Implementation of Wireless Sensor Network For Detection of Forest Fire

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Abstract- **In this paper, we present a new approach for forest fire detection. As we know, forest fires becomes a serious problem to the biosphere. Therefore, it requires such kind of monitoring system for forest fires which should be able to make a real-time monitoring of the target region and the early detection of fire threats. Here, we are presenting a new approach for forest fire detection which is based on the integration of Data Mining techniques into sensor nodes. The idea is very simple we are going to use a clustered WSN where each sensor node will capable of detecting fire using a classifier of Data Mining techniques. Whenever a fire is detected by any of the nodes that node will going to send an alert through its cluster-head and from that cluster-head an alert will pass through gateways to other cluster-heads. In this way, alert will finally reach to the base station to inform the firefighting crews.**

Keywords- Wireless sensor network, Data mining,

1. INTRODUCTION:

A forest fire is an uncontrolled fire occurring in nature. Sometimes, the forest fire is so large that it takes a long time for the fire fighting crews to gain control over the situation. This could result in massive destruction. In the era of global warming, rising temperature is one of the main causes for forest fires. In 1995,around 3.75 lakh hectares of area was affected in Uttrakhand. In 1999,around 80,000 hectares of forest was destroyed in Ganga-Yamuna doab region .In 2008,the forest fire in Melghat in Maharashtra affected some 10,000 hectares of forest. In 2010, about 19,000 hectares forest were affected by fire in Himachal Pradesh. Sikkim, Uttrakhand and Himachal Pradesh are among the most forest fire affected states of india. Also in 2016 forest fire have been noted in numerous places across the Indian state of Uttarakhand. These fires set mainly in pine forest in the slopes of sub-Himalayan region, produced clouds of smoke. Moreover, forest fire is not only a serious problem in India but it is across the globe. On an account from January 2010 to October 2015 over 8388 forest fires have been counted in the Mediterranean region in France. Forest fires can be deadly threats to the biosphere. It is dangerous for both flora and fauna. In some of these fires, large areas of forests of more than 21954.61 hectares have been destroyed and many people or animals have died which will result in massive destruction. Therefore, the monitoring and early detection of forest fires is required for efficient prevention and protection against the loss. Systems employing charge-coupled device cameras and infrared detectors, satellite systems and images [5] and wireless sensor networks [3,4] are some of the technologies and system which have been proposed to detect forest fire. In this paper we state the detection of forest fire by using wireless sensor network. A wireless sensor network(WSN) is a network that consist of spatially distributed autonomous devices using sensors to monitor different physical or environmental conditions such as temperature, smoke, light, etc and cooperatively pass their data through the network to a main location. A wireless sensor network is usually consist of few sinks and a large quantity of small sensor nodes, which are able to detect, process and transfer data from one node to another. For detecting fire, a sensor node can be placed or installed in the forest so that it collect data such as temperature or smoke, and deliver these data to the base station (sink node) when these data reach to base station, it will be manually processed and analysed. In our approach, we are using the integration of data mining techniques for solving the limitations e.g., for improving the quality of collected data in an intelligent way. Data Mining is a process that extracts the hidden patterns from a large volume of data and a critical component consist in knowledge discovery process [2]. We are also implementing this system in a real time for predictive analysis. For real time monitoring, one of the challenges is to detect the forest fire as early as possible and therefore for the accomplishment of this aim, we have proposed a new approach which is based on Data Mining techniques and a wireless sensor network clustered architecture. Individually Each sensor node is capable of predicting a forest fire by using a classifier of data mining technique. Whenever a fire is detected by any of the sensors, the corresponding sensor node will send an alert to its cluster-head which will pass through gateways and then that alert will pass to other cluster-heads until it reaches to the base station to inform the firefighters. After receiving the message from the base station in our system, fire fighters will take further actions.

2. LITERATURE REVIEW:

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In past many years, several studies have been done for forest fire detection using wireless sensor networks. The authors Massinissa Saoudi, Ahcène Bounceur, Reinhardt Euler, Tahar Kechadi of [1] proposed Data Mining Techniques Applied to Wireless Sensor Networks for Early Forest Fire Detection in which the goal was early detection and high accuracy of the localization of forest fire for a rapid intervention of firefighting personnel at the correct place.

The authors, Mirjana Maksimovi´c and Vladimir Vujovi´c of [2] proposed various data mining techniques on WSN by using weka tools. Its goal was to perform comparative anaysis of various data minining techniques and to determine which one is best suited for fire detecion.

The authors, Yunus Emre Aslan, Ibrahim Korpeoglu, and Ozgur Ulusoy of [3] proposed the various cluster network architecture for forest fire detection that provide effective and efficient way to consume less energy.

In [4], the authors, Hamdy Soliman, Komal Sudan, and Ashish Mishra proposed another methodology for forest fire detection which combines WSN with artificial neural network(ANN). In this system they gathered the data from the particular region throgh WSN by sensors(like temperature and smoke). Then these data are transmitted to ANN at base station. Then the base station use that received data to test whether it belongs to fire class or not.

In [5], the authors, Jaime Lloret, Miguel Garcia, Diana Bri, and Sandra Sendra proposed a unique methodology For forest fire detection. In this, they are conbining wireless local are network with sensor node technology for detction of forest fires. They use multi-sensor nodes and IP cameras for detection and verification of fires.

3. PROPOSED METHODOLOGY:

When a fire is detected, the corresponding node will send an alert through its cluster-head which will pass through gateways and other cluster-heads until it will reach the sink in order to inform the fire fighters.

Through extensive simulation experiments and its hardware implementation, we show that our approach can provide a fast reaction to forest fires while consuming energy efficiently.

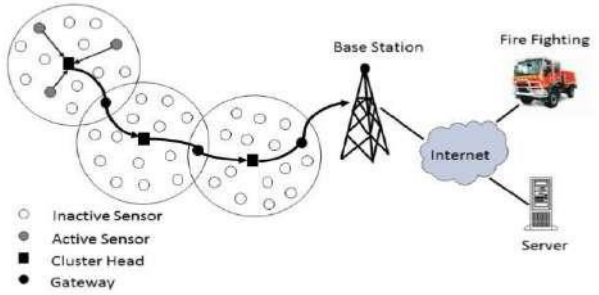

Figure 1: architecture of forest fire detection

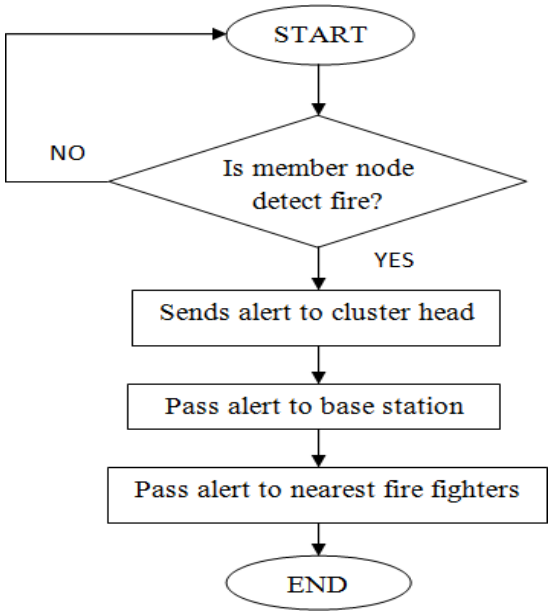

Figure 2: Flowchart for implementation of wireless sensor networks for forest fire detection

3.1 Hardware Implementation:

In real time implementation, we have designed a cluster that consist of four nodes, a cluster head, a base station which is connected with GSM module.

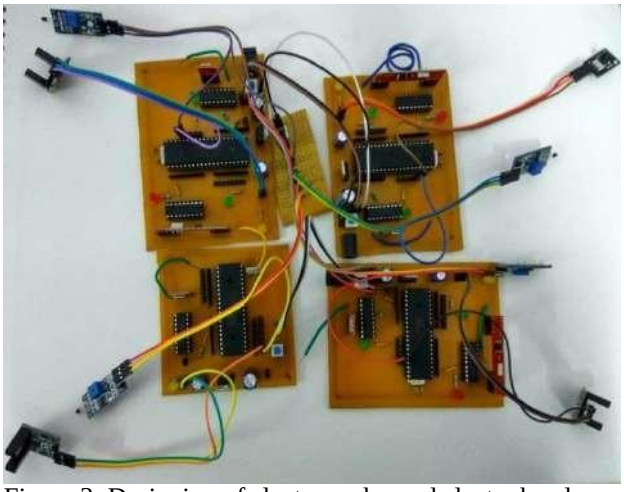

Figure 3: Designing of cluster nodes and cluster head

In our approach,first we have designed a cluster as shown in figure 3. For designing cluster nodes and its head we have used PCB plates. Each node consist of two sensors(i.e., temperature sensor and smoke sensor). It also consist of IC 8051 microcontroller, Encoder IC HT12E, Decoder IC HT12D, Regulator IC 7805, Receiver, Transmitter, LED's.

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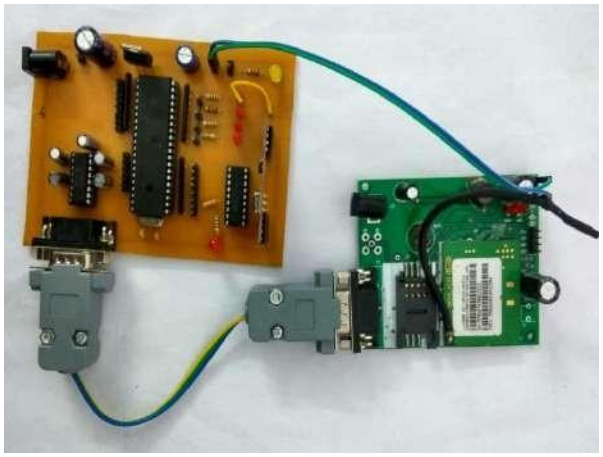

Figure 4: Base station with GSM module

Then, we have designed a base station and connect it with a GSM module as shown in figure 4. Base station receives an alert from the cluster head and has capability of detecting the node in which fire is detected. In our work, we have connected the base station with the GSM module for sending a message to fire fighters. Base station consist of IC MAX 232, IC 8051 microcontroller, Decoder IC HT12D, Regulator IC 7805 and LEDs.

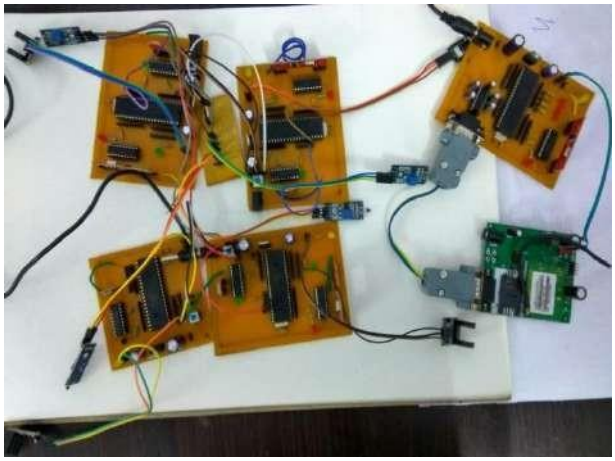

Figure 5: Connection setup of the hardware components

As shown in figure 5, we have done a setup of wireless sensor network with a base station and a GSM module.

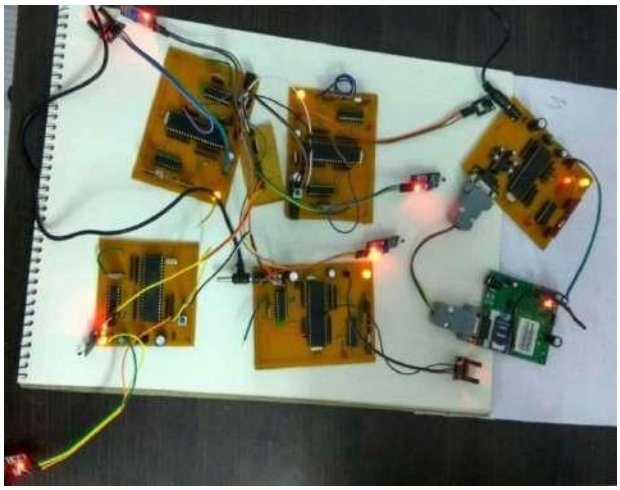

Figure 6: Implementation of wireless sensor network for detecting fire

Figure 6 shows a successful implementation of wireless sensor network for forest fire detection. Here, when a smoke sensor of first node detect smoke, it send an alert to cluster head and then cluster head will pass it to the base station. When base station receives an alert it will notify the alert by blinking its first LED and sends the SMS to fire fighters using GSM service to take further actions.

Our work is mainly divided into four parts: Clustering, Routing, Fire Detection and Routing alert.

3.2 Clustering:

Clustering is the grouping of a particular set of objects based on their characteristics, aggregating them according to their similarities.In our work we have use cluster of wireless sensor network as it has various advantages:

- It transmits aggregated data to the data sink, reducing number of nodes taking part in transmission.
- It is useful in energy consumption.
- It provides scalability for large number of nodes.
- It also reduces communication overhead for both single and multi-hop.

TABLE II.

3.3 Routing:

In our work, we are using routing algorithm based on cluster network. At the beginning, after applying clustering algorithm, the routing table is empty. When the sink(base station) sends the discovery route message containing its idi, then the corresponding gateways will receive the message and store the identifier idi of the base station in the routing table, then that gateway node will pass that meassage which contain identifier idi to the corresponding cluster-heads except the base station. After receiving the meassage of route discovery, the cluster head will store the gateway identifier idi in their routing table and this process will continue until all the cluster-heads and gateways receive the discovery route message. When all the cluster-heads and gateways received the message, they send the meassage to the sink(i.e., base station). For routing the meassage to the sink, multiple paths can be used by cluster-heads and gateways.

3.4 Fire Detection:

Our work is based on real time monitoring of data in the targeted region. For detection of forest fire, we use two different sensors, i.e., temperature sensors and smoke sensors. When the temperature exceeds its defined limits or smoke is detected then sensor will predict the fire. After detecting the fire, it will send an alert to its cluster-head. This cluster-head then pass that alert to the next head through the gateway. The last cluster head then finally pass the alert to the base station where base station will determine the concerned node or

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cluster in which fire is detected and finally notify the fire fighters to take further actions.

4. EXPECTED OUTCOME:

The expected outcome in our work is that each of the sensor node is capable of detecting the fire. When a fire is detected by a sensor node, it will send an alert to a cluster head. Then this cluster head will pass that alert to the next cluster head through the gateway. In this way the alert will pass to the base station, then the base station will send the message to nearest fire fighters.

5. FUTURE WORK:

Our future work will be based on providing the best classification techniques for comparative analysis of various data mining techniques. Also we will work to provide more efficient clustering algorithm for forming WSN which require less response time. By using efficient clustering algorithm we can make our WSN less energy consuming. We also wants to provide more secure exchange of data throughout the network.

6. RESULT:

As per our expectations, we have successfully performed simulation experiments and implementation. We have shown our work in simulation by using MATLAB.In simulation, there are number of clusters. Each cluster consist of a pairs of temperature sensor and smoke sensor. Whenever the fire is detected by any of the member node, it will send an alert to its cluster head. The cluster head will pass that alert to the next cluster head through gateway. In this way, alert will finally reach to the last cluster head and it will send that alert to the base station which has capability of detecting the node in which fire is detected and finally the message will send by the base station to the nearest fire fighter. We have also done the real time implementation for forest fire detection in which same approach is used. In this, each cluster is using the shortest path to send an alert to the base station. For notifying the fire fighters, the base station sends message through GSM.

7. CONCLUSION:

In this paper, we proposed a new approach by using wireless sensor networks for forest fire monitoring and detection. This work is based on measuring and combining real data from diff erent sensors (temperature, smoke). We have taken into account all the characteristics of wireless sensor networks that include low energy capacity computing limitations, low memory capacity of sensor nodes and various environmental conditions which can affect detection of fire and WSN performance. Our work is based on monitoring the real data from different sensors (i.e., temperature and smoke) and applying classification of data mining techniques for forest fire detection. A node itself detect fire Then it abort the normal values and sends the abnormal values to base stations for detecting the location of fire and to inform the fire fighters.

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