A

MAJOR PROJECT REPORT

on

FOREST FIRE NOTIFIER

Submitted in partial fulfilment of the requirements of the degree of

BACHELOR OF TECHNOLOGY

Under Guidance of :
Yogendra Singh Solanki
Assistant Professor
TINJRIT, Udaipur

Submitted by :
Abdul Majid Bhat (17ETCEC002)
Samiksha Dashora (17ETCEC015)
Tanisha Dawda (17ETCEC020)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR

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Department of Electronics and Communication Engineering
Techno India NJR Institute of Technology, Udaipur

Certificate

This is to certify that this Major Project report entitled "FOREST FIRE NOTIFIER" by Abdul Majid Bhat, Samiksha Dashora, Tanisha Dawda have completed the work under my supervision and guidance, hence approved for submission in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication to the Department of Electronics and Communication Engineering, Techno India NJR Institute of Technology, Udaipur during academic session 2017-2021.

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ABSTRACT

It has been found in a survey that 80% losses caused due to fire would have been kept away from if the fire was identified promptly. Node Mcu based IoT empowered fire indicator and observing framework is the answer for this issue. In this task, we have assembled fire finder utilizing Node Mcu which is interfaced with a temperature sensor, a smoke sensor andsignal.

The temperature sensor detects the warmth and smoke sensor detects any smoke produced because of consuming or fire. Buzzer associated with Arduino gives us an alert sign. At whatever point fire activated, it consumes protests adjacent and produces smoke. A fire caution can likewise be activated be-cause of little smoke from candlelight or oil lights utilized as a part of a family.

Likewise, at whatever point warm force is high then additionally the alert goes on. Bell or alert is killed at whatever point the temperature goes to ordinary room temperature and smoke level decreases.

We have additionally interfaced LCD show to the Node Mcu board. With the assistance of IoT innovation. Node MCU fire checking serves for mechanical need and also for family unit reason. At whatever point it recognizes fire or smoke then it immediately alarms the client about the fire through the ethernet module. For this reason, we are utilizing ESP8266 which is from Arduino IDE.

Likewise, the Node Mcu interfacing with LCD show is done to show the status of the framework whether the Smoke and Overheat is identified or not. What's more, Node Mcu interfacing with Ethernet module is done as such that client become more acquainted with about the predominant condition message.It insinuate the client about the fire identification. This framework is extremely helpful at whatever point the client isn't in the closeness of control focus. At whatever point a fire happens, the framework naturally faculties and alarms the client by sending an alarm to an application introduced on user's Android portable or page open through web.

ACKNOWLEDGMENT

We take this opportunity to record our sincere thanks to all who helped us to successfully complete this work. Firstly, We are grateful to our **supervisor Mr. Yogendra Singh Solanki** for his invaluable guidance and constant encouragement, support and most importantly for giving us the opportunity to carry out this work.

We would like to express our deepest sense of gratitude and humble regards to our

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Finally, We would like to thank my friends for their support and discussions that have proved very valuable for us. We are indebted to our parents for providing constant support, love and encouragement. We thank them for the sacrifices they made so that we could grow up in a learning environment. They have always stood by us in everything we have done, providing constant support, encouragement and love

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CONTENTS

1. **Abstract**		i
2. **Acknowledgement**		ii
3. **Contents**		iii
4. **List of components**		iv
5. **List of figures**		v
6. **List of tables**		vi
Chapter 1	Introduction	
	1.1 Overview	1
	1.2 Major objective	3
	1.3 Main features	7
	1.4 Work plant	9
Chapter 2	Literature survey	13
Chapter 3	Hardware Implementation	
	3.1 Block diagram	17
	3.2 Power supply	19
	3.3 Component detail	20
Chapter 4	Software description	
	4.1 Introduction	24
	4.2 Arduino Uno	26
Chapter 5	Project implementation	
	5.1 Operation of project	28
	5.2 Project code	30
Chapter 6	Advantages and application	38
Chapter 7	Conclusion	41
Bibliography		42

LIST OF COMPONENTS

SR NO.	NAME OF COMPONENTS
1.	ARDUINO UNO (1)
2.	ITEAD GBOARD PRO 800 SIM 800GSM (1)
3.	TEMPERATURE AND HUMIDITY SENSOR – 3 PINS(1)
4.	JUMPER WIRES

LIST OF FIGURES

SR NO.	NAME OF FIGURE	PAGE NO
1.	Forest Fire scenes	2
2.	Architecture of forest fire system	8
3.	FIRESENSE system architecture. The various system components (sensors, software modules, etc) and their interaction are illustrated.	12
4.	Working of project	18
5.	GSM/GPRS model	21
6.	Jumper wires	23
7.	Arduino Uno	26

LIST OF TABLES

SR NO.	NAME OF TABLE	PAGENO
1.	Components	20
2.	GSM specification	22
3.	Arduino specifications	28

Chapter 1

INTRODUCTION

1.1 Overview:

Forest fire is also called wildfire or wildland fire is an uncontrolled fire occurring in forest areas It is essential to distinguish these sorts of flames as ahead of schedule as conceivable in order to keep the harm from it to a biological framework.

Consistently a large number of sections of timberland are burned to the ground. The land were woods is singed it winds up plainly diffi-cult to develop vegetation over yonder. This is on account of soil moves toward becoming water repellent and acknowledges no more water, prompting lessening in ground water level.

The Global Warming Report 2008 says rapidly spreading fire as one of the real reasons behind the increase in an Earth-wide temperature boost. In late 2016 more than 4000 hectares of timberland were signed in the slopes of Uttarakhand. Common causes of wildfire are lightning, extreme hot and arid weather and human carelessness. The utilization of wireless sensors in this paper presents one of the methods for early wildfire identification.

One of the main causes of destruction of archaeological and cultural heritage sites, especially in the Mediterranean region, is wildfires. These sites, treasured and tended for long periods of time, are usually surrounded by old and valuable vegetation or situated close to forest regions. The increase in seasonal temperatures has caused an explosion in the number of self-ignited fires in forested areas, which fanned by winds and fuelled by dry vegetation become disastrous. Extreme weather conditions such as storms or floods also pose greats risk for these sites.

Fig 1: Forest fire scenes

Beyond taking precautionary measures to avoid forest fires, early warning and immediate response to a fire break out is the only way to avoid human losses and environmental and cultural heritage damages. Thus, the most important goal in fire surveillance is quick and reliable detection and localization of fire, since it is much easier to suppress a fire when the location of the ignition point is known and while the fire is at an early stage. An automatic fire detection system relying on multi-sensor networks should be able to provide early fire warning and also collect information about the location and spread of fire to facilitate efficient fire management. Based on this information, the firefighting staff can be guided on target to contain the fire before it reaches cultural heritage sites and to suppress it quickly by utilizing the appropriate equipment and vehicles.

1.2 Main objectives:

To main S&T objectives of FIRESENSE are the following:

Identification of user requirements and system design:

- Extensive survey of state-of-the-art algorithms, technologies and systems related to FIRE SENSE including EU and national research projects.
- Sensor PollingVideo-based Fire DetectionData FusionPrediction of Fire Propagation 3D GISIR –based Fire DetectionWeather Data ProcessingExternal Weather Forecast Area Fuel ModelAlarm establishment of an international group of users including people related to fire suppression and cultural heritage preservation and launch of international survey for the identification of user requirements.
- Definition of FIRESENSE system requirements based on the state-of-the-art survey, the user requirements and technical, economical and legal constraints.

Smoke and fire detection based on cameras and WSNsensors

- Development of novel algorithms for fire and smoke detection based on visible cameras.
- Development of novel techniques for thermal data processing using infrared cameras at different wavebands. Development of low-cost pyroelectric

- Estimation of fire propagation based on the semi-empirical BEHAVE model and examination of physical and hybrid models for fire spread calculations.
- Development of user friendly GIS-based platform for 2D/3D visualization of the estimated fire propagation.

Development of FIRESENSE ControlCentre

- The control centre will provide various functionalities to the end users such as visual and acoustic alarms in case of fire/smoke detection and extreme weather conditions, easy access to camera streams and sensor measurements, manipulation of cameras and sensors, video on demand, maps for location and visualisation, visualization of fire propagation estimation, etc through a user friendly interface.

System installation, integration and demonstration

- The system will be demonstrated in five cultural heritage sites in the Mediterranean area: the sanctuary of Kabeirion in Thebes, Greece, the ancient city of Rhodiapolis in Antalya, Turkey, the Dodge Hall building in Istanbul, Turkey, the Roman Temple of Water in Djebel Zaghouan, Tunisia and Monteferrato-Galceti Park in Prato,Italy.

System Evaluation

- Development of methodological framework for assessing the performance of the proposed system, in terms of covering the user requirements and expectations.
- Laboratory testing of system components and functionalities.

- Organization of real fire experiments for data collection and system evaluation.
- Evaluation of the final system in terms of technical performance and user acceptance and validation against initial requirements.

FIRESENSE dissemination and exploitation

- Dissemination of project information and results through the project website and project brochure, publications, media releases, meeting with stakeholders, etc.
- Education of inhabitants through a series of lectures aiming at making people living close to test sites conscious about the importance of their surrounding area.
- Organization of Workshop to demonstrate and disseminate projectresults.
- Market analysis and development of strategy for exploiting project results beyond the life of the project.

1.3 Main Features:

FIRESENSE aims to develop an automatic early warning system integrating multiple sensors to remotely monitor areas of archaeological and cultural interest for the risk of fire and extreme weather conditions. FIRESENSE will take advantage of recent advances in multi-sensor surveillance technologies by employing both optical and infrared cameras to monitor the site and the surrounding area as well as a wireless sensor network capable of measuring different environmental parameters (e.g. temperature, humidity).

The signals and measurements collected from these sensors will be transmitted to a monitoring center, which will employ intelligent computer vision and pattern recognition algorithms as well as data fusion techniques to automatically analyze and combine sensor information. The control centre will be capable of generating automatic warning signals whenever a dangerous situation arises, i.e. when fire or smoke is detected. Moreover, the system will read weather data from official meteorological services as well as from local weather stations installed at the site and will issue alerts in case of extreme weather conditions. It will also provide real-time information about the evolution of the fire based on wireless sensor network data.

Furthermore, it will be able to estimate the propagation of the fire based on the fuel model of the area and other important parameters such as wind speed and direction and ground morphology. Finally, the estimated fire propagation will be visualized on a 3D Geographic Information System (GIS) environment.

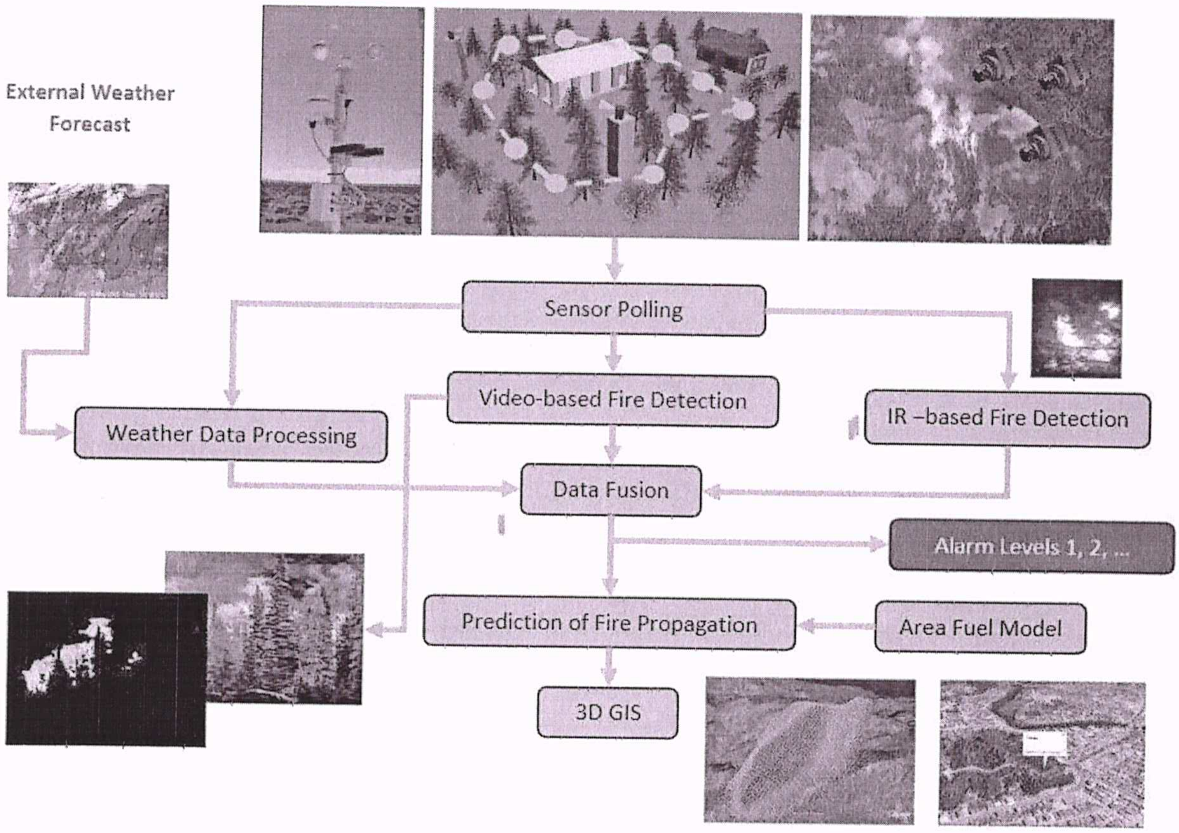

Fig 2: Architecture of fire notifies system

The majority of commercial wildfire surveillance systems do not realize the full potential offered by available technologies due to the lack of an integrated approach. Most of the systems use visible range cameras mounted on watch towers to monitor large forested areas. Some systems utilize infrared cameras, which are usually much more expensive compared to regular pan-tilt-zoom (PTZ) cameras and their range may be limited. Few systems employ wireless temperature sensor networks, which can provide real-time feedback for the detection and evolution of fire. All the aforementioned approaches have their own advantages and limitations. What is currently missing is an integrated solution that will combine the outputs of different sensors to increase the detection accuracy and overcome individual sensor limitations.

1.4 Workplant:

In the context of the FIRE SENSE project, an automatic early warning system integrating multiple sensors to remotely monitor areas of archaeological and cultural interest for the risk of fire and extreme weather conditions was developed.

The system integrates various sensors including optical cameras, infrared cameras at different wavelengths, passive infrared (PIR) sensors, a wireless sensor network of temperature and humidity sensors as well as local weather stations on the deployment sites. The signals and measurements collected from these sensors are transmitted to the control centre, which employs intelligent computer vision and pattern recognition algorithms as well as data fusion techniques to automatically analyze and combine sensor information. The control centre is capable of generating automatic warning signals for smoke/flame detection, abrupt temperature rise and extreme weather conditions. It also allows inspection of the site through the cameras, manipulation of cameras and sensors and provision of statistical data on user demand. Moreover, it estimates the propagation of the fire based on the fuel model of the area, the local weather conditions and the ground morphology.

Finally, the estimated fire propagation can be visualized on a Google Earth based 3D interface. In the following, the main science and technology results of the FIRE SENSE project are summarized per work package.

The main working plant is

a) The identification of user requirements for an early warning system for the protection of cultural heritage areas from the risk of fire.

b) The specification of the FIRE SENSE system architecture, components and interfaces.

User requirements were defined through a two-stage process: first, conclusions/ information were drawn from the state-of-the-art survey and the analysis of user questionnaires. Then, a list of conclusions drawn from interviews and e-mail communications with experts and discussions among partners was generated.

The outputs of thisprocess were used to synthesize the final list of requirements including:

a) Technical / operational requirements (cameras, sensors, communication links, power, software modules, interfaces, and maintenance)

b) Requirements associated with system installation and cost an

c) Environmental constraints.

The initial system requirements were updated during the final months of the project based on the feedback received by experts. User feedback was received through questionnaires evaluating system performance and functionalities, which were filled during system demonstration activities by users employed in fire service, forest service, cultural heritage organizations, local authorities and research institutions. Feedback from experts in fire prevention,suppression and management was also received through discussions and delivery of brief evaluation reports.

1.4.1 Fieldtest

Numerous field tests with real controlled fires were conducted in different settings using visible spectrum cameras and infrared cameras on different wavebands. These tests provided valuable information for recognizing potential problems and vulnerabilities of the system and allowed selection of the cameras that are suitable for FIRESENSE. In addition, they resulted in the creation of a large database of video recordings, which were also used for algorithm testing.

1.4.2 System Specification

The components and functionalities of the FIRESENSE system were designed taking into consideration:

a) User Requirements

b) Analysis of the state-of-the-art technologies and systems,

c) Results of field tests

d) Various technical, economical and legal constraints.

System architecture, specifications for different sensors and communication links, specifications for software modules (video-based fire/smoke detector, IR-based fire detector, WSN sensor and gateway software, data fusion and alarm generation, estimation & visualization of fire propagation) and specifications for control centre components, functionalities and interfaces were defined. Moreover, detailed plans for the deployment of the FIRE SENSE systems in the five pilot sites were prepared (e.g. sensors and communication links to be used, installation plans, power supply, possible problems, etc) anda set of use cases corresponding to different real world fire detection scenarios was identified.

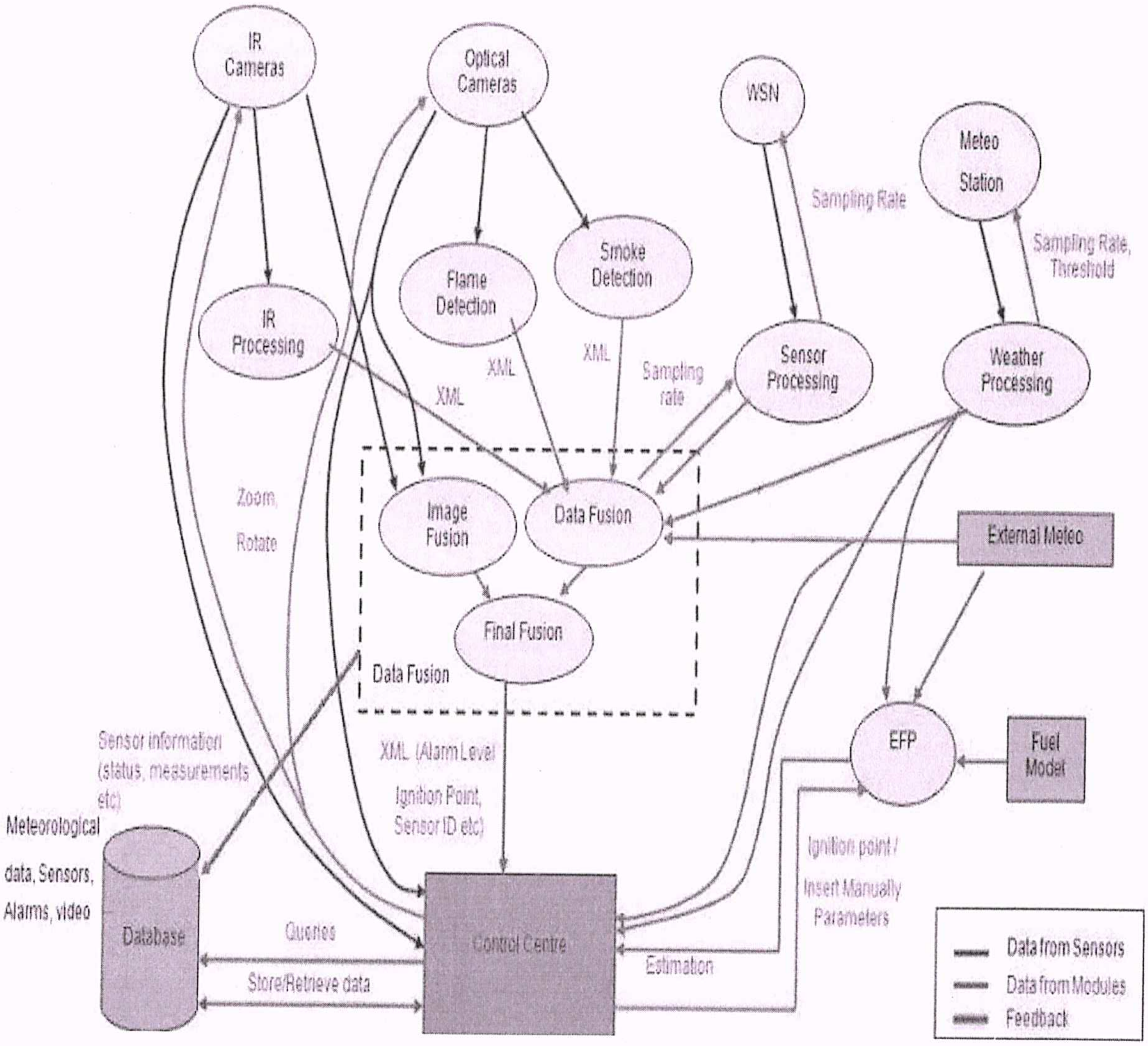

Fig 3: FIRESENSE system architecture.

The various system components (sensors, software modules, etc) and their interaction are illustrated.

Chapter 2

LITERATURE SURVEY

Numerous answers for identification of out of control fire are displayed and executed in recent years. Video Surveillance System is most generally utilized for identification of wild fire. It is isolated into four classifications:

1. Video Cameras delicate in unmistakable range in light of acknowledgment of smoke amid sunlight and fire blazes at night
2. Infrared(IR) Thermal Imaging cameras in view of discovery of warmth transition from the fire
3. IR Spectrometer which distinguishes unearthly attributes of smokegases.
4. Light Detection and Ranging (LIDAR) system which measures the laser light back scattered by smoke particles.

The limitation of these systems was high false alert rate as a result of climatic conditions, for instance, proximity of fog, shadows, clean particles etc.
Another strategy is the utilization of Visual Cameras that take depictions of the forest to identify the fire. These cameras were mounted on the highest point of correspondence towers. A turning engine is introduced to give a full round perspective of the forest. The pictures obtained from the camera are prepared utilizing project or MATLAB code and are contrasted and the reference pictures taken at introductory stage. This framework additionally had impediment of high false caution rate. Additionally the cost of establishment of visual cameras on correspondence towers washigh.

Another technique is the utilization of satellite framework to dis-tinguish the wildfire. The primary segments of the framework are satellite(s) and the base station that gathers the information sent by the satellite(s) and runs the dissecting calculation. The crude information from the satellite(s) is handled and after that Best in class High Determination Radiometer (AVHRR) instrument is utilized to recognize nearness of Problem areas. However the mists enormously influence the framework.

Wild Fire Reconnaissance Framework which comprises WSN was likewise proposed for identification of wildfires in South Korea. The WSN decides the temperature and dampness after which a middleware program and web application examines the gathered information .However in this approach of discovery of wild fire there was some loss of information amid correspondence.

WSN comprising three various types of sensors which can distinguish temperature, fire and smoke levels of methane, carbon monoxide and carbon dioxide was additionally proposed for wildfire recognition .

The information gained by sensors is transmitted utilizing the radio recurrence module. The radio recurrence module used has limited bandwidth and also picks up noise easily. WSN consisting of temperature sensor setup and GPS module was likewise proposed for recognition of backwoods fire .In this temperature information was transmitted to base station through essential and principle receiving wire utilizing satellite. A portion of the impediment of framework was establishment of an excessive number of reception apparatuses; consistent power was required to both temperature sensor setup and receiving wires. Not-withstanding these climatic/regular changes can influence the framework.

Visualization of fire propagation data is important since it enables early intervention of the fire and helps the fire management teams to deploy their forces wisely. To this end, an interactive software application, which provides parameterized simulations of the fire propagation and visualizes the estimated results on a Google-Earth based environment, was developed by CERTH. Fire spread calculations are based on the popular BEHAVE algorithm, while physical models simulations are also supported via the open source VESTA software. According to the BEHAVE model, fire propagation depends on a number of parameters such as the terrain topology around the ignition points, weather conditions such as wind and moisture, as well as fuel information. The latter factor summarizes vegetation characteristics that have a major impact on fire propagation.

These parameters are either provided by the user or are automatically estimated based on available data.

Specifically,

- Wind information is obtained in real time from existing weather stations or from internet weatherportals.
- Digital Terrain Models (DTMs) are obtained by STRM data (90m resolution) that are freely available for the whole world.

- Fuel moisture information can either be manually provided by the user, directly measured using special sensors or estimated from weather data (i.e. temperature, humidity,etc).
- Fuel information is provided either by CORINE land cover maps, which are converted to fuel maps (containing indices to BEHAVE or custom fuel models) or directly as fuel maps.
- Ignition points can be provided manually or obtained by the Control Centre (the Control Centre provides an estimation of the fire ignition point based on the outputs of the fire/smoke detection module and the data fusion module).

FIRESENSE Control Centre:

SUPCOM designed and implemented the FIRESENSE Control Centre (CC) and its related Graphical User Interface (GUI). The architecture of the CC application and its connections to the other modules.
The Control Centre allows:

- Display of layered maps of the monitored site.
- Monitoring of the site through different sensors and cameras.
- Collection and visualization of measurements from the sensors and videos from the cameras.
- Configuration of sensors and manipulation of cameras; •display of sensor statistics.
- Generation of different types and levels of alarms when a situation is judged as suspect or dangerous by the data fusion module.

Chapter 3

HARDWARE IMPLEMENTATION

3.1 Block diagram

The process of detection of forest fire initiates at any of the nodes planted on atree inside the forest. The forest has a network of nodes placed at suitable distances from each other, the nodes have a capability to communicate through devices (RF module in our case) and by usingArduino.

If any change above a threshold value is found in the atmospheric parameters (temperature rise, contamination of air with smoke, etc.) near a node (source node), the information is passed to a nearest intermediate node until it reaches to the main/head terminal. The main/head terminal uses a GSM modem to pass the information to a cell phone (the forest fire monitoring centre).

The entire outlining of this IoT empowered woodland fire location and observing framework has been for the most part classified into 4 sections :-

- Interfacing and programming of LCD withArduino
- Interfacing and programming of Collector and transmitter withArduino
- Interfacing of Ethernet Shield with Arduino and making Taste condition by programming.
- Interfacing of sensors with transmitter.

FLOWCHART OF THE PROJECT

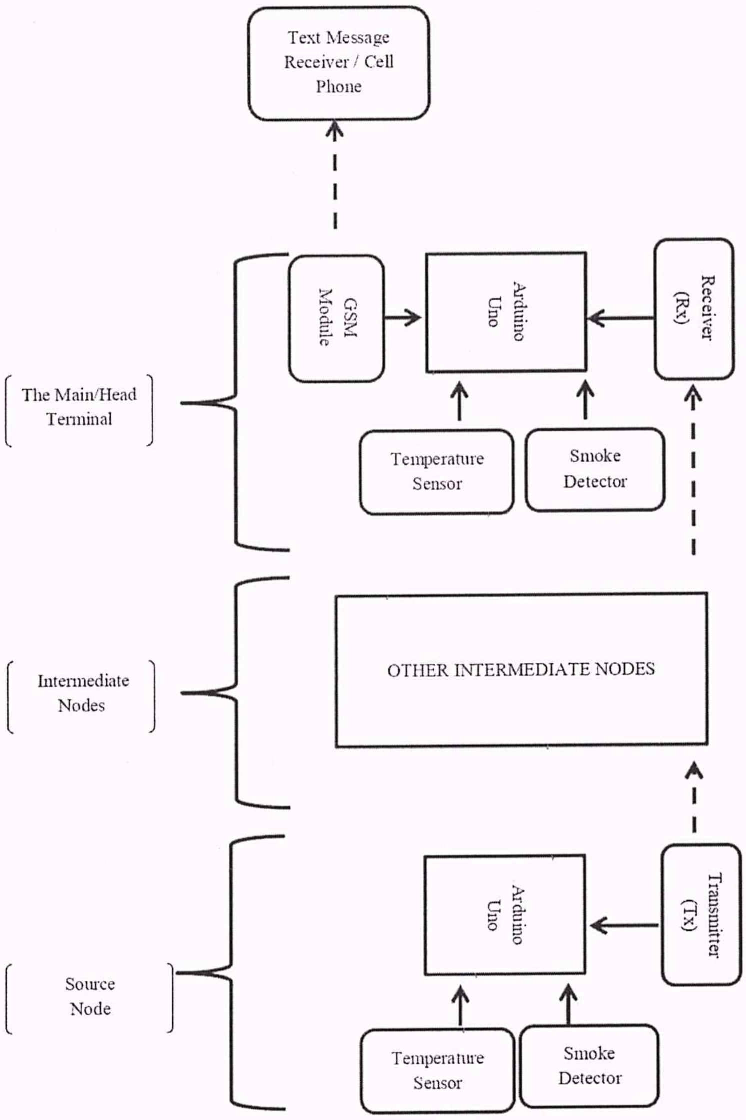

Fig 4: Working of project

3.2 Power supply

There's some confusion going on when it comes to how to choose a power supply.
So, I thought I'd clear up some doubts, and give you a simple, beginner- friendly way of choosing a power supply.
A power supply has a voltage and a current specification:

- The voltage is the output voltage from the power supply.
- The current is the maximum current that the power supply cangive.

The device you want to power will need a specific amount of current. If you bought the device, it should say how much current it needs somewhere in the technical documentation or by the power connector. If you built the device yourself, you can calculate or measure the amount of current needed.

So, let's say your device needs 1A (ampere). This means you need to choose a power supply that can give minimum 1A.

Sometimes a power supply gives you a number in Watts (W). Watt is actually just the voltage multiplied by the current. So, if you have a 5V power supply that can give 1A of current, you have a 5W power supply.

If your power supply says 100W and 12V, you can figure out the maximum current by a simple calculation:

Current equals the Watt divided by the Voltage. So that's 100 / 12 = 8.3 A.

3.3 Component detail

NAME OF COMPONENTS
ARDUINO UNO (1)
ITEAD GBOARD PRO 800 SIM 800GSM (1)
TEMPERATURE AND HUMIDITY SENSOR – 3 PINS(1)
JUMPER WIRES

Table 1: Components

The process of detection of forest fire initiates at any of the nodes planted on a tree inside the forest. The forest has a network of nodes placed at suitable distances from each other, the nodes have a capability to communicate through devices (RF module in our case) and by using Arduino. If any change above a threshold value is found in the atmospheric parameters near a node the information is passed to a nearest intermediate node until it reaches to the main/head terminal. The main/head terminal uses a GSM modem to pass the information to a cell phone (the forest fire monitoring centre).

3.3.1 ITEAD GBOARD PRO 800 SIM 800GSM(1)

Gboard Pro 800 is a unique Arduino mainboard with SIM800 GSM / GPRS module, XBee socket, nRF24L01 + module interface, micro SD card interface, ITDB02 parallel LCD module interface, electronic brick interface and ATmega2560 chips, which can achieve wireless control via XBee, nRF24L01+ or GSM / GPRS with functions covering from smart home to remote control of robots to meet various needs of different projects.

1. There is a USB connector on the board for debugging or firmware uploading only.

2. The serial interface (boot loader connection) is 3.3v, not the typical 5v as on many Arduino boards - anyone using an alternative to the Foca board must take note not to risk damage.

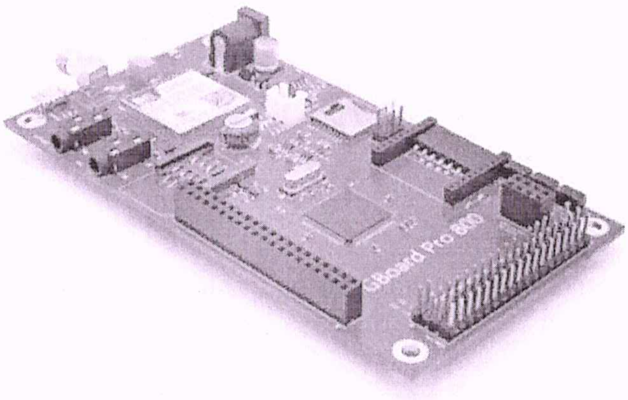

Fig 5: GSM/GPRS mode

Specification

PCB size	131.0mm X 68.8mm X 1.6mm
supply voltage	7~23V DC
operation voltage	3.3V DC
Indicators	PWR, NET, Status, Test
Communication interfaces	XBee, nRF24L01+ , UART, IIC, ITDB02 LCD, micro SD

3.3.2 Jumper wires

A **jump wire** (also known as jumper, jumper wire, jumper cable, DuPont wire or cable) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. Fairly simple. In fact, it doesn't get much more basic than jumper wires.

What Do the Colors Mean?

Though jumper wires come in a variety of colors, the colors don't actually mean anything. This means that a red jumper wire is technically the same as a black one. But the colors can be used to your advantage in order to differentiate between types of connections, such as ground or power.

Types of Jumper Wires

Jumper wires typically come in three versions: male-to-male, male-to-female and female-to-female. The difference between each is in the end point of the wire. Male ends have a pin protruding and can plug into things, while female ends do not and are used to plug things into. Male-to-male jumper wires are the most common and what you likely will use most often. When connecting two ports on a breadboard, a male-to-male wire is what you'll need.

Fig 6: Jumper wires

Chapter 4

SOFTWARE DESCRIPTION

4.1 Introduction

The software implementation stage involves the transformation of the software technical data package (TDP) into one or more fabricated, integrated, and tested software configuration items that are ready for software acceptance testing. The primary activities of software implementation include the:

- Fabrication of software units to satisfy structural unit specifications.
- Assembly, integration, and testing of software components into a software configuration item.
- Prototyping challenging software components to resolve implementation risks or establish a fabrication proof of concept.
- Dry-run acceptance testing procedures to ensure that the procedures are properly delineated and that the software product (software configuration items (CIs and computing environment) is ready for acceptancetesting.

Without the physical architecture, the software implementation effort cannot be properly defined, planned, and controlled. The software engineering integrated product team (SWE-IPT) is responsible for developing and controlling the software architecture and its integrated design and configuration documentation. The software architecture must characterize the design of the software product to be developed. This necessitates the crafting of different types of design diagrams, views, and documentation that depict the software architecture. The general categories of design documentations include:

- Descriptions of the functional architecture and its design representations, such as functional specifications,functional decomposition hierarchies,data flow diagrams, behavioral models, and data dictionaries.
- Descriptions of the physical architecture and its design representations, such as interface block diagrams, structural specifications, and configuration assembly and integration plans.
- Requirements baseline and its representations, such as software requirement specifications, software interface specifications, and database requirement specifications.
- Description of the computational environment.
- Post-development process specifications and design documentation.

4.2 Arduino uno

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

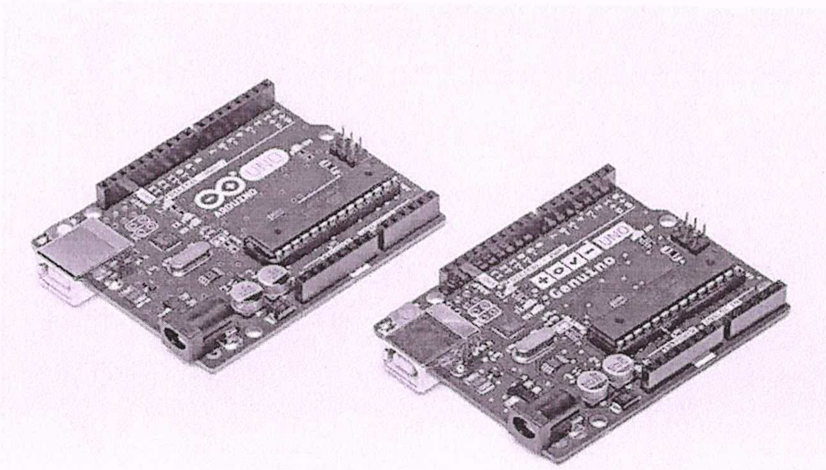

Fig 7: Arduino uno

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Table 4: Arduino specifications

Chapter 5

PROJECT IMPLEMENTATION

5.1 Operation of project

FIRE NOTIFIER aims to develop an automatic early warning system integrating multiple sensors to remotely monitor areas of archaeological and cultural interest for the risk of fire and extreme weather conditions. FIRE NOTIFIER will take advantage of recent advances in multi-sensor surveillance technologies by employing both optical and infrared cameras to monitor the site and the surrounding area as well as a wireless sensor network capable of measuring different environmental parameters (e.g. temperature, humidity). The signals and measurements collected from these sensors will be transmitted to a monitoring center, which will employ intelligent computer vision and pattern recognition algorithms as well as data fusion techniques to automatically analyze and combine sensor information. The control centre will be capable of generating automatic warning signals whenever a dangerous situation arises, i.e. when fire or smoke is detected.

The process of detection of forest fire initiates at any of the nodes planted on a tree inside the forest. The forest has a network of nodes placed at suitable distances from each other, the nodes have a capability to communicate through devices (RF module in our case) and by using Arduino. If any change above a threshold value is found in the atmospheric parameters (temperature rise, contamination of air with smoke, etc.) near a node (source node), the information is passed to a nearest intermediate node until it reaches to the main/head terminal. The main/head terminal uses a GSM modem to pass the information to a cell phone (the forest fire monitoring centre).

5.1.1 TRANSMITTER PART OF PHYSICAL MODEL

The forest fire detection module works in three different stages. The first stage consists of reading some external environmental parameters like temperature and smoke. The first stage is done with the help of some sensors which are used to sense and convert analog data to digital data. The sensors read parameters like temperature, humidity and air quality then sends this information to the next nearest node. This process goes on until the information reaches to the final node or the main terminal which is the second stage of the overall process. The third stage consists of transmission of the information to the forest fire monitoring unit. Each node has a temperature and humidity sensor, a smoke sensor and a microcontroller unit. Arduino has been used as the microcontroller device. The sensors interact with the Arduino and store the information for comparison process. There is a predefined threshold value to each of these parameters. The microprocessor compares the sensor values at regular intervals of times with the threshold values. Based on the comparison if the input values of sensors exceed the threshold the node transmits the information to the next nearby node which again in turn transmits the information to the other nearby node. In this way the message flow is regulated in this model

5.2 Receiver and Transmitter Side Arduino ModuleCodes

This code configures the receiving side Arduino Module for Temperature and Humidity Monitoring, If the values exceed a threshold an SMS is sent to the base station alerting them about the same. If there is a value rise at the transmitter side node then this is communicated through RF-Transmitter module on transmitter side Arduino Uno to the RF-Receiver module on Receiving side Arduino Uno.

NOTE that the code below consists of two parts one for "Receiver side arduino" and the other for "Transmitter side arduino"

```
########( PART-1)######
Receiver Side Arduino CODE ##############################
// Include RadioHead Amplitude Shift Keying Library #include <SoftwareSerial.h>
#include <RH_ASK.h>
// Include dependant SPI Library #include <SPI.h>

#include <DHT.h> SoftwareSerial mySerial(4, 3);
//Constants
#defineDHTPIN2          // what pin we're connected to #defineDHTTYPEDHT11
//DHT11

int smokeA0 = A5;
// Your threshold value int sensorThres = 400;
```

```
// Define Variables

DHT dht(DHTPIN, DHTTYPE); // Initialize DHT sensor for normal 16mhz Arduino

//Variables
float hum; //Stores humidity value float temp; //Stores temperature value

// Define output strings

String str_humid; String str_temp; String str_smk; String str_out;

// Create Amplitude Shift Keying Object RH_ASK rf_driver;

voidsetup()
{
pinMode(smokeA0,INPUT); dht.begin();
// Initialize ASK Object rf_driver.init();
// Setup Serial Monitor Serial.begin(9600); mySerial.begin(115200);
}

void loop()
{
delay(2000);
hum = dht.readHumidity(); temp= dht.readTemperature();
Serial.print("Receiver Humidity = ");
```

```
Serial.print(hum); Serial.print('\n');
Serial.print("Receiver Temperature = "); Serial.println(temp);

int analogSensor = analogRead(smokeA0); String smk;
// Checks if it has reached the threshold value if (analogSensor > sensorThres)
{
Serial.print("Smoke atReceiver"); Serial.print('\n');
smk ="Smoke";
}
else
{
Serial.print("Clean at Receiver"); Serial.print('\n');
smk = "Clean";
}

// Set buffer to size of expected message uint8_t buf[20];
uint8_t buflen = sizeof(buf);
// Check if received packet is correct size if (rf_driver.recv(buf, &buflen))
{
str_out = String((char*)buf);
for (int i = 0; i < str_out.length(); i++)
{
if (str_out.substring(i, i+1) == ",")
{
str_humid = str_out.substring(0, i); str_temp = str_out.substring(i+1, i+6); str_smk =
str_out.substring(i+7,i+12 ); break;
}
}
```

```
}

// Print values to Serial Monitor Serial.print("Humidity: "); Serial.print(str_humid);
Serial.print(" - Temperature: ");

Serial.println(str_temp); Serial.print(" - Air Quality: "); Serial.println(str_smk);



if( hum >= 60 && temp >= 25 )
{
Serial.print("Fire Detected at Receiver "); mySerial.println("AT+CMGF=1"); //Sets the
GSM Module in TextMode delay(1000); // Delay of 1000 milliseconds or 1second
mySerial.println("AT+CMGS=\"+918744984131\"\r");                // Replace x
with mobilenumber
delay(1000);
mySerial.println("      FIRE ALERT !! "); Serial.println('\n');
mySerial.println("Fire at Receiver Node"); Serial.println('\n');
mySerial.println("Temperature : " +String(temp)); Serial.print('\n');
mySerial.println("Humidity : " +String(hum)); Serial.print('\n');
mySerial.println("Air Quality : " + smk); delay(100);
mySerial.println((char)26);// ASCII code of CTRL+Z delay(1000);
}
if( str_humid.toInt() >= 60 && str_temp.toInt() >= 25 )
{
Serial.print("Fire Detected at Transmitter "); mySerial.println("AT+CMGF=1");      //Sets
the GSM Module in TextMode delay(1000);
```

```
mySerial.println("AT+CMGS=\"+918744984131\"\r");                    //    Replace    x
with mobilenumber
delay(1000);
mySerial.println("      FIRE ALERT !! "); Serial.println('\n');
mySerial.println("Fire at Transmitter Node "); Serial.println('\n');
mySerial.println("Temperature : " + str_temp);

Serial.print('\n');
mySerial.println("Humidity : " +str_humid); Serial.print('\n');
mySerial.println("Air Quality : " + String(str_smk)); delay(100);
mySerial.println((char)26);// ASCII code of CTRL+Z delay(1000);
}

}

#######(PART-2       )#####
####### Transmitter Side Arduino Code ############

#include <RH_ASK.h> #include <SPI.h> #include <DHT.h>

//Constants
#defineDHTPIN2         // what pin we're connected to #defineDHTTYPEDHT11
//DHT11

DHT dht(DHTPIN, DHTTYPE); // Initialize DHT sensor for normal 16mhz Arduino

int smokeA0 = A5;
// Your threshold value int sensorThres = 400;
// Define Variables
```

```
floathum;    // Stores humidity value in percent floattemp;        // Stores temperature
value inCelcius floatsmk;

// Define output strings

String str_humid; String str_temp; String str_smk; String str_out;



// Create Amplitude Shift Keying Object RH_ASK rf_driver;
// Initialize DHT sensor for normal 16mhz Arduino void setup() {
dht.begin(); pinMode(smokeA0, INPUT);
// Initialize ASK Object rf_driver.init();

}

void loop()
{

delay(2000); // Delay so DHT-22 sensor can stabilize

hum = dht.readHumidity(); // Get Humidity value temp= dht.readTemperature(); // Get
Temperature Value

// Convert Humidity to string str_humid = String(hum); Serial.print(hum);
```

```
// Convert Temperature to string str_temp = String(temp); Serial.print(temp);
int analogSensor = analogRead(smokeA0);
// Checks if it has reached the threshold value if (analogSensor > sensorThres)
{
str_smk = "1";
}
else
{
str_smk = "0";
}

// Combine Humidity and Temperature if(str_smk == "1")
{
str_out = str_humid + "," + str_temp + "," + "Smoke";
}
if(str_smk == "0")
{
str_out = str_humid + "," + str_temp+ "," + "Clean";
}
// Compose output character const char *msg =str_out.c_str();

rf_driver.send((uint8_t *)msg, strlen(msg)); rf_driver.waitPacketSent();

}
```

Chapter 6

APPLICATIONS AND ADVANTAGES

6.1 Applications

The most frequently used fire detection and suppression techniques employed by authorities can be summarised as follows:

(i) controlled burning,

(ii) fire weather forecasts and estimates of fuel and moisture,

(iii) watchtowers,

(iv) optical smoke detection,

(v) lightning detectors which detect the coordinates of the strike,

(vi) infrared,

(vii) spotter planes,

(viii) water tankers,

(ix) mobile/smart phone calls becoming increasingly common for detecting fires early,and

(x) education through Fire Watch or similar schemes for house owners.

Detection and monitoring systems are divided into the following two basic groups:

(a) volunteer reporting-public reporting of fires, public aircraft, and ground based field staff,

(b) operational detection systems: fire towers, aerial patrols, electronic lightning detectors, and automatic detection systems.

Some of the techniques used in fire suppression include burning dry areas under the management of fire fighters rather than having a crisis later or using flying water tankers like in Canada. Interestingly, others sweep away everything within a planned wide line to surround the fire with a dead end of unfilled areas like in the Middle East. In some parts of Australia, providing the fire does not harm any humans or properties, it is left to burn, until it dies alone.

Taking into account the technological benefits of the developed technology, the FIRE SENSE project is expected to significantly contribute to the protection of forested areas and the safeguarding of cultural heritage, particularly monuments and open archaeological sites. Forest fires cause adverse ecological, economic and social impacts such as:

- Life casualties and loss of properties
- Loss of valuable timber resources
- Degradation of water catchment areas resulting in loss of water
- Loss of biodiversity and extinction of plants and animals
- Loss of wildlife habitat and depletion of wildlife
- Loss of natural regeneration and reduction in forest cover and production

- Global warming resulting in rising temperature

- Loss of carbon sink resource and increase in percentage of CO_2 in the atmosphere

- Change in the microclimate of the area resulting in unhealthy living conditions

- Soil erosion affecting productivity of soils and agricultural production

6.2 Advantages

The FIRESENSE project developed a powerful cost-efficient approach that can be used for the protection of cultural heritage providing:

- High reliability: The system utilizes different sensing technologies (CCTV cameras, PTZ cameras, IR cameras, PIR sensors, temperature and humidity sensors, and meteorological sensors). The different types of sensors operate independently
- Early detection of fire: Automatic detection of flame/smoke/rise in temperature.
- Forest fire management: The system estimates and visualizes the fire propagation based on the area's fuel model (vegetation), the local weather conditions and ground morphology.
- Automation of the fire fighting: The output of the FIRE SENSE system can activate water pipe networks for watering, like the fire sprinkler in buildings.

Such water pipe networks are usually organized in sectors, which can be timely and separately activated in the areas threatened by the fire.

- Early warning for extreme weather conditions: Local weather stations provide useful sensor readings like temperature, wind direction and speed, relative humidity, barometric pressure, rain gauge etc. External weather forecasting is

made available to the system as well, which makes it straightforward to use it as an early warning system for extreme weather conditions.

Furthermore, two significant features of the FIRE SENSE system, which make it applicable to numerous archaeological sites across Europe, are:

- Modular architecture that allows for easy system upgrades and extensions depending on the particular needs of different archaeological sites.

- Protection of archaeological sites through non-destructive and non-intrusive intervention.

The main goal of these activities was to raise awareness about the protection of cultural heritage from natural disasters such as wildfires, disseminate the project's results, educate the inhabitants and exploit the FIRESENSEproduct.

CONCLUSION

The Forest Fire is a serious issue as it has caused loss of huge amount of land, property and lives of people as well as animals.The Paper paves a way to prevent this loss by cutting the supply at the source and preventing the spread at the right time. The project when implemented has huge applications in domestic, Industrial, hospitals, Landscape areas like coal mining and petroleum industries to prevent fire accidents and take necessary preventive measures. The project has huge scope in the future where we will be able to cover huge areas of forest land with the help of Satellites, Thermal Images and Drones. The connectivity of the Wi-Fi in forest areas still remains a technical challenge as using high frequency waves for connectivity may lead to disturbance in birds and animal's life and low frequency may not respond properly, Alternate methods are either too expensive or not effective. Forest still remain an important resource to balance the climate and a possible solution to global warming. Thus when a forest fire occurs not only the valuable forest resource meets damage but the fire tears of the surrounding causing enough pollution by the very source that prevents it.

Early cautioning and quick reaction to a fire breakout are the main approaches to dodge incredible misfortunes and natural and social legacy harms. Hence, the most critical objectives in flame observation are fast and solid identification and restriction of the fire. It is substantially less demanding to stifle a fire when the beginning area is known, and keeping in mind that it is in its beginning periods.

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