Forest Fire Detection using Temperature Sensors Powered by Tree and Auto Alarming using GSM

[1]R. Chandrasekharan, [2]Ashiq M.I, [3]Dr. V. Prakash

1. Professor and Head in Department of Electronics and Communication Engineering, C.S.I College of Engineering, Ketti
2. Assistant Professor in Department of Mechanical Engineering, Easwari Engineering College. Chennai.
3. Professor in Department of Chemistry, C.S.I College of Engineering, Ketti

Absract: **This project proposes an effective viable solution for detecting forest fires, in this paper the system incorporates GSM network, so that the signal could be sent any far distance, where the centralized control centre is located. The proposed system consists of smart sensor which uses tree power for its operation and a GSM module which is connected to the GSM network for transmitting the detected fire alarm signal. When fire is detected, the sensor produces a signal of approximate level which triggers GSM module to transmit the alarm signal to far end control center. The center in turn processes the signal and takes necessary action to counteract the situation. Since the smart sensor in the system powered by tree and the GSM module is powered by solar energy there is no need for conventional electrical energy. It is expected that the system could be a cost effective one and a viable one for detecting fires.**

1.1 INTRODUCTION TO FOREST FIRES

Earth observation has been an integral part of managing human societies for millennia. In the 21st century, mankind has substantially altered the major bio-geochemical cycles on global scales possibly augmenting risks emanating from changes in the behavior of the total Earth system. One of these new risks is linked to an increase in fire calamities, which possibly could cause negative feedbacks to the global carbon cycle, impair ecosystems functions, cause human casualties, and destroy valuable human assets. Thus, in order to attain sustainable development goals, the management of many observation subsystems in a coherent, efficient, and effective manner is needed.[1]

The use of sensor networks covering large territories to ensure the effective monitoring of such phenomena as wildfires remains to be a problem of particular interest and significance [2].There are currently a number of approaches to address this problem. However, from a technical point of view, it has not been completely and effectively resolved as yet [3]. Traditionally, the monitoring task was performed by a specially trained team in a lookout tower located at a high point [4]. This method of monitoring is still applicable in some countries, such as the US, Canada, and Australia. Due to unreliability of human observations, some vision techniques have been proposed to monitor small forests from the tower [5]. Satellite imaging, for example, though able to ensure sensing of vast areas, has, as a method, considerable restraints in terms of real-time spatial resolution and sensitivity. In addition, it is associated with the exceptionally high deployment and operational costs, which make it difficult to use in all cases [6, 7]. Another widely applied method of monitoring wildfires or gas leakages is based on getting data on the emissions source. The ultra sensitive devices installed aboard the airplanes, trailers, and other vehicles enable the acquisition of data in cross patterns [3]. This approach requires the availability of operators and maintenance personnel. Its main shortcoming, however, is that spatial and time resolution is limited to a point measurement at the vehicle current location. Apart from that, in the case of using airborne platforms their ultrahigh sensitivity should be provided to detect ground emissions after the gases have propagated to a considerable distance from the sources. In order to simplify and reduce the costs of fire monitoring, the concept of Wireless Sensor Networks (WSNs) [8] has been recently proposed. Cheap and compact wireless sensor devices deployed over a large territory and operating both jointly and autonomously may be effectively used to detect hazardous gases and monitor wild-fires [9].Forests Fires is the most universal and most immediate destructive agency. This is usually caused due to carelessness and negligence but exceptionally because of matchsticks, friction of rocks etc. Deliberate fires are called incendiary fires are caused. by grazers of cattle for fresh shoots of grass by poachers who collect Minor Forest Produce (M F P) and occasionally by vandalists wantedly.

1.2 THE CAUSES FOR FORESTS FIRES ARE

1. Less moisture content in the fuel
2. Wind movement
3. Topography
4. Forest cover
5. Debris burning
6. Camp fire or fire used for cooking
7. Incendiary
8. Lighting of match sticks negligently

1.3 TYPES OF FOREST FIRES

Forest fires can usually be divided into three categories namely

1. GROUND FIRES

2. SURFACE FIRES

3. CROWN FIRES

1. GROUND FIRES:

These occur in the humus and peaty layers beneath the litter of composed material on the forest floor and produce intense heat but practically no flame. Such fires are relatively rare and have been recorded occasionally at high altitudes in Himalayan fir and spruce forests. This kind of fires is the most difficult to detect because they are undetectable until they blaze up. Generally by the time they are detected, the forest undergrowth is already reduced to ashes, killing all the animals that live underground.

2. SURFACE FIRES:

Surface fires, occurring on or near the ground in the litter, ground cover, scrub and regeneration, are the most common type in all fire-prone forests of the Mediterranean countries. In this type, the spread of fire is regular and usually depends on wind speed.

3. CROWN FIRES:

Crown fires occur in the crowns of trees, consuming foliage and usually killing the trees, these fires occur most frequently in low level coniferous forests. Crown fires the most dangerous fires for a forest, spread rapidly and widely.

1.4 MEASURES TAKEN TO PREVENT FOREST FIRES

The main measures taken to prevent Forest fires are by way of

1. Fire lines

2. Fire walls

1. Fire lines:

Fire lines help to reduce the spread of fire. They are some times naturally formed and some times artificially chopped stripes of land capable of stopping or checking spread of fires and are being used to fight fires.

2. Fire walls:

The Construction of walls with a width of 3 feet or 4 feet and not less than 5 feet to 6 feet and dividing forest in to sectors is done to control the fire without spreading to the entire area. The wall length depends on the slope of the forest. The cleared materials are burnt or taken away. Firewalls are most effective during the fire season.

TYPES OF FOREST FIRE MONITORING AND DETECTION SYSTEMS

In the following subsections, we will briefly review the common approaches to monitoring and detection of forest fires

2.1 WORD-OF-MOUTH FOREST FIRE MONITORING SYSTEM

The word-of-mouth forest fire monitoring system is widely used in the world. It is a human community based bushfire detection system, which utilizes interpersonal communication to transmit forest fire information. Research by the United Nations points out that many human communication chains can be formed through interpersonal communication. These chains would become active in the case of important events. Therefore, if a Forest fire occurs, a warning message is conveyed through human communication chains and reaches a fire service department or an emergency centre.

2.2 FIRE WATCH-TOWERS FOREST FIRE MONITORING SYSTEM

When forest fire detection system is mentioned, fire watch-towers are most likely to leap to mind. Forest fire watch-towers are constructed in a pyramidal shape to provide stability, with a cabin at the top, where an observer is located to spot fires. The towers are usually 10–20 m high and constructed on flat-topped hills, or 30–40m high are commonly used on fairly flat terrain to provide a good view over the surrounding tree cover. Some equipment is provided in the cabin to facilitate detection, recording of information and communication. When observers detect a fire, they guide the pointer of the azimuth angle and report to a forest division or forest enterprise office by telephone or radio transmitter, an observer detects a fire and notes the azimuth angle of the direction of the fire, then a warning message is sent to the forest division or the forest enterprise office by telephone or radio transmitter the office determines the place of fire by using the forest map.

2.3 GROUND AND AERIAL PATROL FOREST FIRE MONITORING SYSTEM

Ground patrolling is carried out by foresters and temporary fireguards. These people undertake forest fire detection, protection and control all round, in addition to their normal and regular duties. A patrol personal communicates the information to a base station, e.g., fire watch-tower, regularly. Therefore, when a forest fire occurs, the patrol personal is in radio contact with fire towers and their headquarters. Aerial patrolling requires hiring an aircraft to watch from the air. Although such approach is expensive, it is commonly used for enhancing other methods of detection. Aerial patrolling is usually used for special purposes, such as to provide an additional detection during fire danger periods. The main working processes of this system starts by the ground or aerial patrolling detection for forest fire, then report to fire watch-tower or forest enterprise office using a radio.

2.4 SATELLITE-BASED FOREST FIRE MONITORING SYSTEM

A report indicates that systems based on space technology can efficiently monitor forest fire because they can locate fire quickly and precisely, in addition to providing extra information, such as temperature. Most of these systems mainly depend on satellites, which include remote sensing technology such as infrared technology. Thus, they are called satellite-based forest fire monitoring systems. Usually, such system consists of two components, satellite and communication network. Their operation process is portrayed as follows. A satellite will monitor ground from space through embedded sensor network, if fire is detected, the satellite will activate forest fire warning sirens. Then, warning messages will travel outwards via communication network, for instance, satellite-computer linkages, ground receiver station, aircraft receiver station, and sea receiver station. Finally, warning messages will be sent to an official department.

INTRODUCTION TO PROJECT

This paper proposes an effective viable solution for detecting forest fires, in our project the system incorporates GSM network, so that the signal could be sent any far distance, where the centralized control centre is located. The proposed system consists of smart sensor which uses tree power for its operation and a GSM module which is connected to the GSM network for transmitting the detected fire alarm signal. When fire is detected, the sensor produces a signal of approximate level which triggers GSM module to transmit the alarm signal to far end control center. The center in turn processes the signal and takes necessary action to counteract the situation. Since the smart sensor in the system powered by tree and the GSM module is powered by solar energy there is no need for conventional electrical energy.

THE PROJECT CONCEPT

The project consists of constructing a device which can effectively detect forest fire and avoid it without human intervention. The main component of the project is a mill volt flame sensor which can function at low voltage levels. This low voltage is tapped from the tree using specific electrodes. Thus the flame sensor functions on green energy. On detecting forest fire in the initial stage, the sensor sends an alarm signal to the FIRES STATION using GSM. To reduce the forest fire on detection, a standby system of pump along with a reservoir is used in forest covers having water resources.

PROCEDURE IN DETERMINATION OF PH IN TREE AND SOIL

ANALYTICAL PROCEDURE:

After calibrating the digital ph meter, the ph buffer solution is replaced by the tree samples and soil samples one by one for obtaining the ph of the sample solution, to record a steady ph, each solution should be left undisturbed for nearly eight hours. The ph obtained for various tree samples and soil samples were recorded and tabulated from the digital ph meter.

ANALYSIS ON THE CONDUCTIVITY OF DIFFERENT LABELED SAMPLES

ANALYTICAL PROCEDURE:

After calibrating the conductivity meter, the distilled water solution is replaced by the tree and soil samples one by one for obtaining the conductivity of the sample solution, to record a steady conduction, each solution should be left undisturbed for nearly eight hours. The conductivity obtained for various tree samples and soil samples were recorded and tabulated from the digital conductivity meter.

FIELD STUDY ON THE OUTPUT FROM THE TREE

The output of different trees were analyzed and recorded for various metal combinations which gives the change in output voltage. This field study was done for a time interval of one hour, the study was done from 9.00 am in the morning to 5.00pm in the evening.

PROCEDURE INVOLVED IN THE FIELD STUDY

The selected sample tree was tested with the multimeter to find out the rough voltage which is available from the tree. Since the selected sample tree was having a low voltage range, we used different metal combinations to boost the voltage which does not require any external supply for boosting from a low voltage range. The metal electrodes used for this boosting were made like a cone with a pointed end and then it was nailed into the trunk of the tree. The other metal electrode used was nailed with a depth of 15.24 cm (6 inches) into the soil which is having a compact soil texture. Using a multimeter the output voltage was now checked after introducing electrodes which was boosted from millivolts to volts.

STATISTICAL DATA ON THE ANALYTICAL ANALYSIS ON PH OF SOIL AND TREE SAMPLES

Table no: 1

S.NO	TREE SAMPLE	SOIL SAMPLE	PH
1.	Acacia nilotica	-	**3.46**
2.	Thorn	-	**6.08**
3.	-	Coconut	**6.70**
4.	Acacia	-	**7.15**
5.	-	Acacia	**5.12**
6.	Silver Oak	-	**6.16**

INFERENCE FROM THE STATISTICAL DATA ON THE ANALYTICAL ANALYSIS ON PH OF SOIL AND TREE SAMPLES

The experimental results obtained from the analytical analysis on ph of the soil and tree samples, was an important statistical data which helped us in deriving a relation which can be used to detect the maximum voltage which can be tapped from the trees without practical examination, which saves the time. Let us consider the sample tree Acacia to prove the relation. The acacia tree sample and soil sample were subjected to analytical analysis to find out their ph.The ph obtained from the acacia tree and soil sample through analytical analysis were 7.15 and 5.12.To find out the maximum current from a particular tree, we devised a simple formula

MAX VOLTAGE = TREE PH – SOIL PH

Applying the ph of acacia to the formula we obtain the maximum voltage

MAX VOLTAGE = (7.15 – 5.12)

MAX VOLTAGE = 2.03 volts

The tree is capable of giving a maximum output of 2.03 volts as per our relation

STATISTICAL DATA ON THE ANALYTICAL ANALYSIS ON CONDUCTION RATE OF SOIL AND TREE SAMPLES

Table no: 2

TIME	CONDUCTION OF SOIL AND TREE SAMPLE						
	S.no	Acacia soil	Coco soil	Silver oak tree	Acacia tree	Thorn tree	Acacia nilotica Tree
11.45	1	0.130	37.4	0.360	0.167	0.268	0.811
12.00	2	0.131	37.6	0.362	0.169	0.270	0.815
12.15	3	0.132	37.8	0.364	0.171	0.272	0.819
12.30	4	0.133	38.0	0.366	0.173	0.274	0.823
12.45	5	0.134	38.2	0.368	0.175	0.276	0.827
1.00	6	0.135	38.4	0.370	0.177	0.278	0.831

INFERENCE FROM THE STATISTICAL DATA ON ANALYTICAL ANALYSIS ON CONDUCTION RATE OF SOIL AND TREE SAMPLES

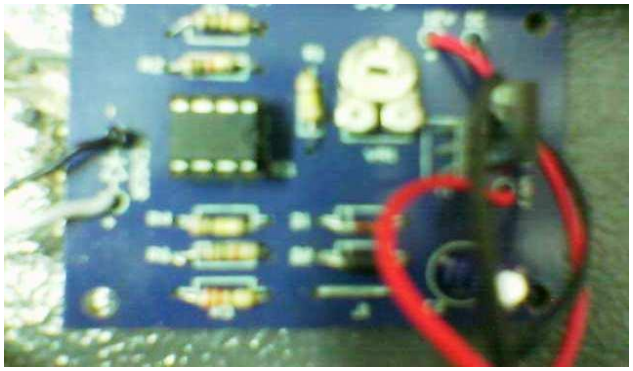
The experimental results obtained from the analytical analysis on conduction of the soil and tree samples, was an important statistical data which helped us in deriving a relation which can be used to interrelate the ph with conduction without practical examination in the field, which saves the time. We can infer from the conduction of each tree or soil sample with that of its corresponding tree or soil ph, that there is an inverse relation between both these parameters.

Relation between ph and conductivity

$$\text{Ph} \quad \frac{1}{\alpha} \quad \text{Conductivity}$$

Let us consider kv tree which has a ph of 3.46, it was the lowest ph recorded in our analysis, but from the conductivity analysis we were able to relate that as the ph decreases the conductivity increases. Using the conductivity analysis we can prove the tree's capability of tapping current with respect to its ph or vice versa.

SMART SENSOR CIRCUIT



WORKING PRINCIPLE OF THE SMART SENSOR

Although temperature sensors are probably the simplest and the most obvious sensors for fire detection, studying various sources in this field reveals that all researchers agree on the fact that it alone cannot accurately indicate fire and gas (e.g., CO, CO2) concentrations are main features for fire detection[10].

The smart sensor circuit describes the use of the operational amplifier and a very common diode in 4148 used in such a way that it can sense variation in the

temperature in the environment. If the temperature Increases the predefined value set by the preset, and then it sends a reference signal to the relay, which makes the relay to conduct thereby switching on the pump and transmitting the signal through G.S.M network. The 741 is a high performance monolithic operational amplifier. It's intended for a void range of analog application. It can be used to amplify as well as compare very small voltage. The sensor is connected across the inverting and non-inverting terminals of the operational amplifier. The resistor1 limits the current and voltage to the reference voltage for the comparison. The present pot of 100K is used for adjusting the sensitivity of the sensor. The resistor R4 is used as a negative feedback between the output and the input such that it limits output within the range. When sensor senses heat it produces change in voltage which is amplified by the IC which acts as a comparator and switches on transistor which sends the reference signal to the relay through a capacitor. The smart sensor is generally in open circuit, but on sensing heat the circuit closes which enables the reference signal to be transmitted over very long distances through G.S.M network.

G.S.M TRANSMITTING DEVICE

The G.S.M refers to global system for mobile. It acts as the transmitting device which can transmit the reference signal over a global area through its wide spread network. The mobile phone panel, the filmstrip sticker and supporting metal lining were removed. Now the mobile is exposed with the numbers and other buttons as two small concentric circles, the inner circle represents a positive terminal and the outer circle represents a negative terminal. A mobile number which the recipient is having is set as the number on speed dial in the transmitting G.S.M part. The two circles are soldered with multistrand wires on a particular number on g.s.m transmitting part say number eight. The g.s.m transmitting part is generally open circuited but on sensing fire the voltage obtained from trees is used to short circuit and speed dial is assigned and a call is made to the recipient that fire has occurred in a particular sensor location.

EXPLODED VIEW OF G.S.M TRANSMITTING PART

DC PUMP

The pump used in our project is a 12 volt dc pump; this pump is selected because of a reason that the relay trips the supply voltage only if the receiving component is a 12 volt dc supply. The pump consists of two opening, one for inlet from the reservoir and the other for supply to the sprinkler as an outlet. Internally the pump consists of windings and a rotor, when supply is given to the pump the windings are energized on opposite field coils and as a result the rotor rotates and creates a suction force which drives the water from the reservoir to the sprinklers for spraying water. To know the discharge rate of the pump, the output level of water from the pump was noted for 1000ml of water flow and time taken for this flow of water was noted in a stopwatch. The flow rate of the pump was found to be 32 seconds per litre.

SPRINKLERS

The sprinklers are used to reduce the fire from further spreading to other neighboring areas in the forest cover region. The sprinkler used in our project is a rain type sprinkler, which utilizes water efficiently and covers a wide area. The backflow protection is typically done by a reduced pressure principle backflow preventer. A backflow preventer prevents the backflow of water into the pump. The normal backflow requirement for an automatic fire sprinkler system is a double check valve assembly.

CONCLUSION

This paper has provided us an excellent opportunity and experience, to expand our knowledge. We also put forward new mathematical relations, which reduces the practical working time.This forest fire monitoring system can be implemented in any place where exist a coverage of a GSM network which is where we usually have lives and properties that need protection. The alarm message is transmitted to the mobile phone or a server; hence a fully automated process with no people is involved. It only takes seconds to switch on the GSM module and make a call as soon as the circuit is closed on detection of fire. Using metal combinations we have boosted the tree output to a maximum of 1.5v and 1.6v, by using different metal electrodes the voltage can be increased further, but the initial cost of the metal electrodes goes high.

REFRENCES

[1] Nikolay Khabarov, Elena Moltchanova, and Michael Obersteiner.(2008). Valuing Weather Observation Systems for Forest Fire Management. IEEE SYSTEMS JOURNAL, VOL. 2, NO. 3

[2] Doolin, D.M. and Sitar, N. (2005) Wireless sensors for wildfire monitoring. In Proceedings of Conference on Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems, San Diego, CA, USA, 7–10 March 2005, 477–484.

[3] Volokitina,A., Sofronov, M. and Sofronova, T. (2008) Topical scientific and practical issues of wildland fire problem. Mitig. Adapt. Strateg. Glob. Chang. 13(7): 661–674.

[4] Fleming, J. and Robertson, R.G. (2003) The Osborne firefinder. In Fire Management techtips, October 2003, 1–2.

[5] Den breejen, E., breuers, M., Cremer, F., kemp, R.,Roos, M., Schutte, K. and De vries, J.S. (1998) Autonomous forest fire detection. In Proceedings of the Third International Conference on Forest Fire Research and the Fourteenth Conference on Fire and Forest Meteorology, Luso, Portugal, 16–20 November 1998, 2003–2012.

[6] Leblon, B. (2005) Monitoring forest fire danger with remote sensing. Nat. Hazards 35(3): 343–359.

[7] Burgan, R., Klaver, R. and Klaver, J. (1998) Fuel models and fire potential from satellite and surface observations. Int. J. Wild land Fire 8(3): 159–170.

[8] Chong, C.Y. and Kumar, S.P. (2003) Sensor networks: evolution, opportunities, and challenges. In Proceedings of IEEE 91(8): 1247–1256.

[9] Antoine-santoni, T., Santucci, J.F., De gentili, E. and Costa, B. (2008) Wildfire impact on deterministic deployment of a wireless sensor network by a discrete event simulation. In Proceedings of the Fourteenth Mediterranean Electro technical Conference, Ajaccio, France, 5–7 May 2008, 204–209.

[10] Majid bahrepour, Nirvana meratnia, Paul Havinga , Pervasive Systems Group, University of Twente. SENSEI PROJECT, Supported By the European 7th Framework Programme, Contract Number:215923.