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Automated Fire Detection and Prediction System

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Abstract -The paper titled "Automated fire detection and prediction system" is based on internet of things (IoT). Economic growth in modern industrialized societies has resulted in factories, complex office buildings, and dense apartment blocks located in metropolitan areas. Associated gas stations and oil reservoirs, which are all vulnerable to fire due to the flammable substances they house, are also found in these areas. When a fire occurs in such places, firefighting is hindered by the mazes of crowded buildings, high temperatures, smoke, and the danger of explosions. However, in environments where humans cannot work effectively, it's desirable to extinguish a fireplace quickly using fire-fighting robots. Recently, in order to cope with catastrophic fire related accidents, research on fire-fighting robots has advanced in many countries. The paper is developed using an incremental approach for software model development with the goal of placing where it is actually needed and the programming approach is Top-Down. This IoT application is using low cost NodeMCU ESP8266 board which is an open-source electronics platform based on easy-to-use hardware and software. Forest fire is getting worse lately which may be detected and predicted using NodeMCU supported IoT. In this Paper, a temperature sensor, DHT11 humidity sensor, LM35, LDR for light intensity, soil moisture sensor, ultrasonic sensor is interfaced to NodeMCU detects the various parameters produced from the fire. The values are fetched from the Sensor and uploaded to the cloud i.e. in Thingspeak. Using threshold value, the temperature and humidity value is taken into consideration and an analysis is formed to detect fire. When it's detected an email triggered with an alert message with the sensor values and therefore the fire is predicted. It will be built upon an open-source Arduino Software (IDE) which makes easy to write code and upload it to the board. The outcome of this paper is to detect the fire and trigger an alarm to aware everybody thereby giving an email notification to the end user. This can also be used to inform the fire department automatically in case of fire which will help to avoid mass destruction of nature thereby maintaining the ecosystem and providing sustainable solutions.

***Key Words*:**IoT, AWS, DHT11, LDR, NodeMCU, ESP8266, LM35, Arduino, ADXL335, Naïve Bayes

1.INTRODUCTION

In the field of IoT applications for the control of forest fires, several sorts of systems can be used for the warning, prevention and monitoring of those natural disasters. For example, this is often the case of the appliance fire Danger Meter [1] available for Android. It stands out mainly because it's a calculator to seek out the hearth hazard consistent with the classification of McArthur fire Danger Index [2], taking as reference the following parameters: temperature, ratio, wind speed, dryness factor, vegetation and pending. In the same field, Incendios CyL [3] beta application is under development. Although it currently only provides data for the province of Soria, this application has as its fundamental objective to understand a meteorological forecast which indicates during which recreational areas tourists are allowed to form a fireplace, prohibitions and proposals of the way to act in nature, etc. Wildfire is an uncontrolled fire which cause significant damage to natural and human resources. Once the hearth starts ignited it rapidly spreads everywhere the forest and leads to massive destruction [4]. a number of the explanations for wildfire are lightning, extreme hot and arid weather, severe drought, and human unawareness. Over the past decade there's an enormous destruction within the forest, during which the bulk of these accidents were caused by fire. Supported the Forest Survey of India's data on fire it's stated that around 50% of the forest areas as fire prone. supported the forest inventory records, 54.40% of forests in India are exposed to occasional fires, 7.49% to moderately frequent fires and a couple of .405 to high incidence levels while 35.71% of India's forests haven't yet been exposed to fires of any real significance. Between January 1, 2019, and February 26, 2019, a count of 558 fire occurred in India. This incident shows that forests don't have proper fire prevention system.

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2. EXISTING WORK

The issue with the existing system was that it was not cost efficient nor it was service efficient.

2.1 Problem with existing system

- It was difficult to monitor all parameters related to forest fire.
- The existing system was not power efficient.
- There was no feature to implement real- time data monitoring.
- No provision was available for personalized email and push alert features.

2.2 Objective

- The objective is to detect the forest fire as early as possible by measuring the level of temperature and carbon dioxide level.
- Apart from the preventive measures, early detection and suppression of the fire is the only way to maintain the damage and casualties.
- IOT-based forest fire detection system is proposed to detect the fire by monitoring the values of temperature, humidity, light intensity, soil moisture.

3. HARDWARE AND SOFTWARE REQUIREMENTS

Software requirements

- IDE's: Arduino IDE 1.8.5 for Arduino Uno part of the coding
- Cloud API- Thingspeak: For Data Monitoring and analysis
- Programming Languages: C

Hardware Requirements

- Arduino Uno: The Arduino Uno board is a micro-controller based on the ATmega328. It is used to write and upload computer code to the physical board.
- NodeMCU – microcontroller which contains inbuilt Wi-Fi module for communication
- LM35 – Analog temperature sensor gives Temperature value
- DHT 11 – Digital Humidity sensor gives moisture value
- LDR – Light dependent Resistor gives intensity of light
- Ultrasonic – Sensor gives distance values
- Soil moisture –gives digital moisture of ground
- ADXL335 – accelerometer gives vibration of motion values
- Power Supply: The USB port of the Arduino Uno can be connected to desktop/laptop. The current supplied to the board is 500mA at 5V.
- Connecting wires: Jumper wires are used for making connections between items on your breadboard and your Arduino's header pins.

4. ARCHITECTURAL DIAGRAM

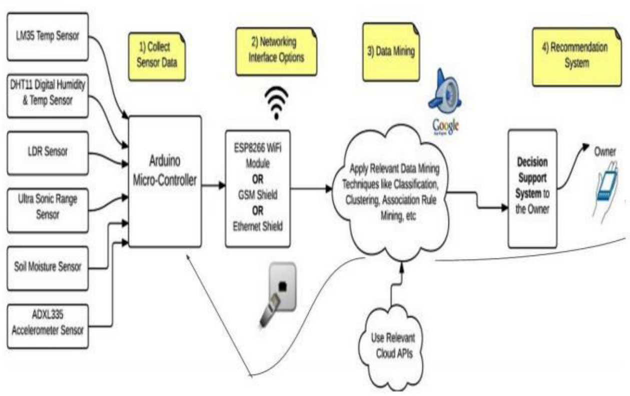


Fig-1: ArchitectureFlow

In figure 1 we see how different sensors are integrated with NodeMCU board and send to cloud. Here we are using six sensors among which DHT11 pin contains vcc pin connected the 5v supply pin in Arduino and second pin is connected to A2 pin of analog side in Arduino, third pins are grounded. it's an analog sensor which us in analog format. Then we are having buzzer which has only two pins during which one is connected to 5v and another is grounded. it's useful for informing the condition. and that we have LDR sensor similarly, it's three pins during which one is connected to 5v and another is given to offer output and another is grounded. it's a digital sensor which provides us in ons and zeros. we'll be using power board because we are using more power consuming inputs so to provide power, we are using it. We are using LCD of 16x2 which is nothing but it's 16(0-15) columns and two rows (0&1). it's of 4 bits because to compress the complication. Arduino here we are using its two sides one is analog pins which is connected to temperature sensor and another side are is digital pins connected to temperature sensors. The soil sensor is attached to the board which also contains 3 pins. The sensor is in a position to convert the analog data to digital data through Arduino and NodeMCU. Thingspeak app is been integrated with the system which is controlling the device from the pair of widgets and gauges. The interface of the applet's the top user to interact with system in additional simple and friendly manner. The app is in a position to send the email/push notification to the required user.

5. RESULTS AND DISCUSSIONS

5.1 Temperature Condition

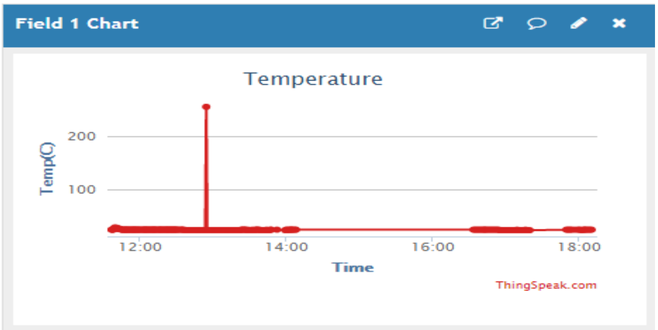


Fig-2: Real time representation of Temperature

In figure 2 we see how temperature sensor's value is been plotted graphically in thinkspeak dashboard which can be monitored by the end user.

5.2 Humidity Condition

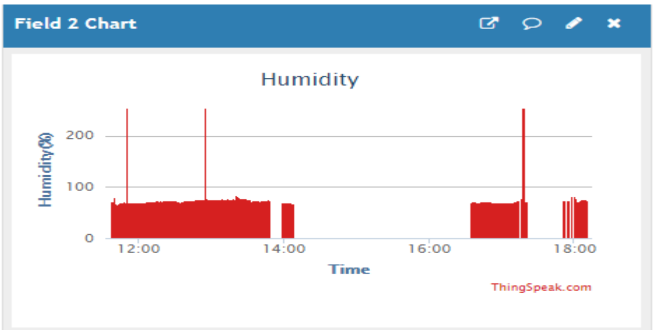


Fig-3: Real Time Representation of Humidity

In figure 3 we can see live humidity data coming from DHT11 sensor's value is been plotted graphically in thinkspeak dashboard which can be monitored by the end user.

5.3 LDR Sensor Condition

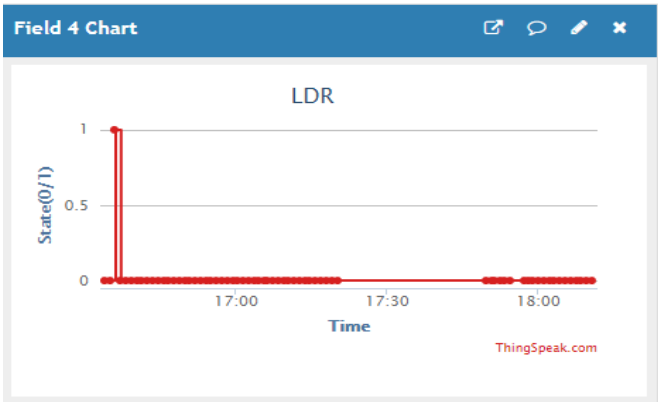


Fig-4: Real Time Representation Of LDR

In figure 4 we can see live light density data coming from LDR sensor which gives the value in 1's and 0's and been plotted graphically in thinkspeak dashboard.

5.4 Distance Condition

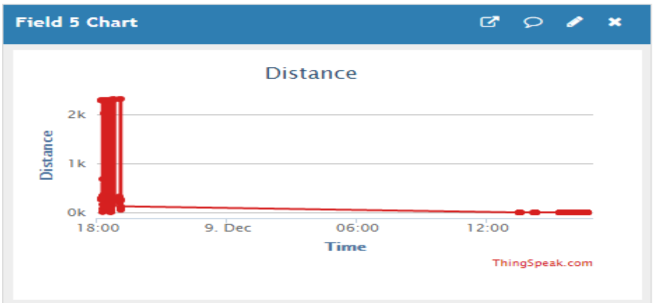


Fig-5: Real Time Representation of Distance

In figure 5.4 we can see live light density data coming from LDR sensor which gives the value in 1's and 0's and been plotted graphically in thinkspeak dashboard.

5.5 Soil Moisture Condition

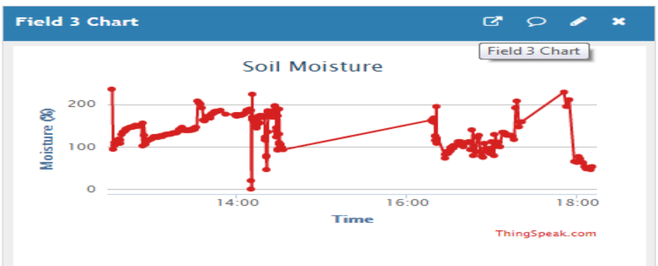


Fig-6: Real Time Representation of Soil Moisture

In figure 6 we can see live moisture data coming from soil moisture sensor graphically in thinkspeak dashboard.

6. RESULTS

6.1 Email Notification

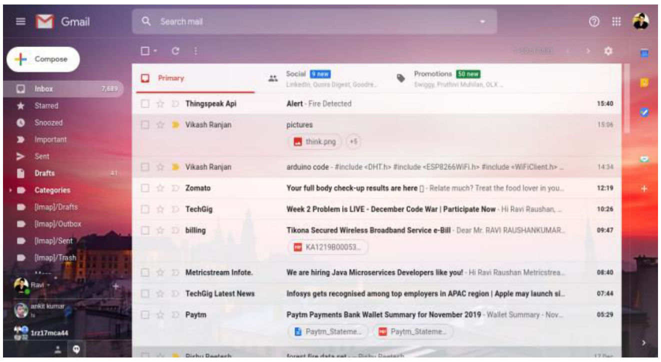
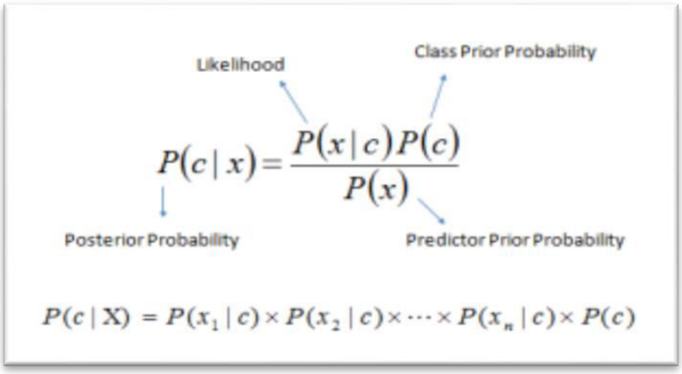


Fig-7: Email Notification to The End User

In figure 7 As the sensor's value exceeds its threshold limit it send the email to the end user as an alert message; so that user can take appropriate action accordingly.

7. ANALYSIS AND PREDICTION

Naïve Bayes Algorithm It is a classification technique based on Bayes' Theorem with an assumption of independence among predictors. In simple terms, a Naive Bayes classifier assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature. For example, a fruit may be considered to be an apple if it is red, round, and about 3 inches in diameter. Even if these features depend on each other or upon the existence of the other features, all of these properties independently contribute to the probability that this fruit is an apple and that is why it is known as 'Naive'. Naive Bayes model is easy to build and particularly useful for very large data sets. Along with simplicity, Naive Bayes is known to outperform even highly sophisticated classification methods. Bayes theorem provides a way of calculating posterior probability P(c|x) from P(c), P(x) and P(x|c). Look at the equation below:



$$P(c|x) = \frac{P(x|c)P(c)}{P(x)}$$

$$P(c|X) = P(x_1|c) \times P(x_2|c) \times \cdots \times P(x_n|c) \times P(c)$$

Fig-8: Bayes Theorem for Calculating Probability

Above,

- P(c|x) is the posterior probability of class (c, target) given predictor (x, attributes).
- P(c) is the prior probability of class.
- P(x|c) is the likelihood which is the probability of predictor given class.
- P(x) is the prior probability of predictor.

The naive Bayes classifier (NB) [11,39,46] is characterized by the conditional independence assumption between variables given the class. Moreover, all variables are included in the model, so the classifier structure is given a priori: complete NB structure. The accuracy obtained with this classifier in its discrete version is surprisingly high in some domains, even in data sets that do not obey the strong conditional independence assumption [14].

Most of the Bayesian network-based classifiers are usually only able to handle discrete variables. However, most real-world domains involve continuous variables. A common practice to deal with continuous variables is to discretize them, with a subsequent loss of information. This work shows how discrete classifier induction algorithms can be adapted to the conditional Gaussian network paradigm to deal with continuous variables without discretizing them. In addition, three novel classifier induction algorithms and two new propositions about mutual information are introduced. The classifier induction algorithms presented are ordered and grouped according to their structural complexity: naive Bayes, tree augmented naive Bayes, k-dependence Bayesian classifiers and semi naive Bayes. All the classifier induction algorithms are empirically evaluated using predictive accuracy, and they are compared to linear discriminant analysis, as a continuous classic statistical benchmark classifier.

```
In [12]: #creating Gaussian classifier
         model = GaussianNB();
         #training the model with training data set
         fitness1 = model.fit(features1, label)
         model.score(features1, label)

Out[12]: 0.6391752577319587

In [22]: #testing and predicting the output
         #0-High
         #1- Low
         #2- Medium
         predicted = model.predict([[2,1,2,1,2,1,2]])
         print(int(predicted))

         1
```

Fig-9: Analysisand Prediction Using Naive Bayes Algorithm

In Figure 9 depicts the analysis been made by Naïve Bayes algorithm which can also be used for future reference.

8. CONCLUSIONS

This paper evaluates the current fire situation and checks all aspects and parameters. Wildfires are among the most prevalent natural disasters occurring without any intervention. This report deals with prevention steps in general, utilizing measurements to prevent fire to a certain degree. The system seen in the paper can be used as an indoor as well as an outdoor network in the case of indoor in homes, shops and factories, as well as in broad woods, dump yards and chemical industries. The analysis been made in this paper can be used as a future reference as a precaution measure for the environment as well as area. It will further look into the various inconveniences and the ways that can be used to automate the process which automatically results in a more secure environment. The inclusion of IOT helps the cause big time as fire is an easy sensory element and the work flow thus can be eased upon significantly.

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