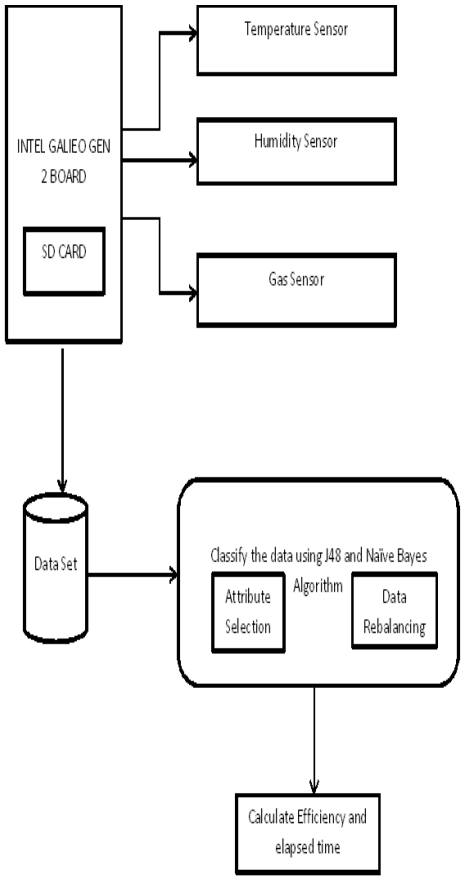


Fig 1: System

System Design comprises of three sensors namely Temperature Sensor, Humidity Sensor, Gas Sensor. These sensors are connected with Intel Galileo Gen 2 Board through jumper wires. The code for these are written and run through Arduino IDE Software. The values collected through Sensors are stored in SD Card which is inserted in Intel Galileo Gen 2 Board. Finally the Stored values will get classified using j48 and Naïve Bayes Algorithm in order to calculate the efficiency and elapsed time of the algorithm.

## III. Implementation

### *A. Interfacing Sensor*

Sensors are sophisticated devices which will detect and measure any non-electrical physical quantity. Sensor converts the physical parameter (for example: temperature, blood pressure, humidity, speed etc…) into signal which can be measured electrically. In this project we interfaced three sensors namely Temperature sensor (LM35), Humidity sensor (DHT11), Gas sensor (MQ2). The challenging work in interfacing sensor is three sensors need to get supplied voltage and ground simultaneously with common Intel Galileo gen 2 board. Hence the bread board is used to supply the voltage and ground simultaneously for three sensors. The output of the Temperature sensor (LM35), Humidity sensor (DHT11), Gas sensor (MQ2) are connected to Analog pins A0, A1, A2 of Intel Galileo gen 2 board. Thus, here three sensors are interfaced and serial monitor of Arduino IDE will display the temperature, humidity, and carbondioxide values of the coal warehouse environment

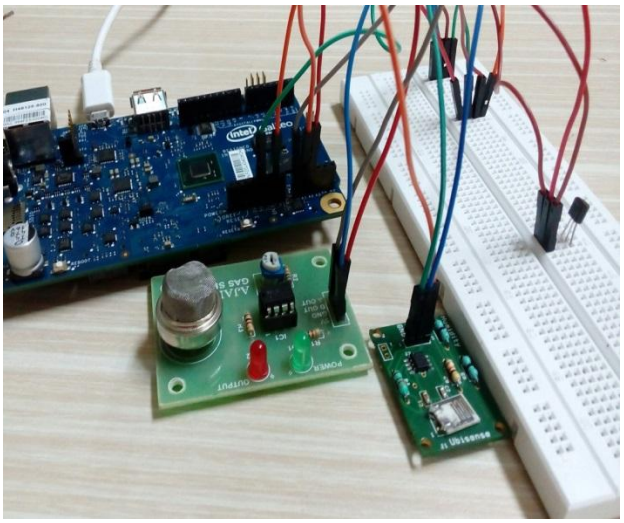

Fig 2: Interfaced Sensor with Intel Galileo Gen 2 Board

### *B. Storing Values in SD Card*

SD card stands for Secure digital (SD) is a non-volatile memory card format developed by SD card association (SDA) for use in portable devices. The SD card used here is a micro size SD card will get inserted in SD card slot of Intel Galileo gen 2 board. The command used to create a text file in SD card is File myFile=SD.open ("filename.txt", FILE_WRITE). myFile is an pointer to the text document, Which need to be stored in SD card. The command to print the values in SD card is myFile.print(" "). The command to print the values in Serial monitor is Serial.print(" ").

## IV. Classification Using J48 And Naïve Bayes Algorithm

Finally, the dataset is collected through sensors and stored in SD card which is in Intel Galileo Gen 2 Board. Experiment are performed on WEKA with 10 fold cross validation. It has proved that statically good enough in evaluating the performance of the classifier. The first step is to find the number of instances of Coal fire dataset using both Naïve Bayes and j48 classification algorithm. In the next step experiment calculates the classification efficiency and Elapsed time. Confusion Matrix**:**Confusion matrix contain information about actual and predicted classification. Standard terms defined for this matrix

- True positive – true positive(TP)(high chances getting Fire explosion in Coal Warehouse)
- False positive-false positive(FP) (False Alarm)
- Precision –precision is measure of accuracy

Precision = tp/(tp + fp)

- Recall-measure the predications

Recall = tp / ( tp + fn).

## V. PERFORMANCE AND RESULT

The values of Interfaced Sensors are displayed on the Serial Monitor of Arduino IDE are shown below.

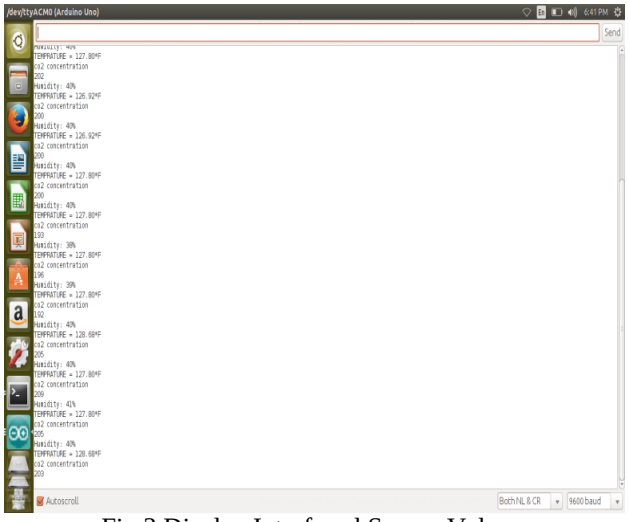

Fig 3.Display Interfaced Sensor Values.

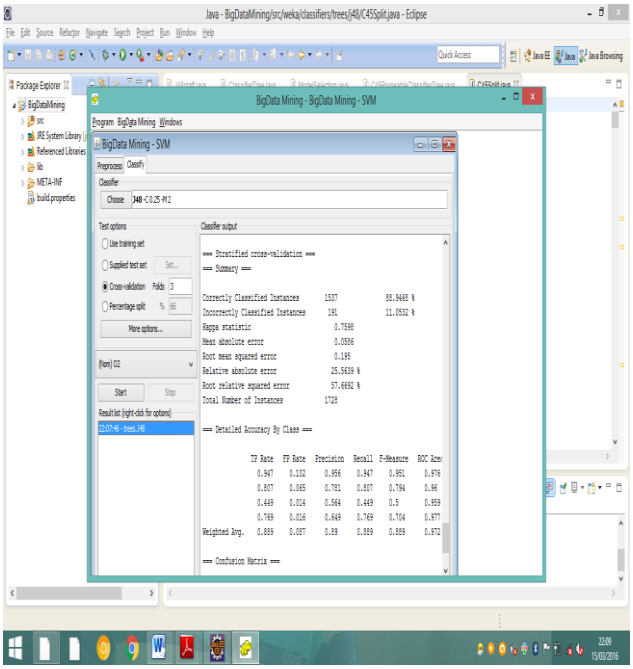

Fig 4.J48 Accuracy Calculation.

In this study we are taking Coal Fire Dataset collected through sensors and for making comparison of two classifier Naïve Bayes and j48. Coal Fire dataset have total no. of 1768 instances. When algorithms are applied to the dataset the confusion matrix is generated.

### *A. Result for Classification using J48*

J48 is a module for generating a pruned or unpruned C4.5 decision tree. When applying J48 on Coal Fire dataset results are as given below:

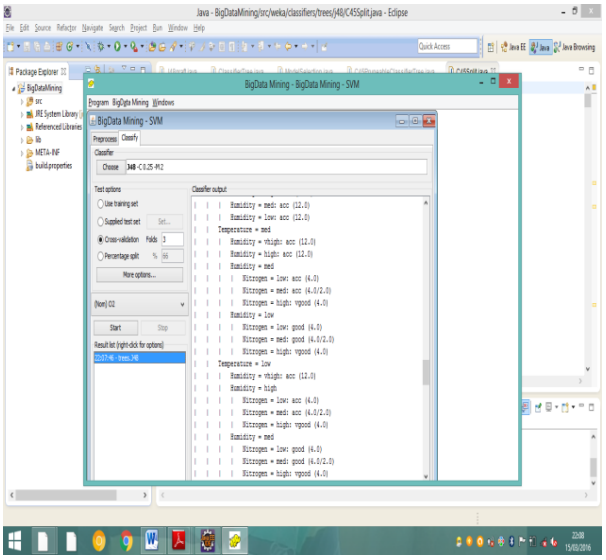

Fig 5.J48 Tree

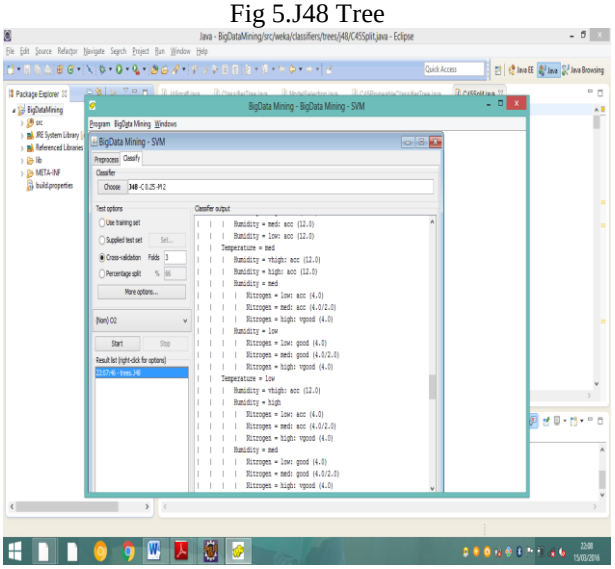

Fig 6. Naïve Bayes Classifier

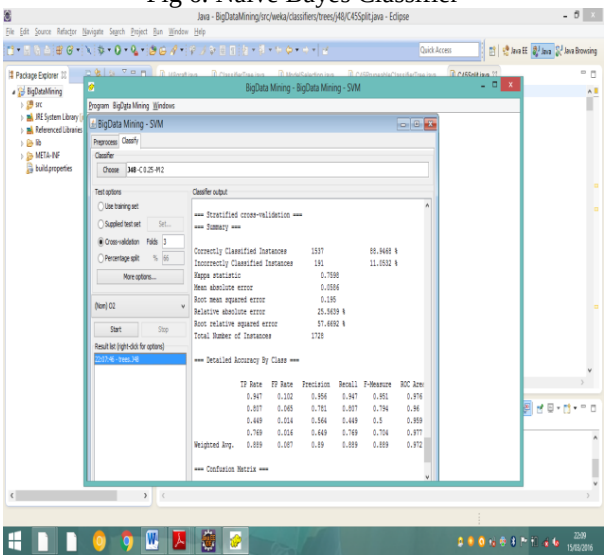

**Fig 7.**Accuracy Calculation

*B. Result for Classification using Naïve Bayes*

When Naïve Bayes algorithm is applied on Coal Fire dataset, we got the results shown below

## VI. Conclusion and Future work

Both the algorithms are applied on the Coal Fire dataset and the results are given below.

| Evaluation Criteria | J48 | Naïve Bayes |
|---|---|---|
| Correctly Classified Instances | 1596 | 1478 |
| Incorrectly Classified Instances | 132 | 250 |
| Predication Accuracy | 50.81761% | 66.9048% |
| Time taken to build a model | 0.09 seconds | 0.04 seconds |

From the result we see time to build the model is less when using Naive Bayes and correctly classified instances are more when using Naive Bayes and prediction accuracy is also greater in Naive Bayes than of J48. Hence it is concluded that Naïve Bayes perform better than of J48 on Coal Fire dataset.

## VII. Future Work

Classification is important data mining technique used to make sense of data. In this study we focused on comparison of two classification techniques and few issues like accuracy and cost. There are still many issues that can be taken into consideration for further research which are as follows:

- Different algorithms which are not included in Weka can be tested.
- The real dataset from the industry can be taken.
- These algorithms can be compared using Tanagra and Matlab tool.

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