

IOT BASED FOREST FIRE DETECTION SYSTEM

Submitted in partial fulfillment of the requirement for the award of Bachelor
of Engineering degree in Electronics and Communication Engineering

By

THARNISA R (38130224)

THAMARAI T (38130222)



DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with grade “A” by NAAC JEPPIAR NAGAR,

RAJIV GANDHI SALAI , CHENNAI- 600119



SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

BONAFIDE CERTIFICATE

This is to certify that this project reports the bonafide work of **THARNISA R (REG.NO 38130224), THAMARAI T (REG.NO 38130222)** who carried out the project entitled “**IOT based forest fire detection system**” under our supervision from DECEMBER 2021 to MARCH 2022.

INTERNAL GUIDE

Dr.M.SUGADEV, M.Tech., Ph.D.,

HEAD OF THE DEPARTMENT

DR.T. M.RAVI, M.E., Ph.D.,

Submitted for Viva voce Examination held on

Dr.V.BALAMURUGAN

Internal Examiner

Dr.NIRMAL RAJ

External Examiner

DECLARATION

We **THARNISA R**(38130224) and **THAMARAI T**(38130222) hereby declare that the project report entitled “**IOT based forest fire detection system**” done by us under the guidance of at **Dr.M.SUGADEV, M.Tech., Ph.D., Sathyabama Institute of Science and Technology, Chennai 600119** is submitted partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and communication Engineering.

DATE:

PLACE:

THARNISA R (38130224)

THAMARAI T (38130222)

SIGNATURE OF THE CANDIDATES

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ABSTRACT

Nowadays there are numerous occurrences regarding the pirating of trees like sandal, Sagwan and then forth. These trees are high-ticket and pitiful. They're utilized within the medicinal sciences, beautifying agents. To limit their sneaking and to spare woodlands around the world some preventive estimates ought to be sent. The wave got designed up a framework that may be utilized to limit sneaking.

The structure framework utilizes 3 sensors tilt sensor to acknowledge the tendency of the tree once it's being cut, temperature sensor to determine timberland fires, a sound sensor for the successful discovery of unlawful work for instance so, even the sounds created whereas chopping out the tree are in addition detected.

Information created from these sensors is consistently observed with the page. As for the sensors, their yield gadgets are initiated through a hand-off switch. For a tilt sensor and sound sensor, a ringer is enacted and for the temperature sensor, the water siphon is actuated. Created data is placed away within the cloud Server over the Wi-Fi module. Woods authorities square measure suggested once an occasion happens therefore correct move is created.

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CHAPTER 1

INTRODUCTION

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. Current firefighting systems are based on humans using deluge guns and chemical fire repression systems. However, in environments where humans cannot work effectively, it is desirable to extinguish a fire 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.

Nowadays, emergency situations involve huge losses, both material and personal. Adverse natural events and atmospheric pollution caused by human activities become disasters when they exceed a limit of normality and cause damages to the ecosystems and various diseases for the population. The effects of these events can be amplified due to poor planning of resources, such as lack of security or control steps, emergency plans and alert systems that can increase the options for predicting their occurrence or controlling their progress once they have occurred. The existence and combination of certain atmospheric conditions in addition to unusual and excessive presence of pollutant gases (carbon monoxide and carbon dioxide) can anticipate the occurrence of an increasingly frequent natural disaster: forest fires. Generally, these kinds of events usually result in serious emergency situations that cause the need of mobilization of different emergency management agencies and services. The land topography, different types of vegetation in the area and weather conditions are the main factors that affect forest fires generation and progress. The control and monitoring of atmospheric variables (temperature, relative humidity and atmospheric pressure) in addition to the concentration levels of certain pollutant gases (such as CO₂ and CO) can favour the detection of fire generation and the monitoring of their progress. In this sense, some factors (excessive temperature increase,

relative humidity decrease or dioxide and monoxide levels increase) could be important indicators to detect fire emergence or its proximity. It is important to name "the rule of 30" which is based on three relevant factors associated with the forest fires detection: temperature values above 30°C, humidity values below 30% and wind speed values above 30 Km/h in the same area. The use of this rule as forest fires prevention standard can contribute to determine which areas have a high probability of fires occurrence, in order to enable the deployment of preventive mechanisms and action protocols that could favour the environmental conservation. Thus, an information system has been developed that integrates IOT devices and sensors which are able to register atmospheric variables, such as temperature, humidity and pressure in addition to pollutant gases, such as CO₂ and CO (which are very important in the air quality measurement). These gases can affect people's health and are emitted during forest fires excessively as result of combustion of huge amounts of biomass. Furthermore, this system is responsible of realising a real time management of alerts that could be activated according to the latest events as well as realising the coordination of operations required between emergency teams situated in affected area and the emergency services platform. we present the state of art and the preliminaries about the general topic that is addressed. Then, the proposed system is explained The developed system is explained in detail and the system security is detailed brief conclusions and future research lines.

1.1 PRELIMINARIES

In the field of IOT applications for the control of forest fires, several kinds of systems can be used for the warning, prevention and monitoring of these natural disasters. For example, this is the case of the application Forest Fire Danger Meter [2] available for Android. It stands out mainly because it is a calculator to find the fire hazard according to the classification of McArthur Forest Fire Danger Index [3], taking as reference the following parameters: temperature, relative humidity, wind speed, dryness factor, vegetation and pending. In the same field, IncendiosCyL [4] beta application is under development. Although it currently only provides data for the province of Soria, this application has as its

fundamental objective to realize a meteorological forecast which indicates in which recreational areas tourists are allowed to make a fire, prohibitions and recommendations of how to act in nature, etc. Copyright (c) IARIA, 2017. ISBN: 978-1-61208-598-2 121

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Another important element in the area of emergency situations and forest fires management is how Geographic Information Systems (GIS) [5] have become very relevant in the forest fires prevention and control. GIS allows real time access to data in the area, creating strategies to evacuate affected people, performing simulations, establishing health care points and redefining transport routes depending on the affected areas among other aspects. In fact, this system has been used recently by organizations such as the Civil Guard during the work of extinguishing the last fire in La Palma Island in 2016 and in other cases, such as a Portugal forest fire in 2017. Similarly, Senticnel fire detection system (NTForest company) uses sensors and IOT technology to collect information on humidity, temperature and other environmental factors that could allow to predict the evolution of this type of natural disasters and encourage their extinction. Due to the importance of natural disasters and emergency situations management, multiple projects and IOT applications exist.

The system Find& Rescue offers a global online vision of emergency teams through a specific device carried by each emergency team member. Several IOT applications are based on the deployment from helicopters of different kinds of sensors, which could register environmental data: temperature, gases, etc. In the MERIS project, a real time application allows accessing the information of the status of recoverable victims through devices and sensors that control vital signs .The management of emergency tactics is done using sensor technologies, such as liDAR and the Esphera platform: helicopter tracking through a 3D environment, integration of video from different resources and others aspects . iSafety is a comprehensive emergency management system, which allows the integration of smart sensors and other applications to realize a real time emergency situation control .Taking into account the previous applications, the proposed system in this paper offers new improvements, such as the use of innovative IOT technologies and a data treatment focused on the prevention, detection, activation of alarms and management of operations for the extinction of fires. A system with secure communications has been configured that allows the monitoring of different variables of the environment and the processing and visualization of the

information registered in real time guaranteeing the access for all users through diverse platforms. 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. Current firefighting systems are based on humans using deluge guns and chemical fire repression systems. However, in environments where humans cannot work effectively, it is desirable to extinguish a fire 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 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

Sensor Polling

Video-based Fire Detection

Data Fusion

Prediction of Fire Propagation

3D GIS

IR –based Fire Detection

Weather Data Processing

External Weather

Forecast

Area Fuel Model

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 WSN sensors

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 infrared (PIR) sensor based system for indoor fire detection

Collection and analysis of weather data from local weather stations and official sources. Definition of WSN architecture and related communication protocols; definition of constraints and requirements for the network topology and the network node/gateway hardware/software. Hardware and software design, development and integration of sensor nodes, WSN gateways and housing. Design and development of communication protocols, routing algorithms and network topology for maximizing the lifetime of the WSN.

Establishment of guidelines and test procedures for WSN deployment and maintenance.

Multi-sensor data fusion

Development of novel data fusion techniques for the combination of data from multiple sensors to detect fire and smoke. Provision of different alarm levels for cases of temperature rise, detection of smoke or fire, extreme weather conditions, etc based on the result of multi-sensor data fusion.

Estimation and visualization of fire propagation

Estimation of vegetation distribution and relevant fuel model parameters in monitored areas based on satellite images, pre-existing land cover information or ground surveys. 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 Control Centre

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 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 project results.

A forest is basically a place for various types of trees and wildlife. The first thing that comes to our mind when we think about forest is trees. Forest is a home for varieties of plants and animals. The main source of oxygen is plants; it inhales carbon dioxide and other greenhouse gases and exhales oxygen. Since all are aware of the types of pollutions, air pollution has become more and more due to industries and wide use of vehicles these days. Only way to purify toxic air is growing trees and protecting forest. Forest fire causes huge damage to the world. Forest fires are can't be noticed easily and it spreads quickly damaging many plants and killing wild animals. Forest covers approximately 30 percentage of world's land.

Now a day's forest fires are increasing. This may be due to natural or man-made disasters .In recent studies it was shown that damage caused due to forest fire is huge. The survey conducted by Nation Interagency Center says that more than 65,577 wildlife's and trees are affected due to forest fire, in 2017 the damage has increased to 71,499 and more acres of forest land was burned. IOT (Internet of Things) has become common. IOT is nothing but sharing data through internet without human to human, machine to machine and human to machine interventions. In short words IOT is a network that helps to connect to all the physical devices to internet and to communicate with each other and analyze, share data .Using IOT a large range of applications have been

developed . IOT applications have become popular these days. We have many incidents on forest fire which have taken place in all over the world.

The major cause of the forest fire is mainly due to natural or man-made faults. Forest fire spreads quickly so the model should be designed in such a way that detects while the incident is happening and to notify within seconds. The forest fire spreads quickly and if it is not identified and measures are not taken properly it spreads so fast causing damage to the ecosystem. Forest is a home for all the wild animals and trees. There are many incidents which prove the damage caused by forest fires one such example is Bandipur. Bandipur incident took place in February 2019, it burnt down about 10,920 acres of forest land .Bandipur forest is a home for several animals and about 250 species of birds and huge range of vegetation. In many monitoring stations the authorities do not have any pre warning system or a device which sends message while the incident is taking place .So, the life of the forest guards would be in danger. In this project we have designed and developed a hardware model which helps in detecting forest fire at its earlier stage itself. This device helps to detect the fire and prevent loss to the government by indicating about the incident and also takes necessary actions to prevent the forest fire. The hardware model consists of sensor's like gas/smoke sensor and temperature sensor. A buzzer is also provided which helps to alert while the incident is taking place. A buzzer alerts nearby animals, birds and in the worst case it alerts humans with its alarm or buzzing sound. A camera is interfaced to the Raspberry Pi. It can be rotated in any direction. If it detects any trace of fire it sends message to the monitoring station. From the monitoring station if anyone wants to see the state of fire it could be done with the help of help of camera and this camera has 360 degrees rotation feature. Raspberry Pi 4 model is used in the development of the hardware model. Raspberry Pi is just like a mini computer, it has many features and it is more advantageous over Arduino. Raspberry Pi is fast and its clock speed is high When compared with the Arduino. We can detect the exact location where the forest fire is detected with the help of Raspberry Pi 4, it has inbuilt Wi-Fi module. It has water motor, which is interfaced with the Raspberry Pi module. Water motor helps in case of emergency if we want to eliminate the starting level fire. One of the major concern about any hardware device is power. So have come up with an idea of solar panel, it has solar battery to store the power. Here we used solar module for the power consumption. During the day time it takes the power from the solar module and during night times it takes power from the battery to charge the system.

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 and signal. 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 because 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.

Anticipating woods fire is a warmed point the world over in standard assurance. Each stage, from flame affirmation to putting out the flame, some persuading proposition are requested to do help thusly away timberland fire. A lot of examines are made and diverse unmistakable papers are coordinated to get some sensible knowledge. Backwoods blazes are the clarification behind various and irreversible harms to both nature and money related issues. For instance, different gainful

species are tidied up, human's life and assets are undermined, etc. Despite a stretching out of state costs to control this debacle, reliably incalculable accidents happen all around the globe. It spent an immense extent of standard human observation perceiving, at any rate the exactness of report is influenced by hypothetical parts. So it is making to demonstrate the dynamical direct of flame spread in a woodland so as to make course of action to control and battle fire. Different experts rotate around the flame spreading model to duplicate the Propagation of wild impacts. Cash related exercises, for example, the development business can be influenced conflictingly by rapidly spreading blazes in light of harms it causes to the vegetation of common systems[10].

Rapidly spreading flames are an unfaltering peril to ordinary frameworks of backcountry and human security particularly in districts which present hot condition. Models predicting the ate up area are commonly American Rothermel outline, Canada's national timberland fire spread model, comparably as China's Wang non-woods fire spread model, Therefore, we pick a locale of woodland fire risk rating as a pointer of the component of backcountry fires, under the known states of backwoods sorts, relationship between meteorological components and timberland flares in the zone between the evaluations on a noteworthy scale. Expected to anticipate woods fire locale may have happened after the timberland fire rating, so as to give a theoretical motivation to backwoods fire evaluating in different districts. Human exercises like clearing field for development, charcoal eating up or smoking can make out of control fire happen. Broken glasses can be another wellspring of insane fire in light of the fact that on occasion they can go about as all out purpose of assembly concentrating daylight on a little spot for a period length, a condition that could trigger flame. A lot of focuses reliant on remote sensor frameworks have been done by experts worldwide in order to consider structures fit for looking at and perceiving of control fire. Bolourchi and Uysal in 2013 prepared an investigation work that proposes the use of remote sensor compose (WSN) for data gathering to be used as unrefined information data into a control system that they made. They pick fire acknowledgment to speak to the Intelligent Decision Making (IDM) limit of the structure and made Fuzzy Logic figuring using temperature, smoke, light, dampness and detachment as limits. Probability of fire subject to fleecy rules using the status of the limits is shown by mirroring the made structure on the Matlab programming. The weakness in this investigation is that it is just a theoretical work reliant on generation on the Matlab programming to discover the probability of occasion of fire. The structure isn't attempted in the really condition to give out some understanding on how it will continue. An examination work by Lloret et al. in 2009 proposed a remote sensor net work sending

for nation and timberland fire acknowledgment and affirmation .This structure uses IP (Internet Protocol) cameras in a remote framework in order to perceive and affirm fire in nation and woodlands areas. The structure involves various sensors and entries to perceive fire and send a sensor alert through the remote

combination in the speed, temperature and substance species focus fields with time. Intelligent model and the postponed result of the count offer a chance to study essential states of the forested regions fire starting and spread which gifts applying the given model for of techniques for dismissing flares.

Forest fires are a recurrent phenomenon, natural or man-made, in many parts of the world. Vulnerable areas are mainly located in temperate climates where pluviometry is high enough to enable a significant level of vegetation, but summers are very hot and dry, creating a dangerous fuel load. Global warming will contribute to increase the number and importance of these disasters. Every season, not only are thousands of forest hectares destroyed by wildland fires, but also assets, properties, and public resources and facilities are destroyed. Moreover, firefighter and civilians are at risk, with a terrible toll in human lives each year.

Although progress has been made in the field of wildfire fighting in the last decades, there is still a need to strengthen the disaster response capacity, including early warning systems and improvements in real time exchange of data at all stages and levels of a forest monitoring scheme. Technological breakthroughs will be a key force driving change in wildland fire fighting. Recent developments in information and communication technologies are already having a huge impact, specially forest fire detection system.

There are systems based on satellite imagery .but they are not used in real time applications due to their long scanning cycle ,poor resolution, and cost. Other systems based on short range images have been proposed, using either optical, infrared, or thermal images. However, these approaches are very outlier sensitive: direct and strong sunlight, insufficient light, or smoke. They are also very false alarm prone. Radio acoustic sounding has also been proposed as a way to infer the meteorological flow or temperature profiles in forest areas. Nevertheless, it lacks resolution, it is expensive (radars and acoustics sources required), and it is susceptible to interferences, such as wind direction changes.

Other recent works describe detection systems based on distributed wireless sensor networks (WSNs). In a WSN based on cameras, fire detectors, and 802.11g access points is described. This approach is aimed at detecting and verifying fires in rural and forest environments, and it sends alarms to a central server. The work in proposes a WSN based on ZigBee, GPRS, and Ethernet communication modules. Ganesh et al. describe a forest fire detection system based on WSN and on solar energy harvesting modules. It applies a node hopping scheme to reach the data server.

Our approach is also based on the WSN paradigm but has been designed and developed in the context of a research project that included all the key actors in forest fire fighting operations: engine, hand, and helitack crews, satellite operators, forest services agencies, information and communication technologies providers, management organizations (wildland fire management, fire operations, fuel management, and aviation management), authorities, aviation services, airtankers, weather services agencies, and burned area rehabilitators. This unique research ecosystem has provided our solution with a holistic perspective that results in a set of distinguishing features: (i) no need for a preinstalled communications network: most schemes need to have GSM coverage or Wi-Fi to work. This approach assumes that there is no communication network available at the monitoring zone and creates its own network; (ii) time synchronization: all measurements taken must have a time-stamp, but some wireless nodes have no way to get the current time by themselves. The network is able to get the current time from the GPS module and correct time deviations; (iii) dual functionality, that is, environment monitoring and fire early detection: deployment of networks can be costly for the only purpose of fire detection. Even at high risk areas, the probability of fire may be very low, and a WSN can be underexploited and become a waste of resources. Environment monitoring contributes to optimize the usage of the network; (iv) not being based on cameras/images: video or image acquisition and transmission are very demanding in terms of bandwidth and power consumption. This approach is very suitable for ground based monitoring stations, but not for general “deploy and forget” approaches ;(v) integration with the operation centre: the network proposed includes a middleware layer to share data with command centres and other wild land fire fighting units. This enables a full picture of the emergency in real time.

The general structure of our approach is depicted in Figure 1. The node structure is composed of 2 levels, central nodes, devoted mainly to short and long range communications and control

purposes, and sensor nodes, used to collect data from the area under monitoring and send them to the central nodes. All node types can include environment and meteorological sensors

CHAPTER II

LITERATURE SURVEY

Fire-Smoke Detection and Weather Data Collection

The main S&T result of WP3 is the development of algorithms and software for fire and smoke detection based on optical and IR cameras. The developed software enables early detection of fires in large open areas and can be used for the protection of forests and cultural heritage areas, as well as for the detection of fires in landfills, industrial areas (chemical fires, warehouses) and military training areas. Computer vision based flame detection Optical cameras and video-based algorithms provide an effective and low cost solution for the detection of flames at an early stage. However, video-based flame detection systems are affected by several limitations that challenge their performance such as the presence of sun reflections, car lights, bad lighting conditions, poor image quality, movements of fire-like coloured objects, etc. To overcome the aforementioned drawbacks, partners focused on improving existing algorithms and developing three new techniques for flame detection. The developed algorithms offer increased detection rates and lower false positive ratios compared to the literature. BILKENT developed a covariance matrix based fire detection method for video sequences. The algorithm divides the video into spatiotemporal blocks and uses covariance-based features extracted from these blocks to detect fire. Both the spatial and the temporal characteristics of flame coloured regions are exploited. Unlike other algorithms used for similar tasks, the proposed method does not use background subtraction, which means that it does not require a stationary camera for the detection of moving flame regions and can, therefore, be also used with moving cameras. This is an important advantage because fixed cameras may sway because of the wind or a PTZ camera can slowly pan an area of interest to detect fire.

CERTH's flame detection

algorithm results: 1) input video frame, 2) estimated foreground i.e. detected moving objects, 3) result of colour analysis (detection of regions with fire-like colour), 4) result of spatial analysis, 5) result of temporal analysis (flame flickering detection), 6) result of feature fusion, i.e. detected flames. Red rectangles indicate the regions of the image where flame was

detected. Detected flame blobs are illustrated as coloured regions. CERTH developed a video based flame detection algorithm, which initially applies background subtraction and colour analysis to identify candidate flame regions on the video frames and subsequently distinguishes between fire and non-fire objects based on a set of five extracted features including colour probability, spatial variation, temporal variation (flickering), spatiotemporal variance and contour variability of candidate blob regions. Classification is based either on classifiers trained with fire and non-fire video frames or on a rule-based approach. Finally, SUPCOM developed a real-time flame detection system for video sequences captured by both fixed and moving (PTZ) cameras. First, moving objects are detected in each frame. Then, a set of flame characteristics including colour, temporal intensity variance, spatial intensity variance, shape variation and shape complexity are extracted and classified as flame or non-flame using a set of fuzzy Context Independent Variable Behaviour (CIVB) classifiers.

Computer vision based smoke detection

Smoke observed from a long distance and smoke observed from up close have different spatial and temporal characteristics. Wildfire smoke appears to move very slowly after a couple of hundred meters and it does not exhibit turbulent behaviour when monitored by a video camera. Based on this observation, BILKENT developed two different algorithms for close range and long range (wildfire) smoke detection. The close range smoke detection algorithm first detects regions with smoke-like colour (grey/white) to decrease the search area in the frame. Then, the video is divided into spatiotemporal blocks and a set of covariance descriptors is extracted for blocks with smoke-like colour. The long-range smoke detection algorithm consists of three main sub-algorithms: (i) slow moving object detection, (ii) smoke-coloured region detection, and (iii) correlation based classification. Both algorithms obtain high detection rates while exhibiting increased robustness to false positives due to the presense of clouds, fog or moving objects. Figure 6: Smoke detection results using BILKENT's algorithms for close range (first two images) and long range (last two images) fires. BILKENT also developed an Entropy functional based Online Adaptive Decision Fusion (EADF) framework for image analysis and computer vision applications and improved former smoke detection results. In this framework, sub-algorithms of the smoke detection module are combined with weights, which are adjusted online according to the changing light and environmental conditions. In this way, it is possible to fuse the results of several smoke

detection algorithms analyzing the scene in parallel. Improved performance was achieved for wildfire smoke detection at an early stage. Finally, SUPCOM investigated the possibility to embed an early smoke detector into the camera in order to send a quick alert to the monitoring center immediately after video acquisition. Generally, the two video compression standards MJPEG and MPEG2 are commonly available in most cameras. They both involve a blockwise Discrete Cosine Transform (DCT). SUPCOM's first contribution for designing such smart camera functionality consists of exploiting the local fractal feature of smoke areas based on the DCT coefficients. The second novelty relies in refining the estimation of the fractal feature by considering larger blocks of coefficients to increase detection accuracy without increasing the complexity. This technique could be very useful in low bit-rate transmission applications. Figure 7: Smoke detection results using the EADF framework in wildfire video sequences. IR camera based fire detection Three prototype multispectral cameras were developed by XENICS. Meerkat Fusion consists of three cameras at different wavebands: visible, SWIR and LWIR. Meerkat PTZ consists of two cameras at visible and LWIR spectrums. Finally, Meerkat Fix consists of a LWIR and a SWIR camera. The cameras are capable of recording videos simultaneously and transmit the videos to a computer through Ethernet. Figure 8: Meerkat Fusion, Meerkat PTZ and Meerkat Fix cameras developed by XENICS. Figure 9: Images from field tests performed in Antalya, Turkey in May 2011 using the Meerkat Fusion multispectral camera: a) visible image, b) SWIR image and c) LWIR image of the same scene. Page 12 of 97 XENICS made an in-depth analysis for infrared data processing. Each aspect of the infrared radiation was studied: (i) physical aspect (physical infrared radiation modelling and effect of environment), (ii) electro-optical system aspect (infrared radiation detection, including image contrast and background noise influenced by lenses, camera resolution and other sensor characteristics) and (iii) image processing aspect (infrared data analysis). Three approaches were implemented by XENICS for automatic infrared fire detection: the first two approaches are designed for long range fire detection based on SWIR and LWIR cameras. The image processing is performed separately in each waveband and the fusion is performed at the decision level. These two methods take advantage of the high dynamic of these cameras. The third approach is designed for short range fire detection based on both LWIR and visible cameras. The multi-sensor flame detection algorithm first searches for candidate flame objects in both LWIR and visual images based on moving object detection and flame feature

analysis. Next, the registration information is used to map the LWIR and visual candidate flame objects on each other. An alarm is issued if the flame probability of the mapped objects is high. Figure 10: Detection of fire in a sequence recorded by a SWIR camera. Two fires with size 1m² and 2m² respectively are detected. The screenshot is from the IR software platform developed by XENICS. Other methods were also investigated such as the detection of the potassium lines or the Time of Flight flame detector. The first method is better fitted for airborne fire detection because the forest could occlude the potassium emission. The potassium lines are seen at the start of the fire because the potassium is released at the beginning of the fire when the temperature is high. These potassium emission lines could be occluded by the dark smoke. The Time of Flight flame detector is best fitted for short-range fire detection. BILKENT also developed an IR-based flame and smoke detection algorithm. The algorithm starts with segmenting moving hot objects. Then several features including boundary box disorder, histogram roughness, principal orientation disorder, center mass disorder, etc. are extracted from the segmented regions and are used to decide whether the hot moving objects represent fire or not..

PIR sensor based fire detection

A flame detection algorithm using pyro-electric infrared or passive (PIR) sensors was developed by BILKENT. Two versions of this algorithm were implemented. The first can run on a PC. The second is implemented as a standalone system using digital signal microprocessors. A differential PIR sensor is only sensitive to sudden temperature variations within its viewing range and it produces a time-varying signal. This signal is analyzed using Markov models corresponding to the flame flicker process of an uncontrolled fire, ordinary activity of human beings and other objects. Comparative results show that the system can be used for fire detection in large rooms. Conventional point smoke and fire detectors typically detect the presence of certain particles generated by smoke and fire by ionization or photometry. An important weakness of point detectors is that the smoke has to reach the sensor. This may take significant amount of time to issue an alarm and therefore it is not possible to use them in open spaces or large rooms. The main advantage of the differential PIR based sensor system over the conventional smoke detectors is the ability to monitor large rooms and spaces because it analyzes the infrared light reflected from hot objects or fire flames to reach a decision. The PIR system shows very high detection rate and low false alarm rate. A flood detector, which works by sensing if water is present at its contacts, was

also integrated in this board. This standalone system presents an ideal low-cost solution for fire and flood detection in large rooms. Standalone PIR system. A flood detection sensor is also integrated in the board (the PIR sensor is the white box; the flood sensor is the one with the white cable) Software platforms for fire/smoke detection The video-based smoke and flame detection algorithms developed within WP3 have been integrated in two software platforms: a standalone software platform used for algorithm testing using prerecorded videos and an online software platform that can be connected with a range of different cameras and can detect fire in real-time. The on-line platform can support many cameras at the same time (PTZ cameras also) and provides a user friendly interface that allows the display of live streams from the cameras, issue of visual and audio alarms at real time, addition of new cameras, adjustment of camera parameters, selection of flame/smoke detection algorithm to use, display of camera positions in Google Earth, etc. The online smoke and flame detection platform developed by BILKENT has been installed in many watch towers in Turkey in cooperation with the Turkish General Directorate of Forestry. A software platform for the detection of fire in pre-recorded IR sequences was also developed by XENICS. Weather data collection Weather measurements are collected from local weather stations installed at the test sites. Polling of real time weather and forecast data from public weather sites and national meteorological agencies is also supported. Commercial weather stations were installed in most pilot sites, while in Kabeirion a prototype weather station, especially designed for FIRESENSE, was employed.: Online fire/smoke detection software platform.

WP4: Wireless Sensor Network The main results of the research performed within WP4 is the development of a novel wireless sensor network (WSN) for monitoring environmental parameters, which coupled with a wireless data network (WDN) for video surveillance can be used for the detection of fire. Wireless Sensor Network A novel wireless sensor network was designed and developed by CERTH. The design approach primarily targeted at a robust solution for outdoor deployment that can operate on cheap-to-replace batteries for a long period, while maintaining a good response to sensing a wildfire. Moreover, given that the WSN is part of a critical system to which responsible personnel relies for early warnings, any WSN subsystem malfunction should be reported immediately and effectively along with its location. For that reason, a clustered network hierarchy is designed with clusters of approximately 10 sensors governed by a dual-radio clusterhead device with more resources than the sensor platform. Clusterheads uses low range, ultra-low power radio to communicate

with sensors that can be placed around them at a distance of 80 meters at most. The clusterheads themselves are collecting local sensor measurements and send them via long range WiFi (upto 200 m) to a WSN aggregation point. In addition, the clusterheads are passively monitoring local sensors and their behavior and report problems immediately. Within FIRESENSE, the clusterheads implemented advanced sleep scheduling and multi aggregation point selection algorithms, which increase robustness and fault tolerance. The WiFi network formed by the clusterheads is an ad-hoc network that introduces full deployment flexibility since a clusterhead can be placed beyond the 200 m barrier from the aggregator point and use neighbour clusterheads that are closer for measurement propagation in a multi-hop manner. A considerable amount of effort was invested in integrating the WSN in a controllable and effective way with the Data Fusion module. For that reason, an HTTP-based REST API with human readable XML responses was used to drive the WSN. The API recovers from malfunctions during request processing like network loss or device failure and returns appropriate messages for all error conditions, so that the data fusion can handle them. The integration with data fusion included a long testing period and the behavior of the WSN has been selected to bridge the Data Fusion response demands with the low power requirements. As a result, the Data Fusion engine can effectively interpret temperature and humidity readings to discriminate between fire and direct sun light exposure, which is one of the main problems in WSN-based fire detection.: WSN cluster based architecture (left), sensor node (top) and clusterhead (bottom). WSN security has been thoroughly considered and several security extensions have been implemented to both the WiFiahoc network and to the authentication of REST API messages to avoid man-in-the-middle attacks that wish to deceive the control centre. The WSN has been thoroughly tested and has been deployed in Kabeirion, Rhodiapolis and Dodge Hall test sites.

Apart from causing tragic loss of lives and valuable natural and individual properties including thousands of hectares of forest and hundreds of houses, forest fires are a great menace to ecologically healthy grown forests and protection of the environment. Every year, thousands of forest fires across the globe cause disasters beyond measure and description. This issue has been the research interest for many years; there are a huge amount of very well studied solutions available out there for testing or even ready for use to resolve this problem. A lot of

methods and systems are available in the market and for research. The paper reviews all the methods and discusses examples of research experiment results and some market product methods for better understanding. Forests are the protectors of earth's ecological balance. Unfortunately, the forest fire is usually only observed when it has already spread over a large area, making its control and stoppage arduous and even impossible at times.

2.2 International Journal of Innovative Research in Science, Engineering and Technology

Forest is considered as one of the most important and indispensable resource, furthermore, as the protector of the Earth's ecological balance. However, forest fire, affected by some human uncontrolled behaviour in social activities and abnormal natural factors, occurs occasionally. Forest fire was considered as one of the severest disasters. In forest fire detection, it is essential to know how fire affects the soil mantle, stems and treetops, as well as how to detect underground fires. The sensor network must cover large areas, distributing high amount of sensing nodes, inexpensive sensors are needed to achieve cost reduction. Video cameras sensitive in visible spectrum based on smoke recognition during the day and fire flame recognition during the night, Infrared thermal imaging cameras based on detection of heat flux from the fire, IR spectrometer which identifies the spectral characteristics of smoke gases, and "Light detection and ranging" system which measures laser light backscattered by smoke particles. Infrared and laser-based systems have higher accuracy than the Other systems A forest is basically a place for various types of trees and wildlife. The first thing that comes to our mind when we think about forest is trees. Forest is a home for varieties of plants and animals. The main source of oxygen is plants; it inhales carbon dioxide and other greenhouse gases and exhales oxygen. Since all are aware of the types of pollutions, air pollution has become more and more due to industries and wide use of vehicles these days. Only way to purify toxic air is growing trees and protecting forest. Forest fire causes huge damage to the world. Forest fires are can't be noticed easily and it spreads quickly damaging many plants and killing wild animals We have many incidents on forest fire which have taken place in all over the world. The major cause of the forest fire is mainly due to natural or man-made faults. Forest fire spreads quickly so the model should be designed in such a way that detects while the incident is happening and to notify within seconds. The forest fire spreads quickly and if it is not identified and measures are not taken properly it spreads so fast causing damage to the ecosystem. Forest is a home for all the wild animals and trees. There are many incidents which prove the damage caused by forest fires one such example is Bandipur. Bandipur incident took place in February 2019, it burnt down about 10,920 acres of forest land .Bandipur forest is a home for several animals and about 250 species of birds and huge range of vegetation . In many monitoring stations the authorities do not have any pre warning system or a device which sends message

while the incident is taking place . So, the life of the forest guards would be in danger. In this project we have designed and developed a hardware model which helps in detecting forest fire at its earlier stage itself. This device helps to detect the fire and prevent loss to the government by indicating about the incident and also takes necessary actions to prevent the forest fire. The hardware model consists of sensor's like gas/smoke sensor and temperature sensor. A buzzer is also provided which helps to alert while the incident is taking place. A buzzer alerts nearby animals, birds and in the worst case it alerts humans with its alarm or buzzing sound. A camera is interfaced to the Raspberry Pi. It can be rotated in any direction. If it detects any trace of fire it sends message to the monitoring station. From the monitoring station if anyone wants to see the state of fire it could be done with the help of help of camera and this camera has 360 degrees rotation feature.

2.3 Forest Fire Detection using Wireless Sensor

Many solutions for detection of forest fire are presented and implemented in past few years. Video Surveillance System is most widely used for detection of forest fire. It is divided into four categories : Video Cameras sensitive in visible spectrum based on recognition of smoke during day light and fire flames at night, Infrared(IR)Thermal Imaging cameras based on detection of heat flux from the fire, IR Spectrometer which identify spectral characteristics of smoke gases and Light Detection and Ranging (LIDAR) system which measures the laser light backscattered by smoke particles. The limitation of these systems was high false alarm rate due to atmospheric conditions such as presence of fog, shadows, dust particles etc.

Effectiveness and response time in emergency situations management are key factors that directly influence the number of victims. The analysis of environmental conditions in real time (such as weather events and polluting gases) could provide relevant data on the environment that could help prevent or detect an emergency situation. Nowadays, IOT (Internet of Things) devices and sensors allow the monitoring of different environmental variables, such as temperature, humidity, pressure and concentrations of pollutant gases, such as carbon monoxide and carbon dioxide. Radical

changes and combinations of these variables could indicate the occurrence of adverse weather events that could cause a natural disaster, such as a forest fire. Thus, the developed system integrates IOT devices and sensors that can perform a real time control of different atmospheric variables and polluting gases, in order to activate alerts when pollution levels increase excessively or when detecting certain conditions that are considered to be possible factors for causing adverse climatic events. These events can favour the occurrence of fires and other emergency situations. Particular attention has been paid to the communication security among IOT devices, Web service and mobile devices. Moreover, a secure data transmission protocol, a block cipher algorithm and a secure authentication scheme have been implemented.

CHAPTER III

PROPOSED WORK

SYSTEM DESIGN

The issue with timberland fires is that woodlands are generally remote, unmanaged domains stacked with trees, and dry wood and leaf litter that go about as fuel sources. These pieces are especially ignitable materials and address the ideal setting for impacts. Flame start can be polished by human activities like smoking or fire cooks, or by regular causes, for example, high temperatures on a mid year's day. Right when start begins, by then the burnable materials may effectively fuel the flame. The flame by then breezes up continuously basic and reasonably clearing.

DISADVANTAGES: Difficult to screen all the woodlands zones in light of the fact that here we are using model we won't have much partition to cover certain area.

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 carbon dioxide level and temperature.

- Existing system they are used Robots for Extinguish fire robot is interfaced with several sensors
Unmanned Ariel Vehicle (UAV) – For monitoring Forest fire
- Unmanned Ground Vehicle (UGV) – For extinguish fire
- Both Vehicles are communicating through Radio Frequency Communication if UAV is detecting fire means it will send to UGV
- UGV will come to that spot and extinguish fire

PROPOSED WORK

Nowadays their area unit numerous occurrences regarding the pirating of trees like sandal, Sag wan and then forth. These trees area unit high-ticket and pitiful. They're utilized within the medicinal sciences, beautifying agents. To limit their sneaking and to spare woodlands around the world some preventive estimates ought to be sent. The wave got designed up a framework that may be utilized to limit sneaking. The structure framework utilizes 3 sensors tilt sensor to acknowledge the tendency of the tree once it's being cut, temperature sensor to determine timberland fires, a sound sensor for the successful discovery of unlawful work for instance so, even the sounds created whereas chopping out the tree area unit in addition detected.

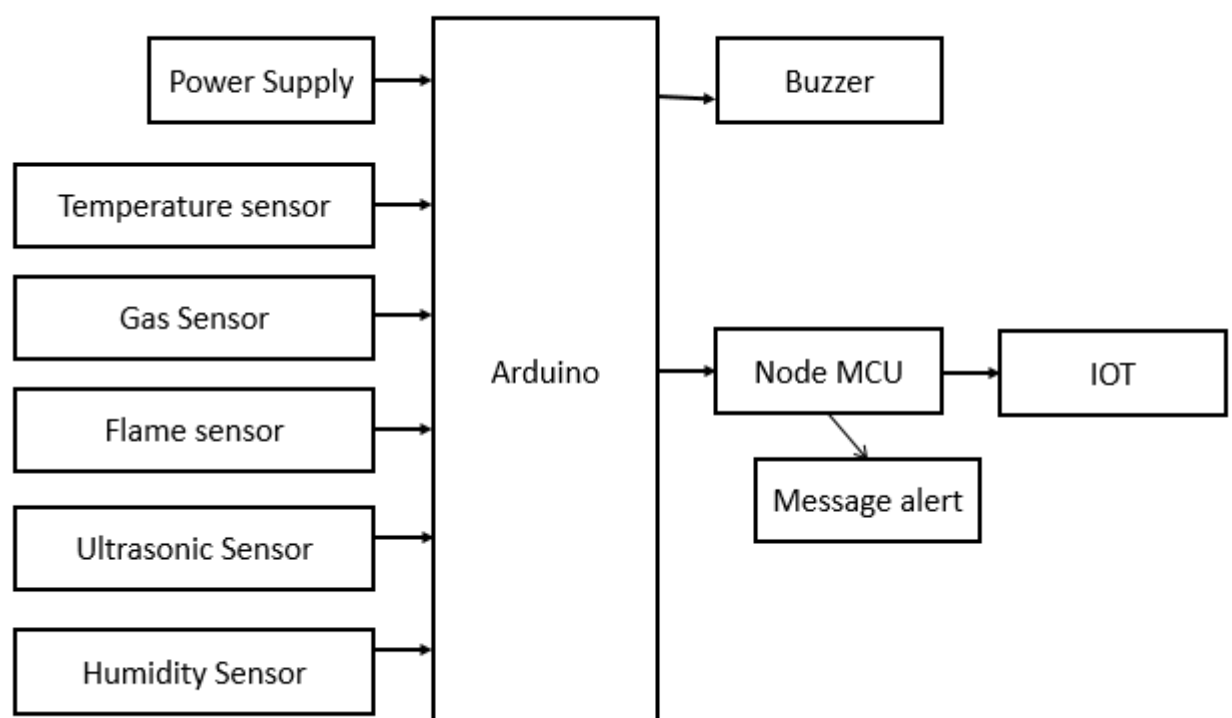
Information created from these sensors is consistently observed with the page. As for the sensors, their yield gadgets area unit initiated through a hand-off switch. For a tilt sensor and sound sensor, a ringer is enacted and for the temperature sensor, the water siphon is actuated. Created data is placed away within the cloud Server over the Wi-Fi module. Woods authorities square measure suggested once an occasion happens therefore correct move is created.

PROPOSED SYSTEM

Effectiveness and response time in emergency situations management are key factors that directly influence the number of victims. The analysis of environmental conditions in real time (such as weather events and polluting gases) could provide relevant data on the environment that could help prevent or detect an emergency situation. Nowadays, IOT (Internet of Things) devices and sensors allow the monitoring of different environmental variables, such as temperature, humidity, pressure and concentrations of pollutant gases, such as carbon monoxide and carbon dioxide. Radical changes and combinations of these variables could indicate the occurrence of adverse weather events that could cause a natural disaster, such as a forest fire. Thus, the developed system integrates IOT devices and sensors that can perform a real time control of different atmospheric variables and polluting gases, in order to activate alerts when pollution levels increase excessively or when detecting certain conditions that are considered to be possible factors for causing adverse

climatic events. These events can favour the occurrence of fires and other emergency situations. Particular attention has been paid to the communication security among IOT devices, Web service and mobile devices. Moreover, a secure data transmission protocol, a block cipher algorithm and a secure authentication scheme have been implemented. In existing system, they use robots to extinguish the fire accidents but robots have its own advantages and disadvantages In this system we go for detection and Monitoring of forest fires through several sensors and send to IOT cloud. Depending upon the sensor values in the cloud if it is greater than the preset values it will send mail to the user. Continuous monitoring and uploading values to Ubidots cloud can be achieved.

Block Diagram



BLOCK DIAGRAM EXPLANATION:

The developed system is based on a sensor network and distributed

wireless IOT devices able to obtain data from the environment and process it in real time. The main goal is to provide information to the systems responsible for the management and strategic planning in emergency situations generated mainly due to forest fires. In this sense, the system consists of gathering data of magnitudes and atmospheric variables that determine the meteorological conditions and the presence of polluting gases in each zone to transform it into useful information that could be visualized through interactive elements (maps, graphs, statistics and gauges) (Figure 1). Atmospheric variables and pollutant gases control and monitoring can favour forest fires prevention in different ways. Firstly, it helps to prevent and determine possible risk areas for forest fires. Taking into account values collected by IOT devices and "the rule of 30", temperature measurements that exceed 30°C and humidity values below 30% in a same zone could implicate a preventive management process through alerts activation. The main reason is the existence of meteorological conditions that are favorable to forest fires generation. In addition to these factors, the pressure value is relevant in the field of early detection of periods of storms or anticyclones that can improve or aggravate the weather conditions in case of fire. Secondly, the control and monitoring of atmospheric variables and pollutant gases can also favour the early forest fires detection (when values and measurements provided by the IoT devices imply unusual meteorological conditions in the area, such as an abrupt rise of temperature values, decrease of humidity in the area or periods of anticyclone). In addition, an excessive increase of the CO₂ and CO concentrations could indicate an evidence of biomass combustion. Thirdly, the control and monitoring of atmospheric variables and pollutant gases can also favour the control of the forest fires progress. The monitoring of the commented variables in the surroundings of the burned zone allows to control the fire progress through detection of progressive increases of temperature, humidity, and CO₂ or CO concentrations. In this way, it is possible to realize a real time management of the area occupied by forest fire. The developed information system is composed of three important parts: IoT devices, Web services and mobile application. Figure 1. Operation of the system A. IoT devices Every IoT device distributed in the environment communicates wirelessly through 4G

with the Web service, which is the responsible for storing and processing all data. So, these devices have integrated 3 different sensors that are able to interact with the environment and collect multiple variables: temperature, humidity, atmospheric pressure and pollutant gases, such as carbon monoxide and carbon dioxide (indicators of air quality). In addition, they are based on Arduino and are composed of a motherboard that is assembled with a 4G module to send the collected data. Other hardware elements are also necessary to integrate the multiple sensors that allow to register the atmospheric variables. The use of a 4G module allows registering the location of each distributed device guaranteeing their visualization and representation through interactive maps. Once the IOT device is in the environment, the atmospheric variables and the pollutant gases of the area where it is located. The overall system “ IOT based Forest fire Detection system” consists of several sensor Modules

LM35 – Analog temperature sensor gives Temperature value

DHT 11 – Digital Humidity sensor gives moisture value

Ultrasonic – Sensor gives distance values

This whole sensor values uploaded to the open source cloud Ubidots. In that cloud we can visualize the values in form of plots – live updated values

Using that cloud API, we can predict the scenario if it is exceeding the preset values it automatically sent mail to users.

HARDWARE REQUIREMENTS

- Arduino
- Node MCU
- Humidity sensor
- Temperature sensor
- Ultrasonic Sensor
- Gas Sensor

SOFTWARE REQUIREMENTS

- Arduino IDE
- Embedded C Programming Language
- Ubidots

ADVANTAGES OF THE PROJECT

- Both local and global fire alert is provided.
- Internet is used for global alert.
- Concerned personal can monitor from anywhere in the world.
- Very low cost implementation also camera based detection is provided as failsafe in case sensors malfunction .

DIS ADVANTAGES OF THE PROJECT

Current systems are local hence the alert is not conveyed to authorities far away. Also local system could be damaged in the fire

APPLICATIONS

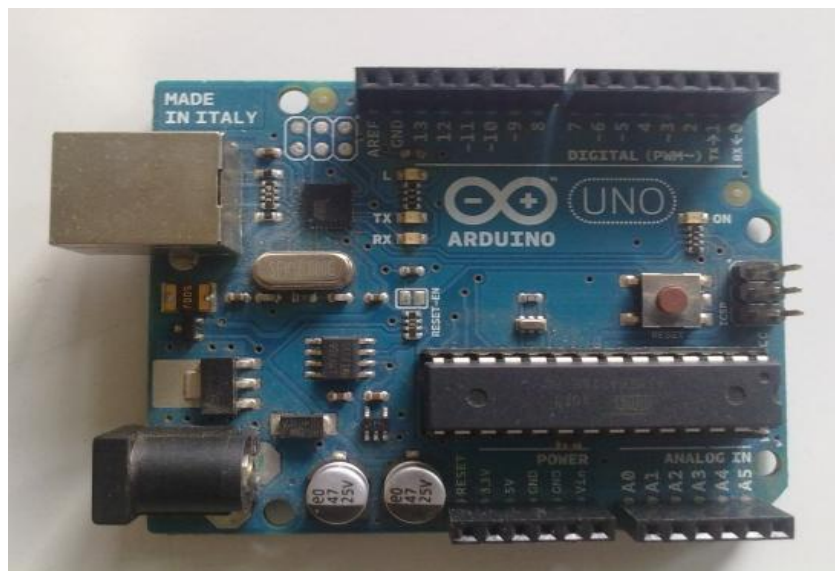
- Remote forest fire detection
- Remote forest fire prevention
- Automated fire department

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicate with software running on your computer. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

Arduino Uno:



Overview

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. For advanced Arduino users, prowl the web; there are lots of resources.

This guide covers the Arduino Uno board (Spark fun DEV-09950, \$29.95), a good choice for students and educators. With the Arduino board, you can write programs and create interface circuits to read switches and other sensors, and to control motors and lights with very little effort. Many of the pictures and drawings in this guide were taken from the documentation on the

This is what the Arduino board looks like.



The Duemilanove board features an Atmel ATmega328 microcontroller operating at 5 V with 2 Kb of RAM, 32 Kb of flash memory for storing programs and 1 Kb of EEPROM for storing parameters. The clock speed is 16 MHz, which translates to about executing about 300,000 lines of C source code per second. The board has 14 digital I/O pins and 6 analog input pins. There is a USB connector for talking to the host computer and a DC power jack for connecting an external 6-20 V power source, for example a 9 V battery, when running a program while not connected to the host computer. Headers are provided for interfacing to the I/O pins using 22 g solid wire or header connectors.

The Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions.

An important feature of the Arduino is that you can create a control program on the host PC, download it to the Arduino and it will run automatically. Remove the USB cable connection to the PC, and the program will still run from the top each time you push the reset button. Remove the battery and put the Arduino board in a closet for six months. When you reconnect the battery, the last program you stored will run. This means that you connect the board to the host PC to develop and debug your

program, but once that is done, you no longer need the PC to run the program.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, 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.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Summary:

Microcontroller ATmega328

Operating Voltage 5V

Input Voltage (recommended) 7-12V

Input Voltage (limits) 6-20V

Digital I/O Pins 14 (of which 6 provide PWM output)

Analog Input Pins 6

DC Current per I/O Pin 40 mA

DC Current for 3.3V Pin 50 mA

Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader

SRAM 2 KB (ATmega328)

EEPROM 1 KB (ATmega328)

Clock Speed 16 MHz

Pin Configuration

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall- wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

5V. this pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board.

3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50mA.

GND. Ground pins.

IOREF This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM.

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode(), digital Write(), and digital Read() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull- up resistor (disconnected by default) of 20-50 kohms. In addition, some pins have specialized functions:

Serial: 0 (RX) and 1 (TX). Used to receive (RX) and Transmit (TX) TTL serial data.

These pins are connected to the corresponding pins of the ATmega8U2 USB-to- TTL Serial chip.

External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt () function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write () function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

LED:13. There is a built- in LED connected to digital pin 13. When the pin is HIGH value,the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference () function. Additionally, some pins have specialized functionality:

AREF Reference voltage for the analog inputs. Used with analog Reference ().

Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication

Microcontrollers depend on a host computer for developing and compiling programs. The software used on the host computer is known as an integrated development environment, or IDE. For the Arduino, the development environment is based on the open source Processing platform (www.processing.org) which is described by its creators as a “programming language and environment for people who want to program images, animation, and interactions.” The Arduino programming language leverages an open source project known as Wiring (wiring.org.co). The Arduino language is based on good old- fashioned C. If you are unfamiliar with this language, don't worry; it's not hard to learn, and the Arduino IDE provides some feedback when you make mistakes in your programs.

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

As you go through the list of programming statements available in the Arduino IDE (choose Help->Reference), you might think²⁴ there isn't much power for doing things like running servos, operating stepper motors, reading potentiometers, or displaying text on an LCD. Like most any language based on C, the Arduino supports the notion of “libraries” code

Repositories that extend core programming functionality. Libraries let you re-use code without having to physically copy and paste it into all your programs. The standard Arduino software installation comes with several libraries you may use, and you can download others from the Arduino support pages and from third-party websites that publish Arduino library code. A good example of a library you'll use with the Robot and likely many other robot projects is

Servo. This library allows you to connect one or more hobby R/C servos to the Arduino's digital I/O pins. The Servo library comes with the standard Arduino installation package Library->Servo. This adds the line

```
#include <Servo.h>
```

Which tells the Arduino IDE that you wish to include the Servo library in your sketch. With the functionality of the library now available to you, you can use its various functions to control one or more servos. For example, you can use the write function to rotate a servo to a specific position, from 0 to 180 degrees. The following code

```
myServo.write(90);
```

Moves a servo to its midpoint, or 90 degree position. Structurally, Arduino sketches are very straightforward and are pretty easy to read and understand. The Arduino program contains two main parts: setup () and loop (). These are programming functions that do what their names suggest: setup () sets up the Arduino hardware, such as specifying which I/O lines you plan to use, and whether

They are inputs or outputs. The loop () function is repeated endlessly when the Arduino is operating.

Arduino IDE (Integrated development environment) is used to write the program and dump into the Arduino board

Node MCU:

The ESP8266 has an engineered Wi-Fi networking, gives a bridge between the node MCU and in addition perform self-contained applications. It includes each code that runs on the

ESP8266 SoC, and hardware that relies on the ESP-12. On setup ESP8266 with these equipment and do wonderful stuff like dominant monitoring, analysis and far additional tasks. Node MCU itself acts as an individual node during this project and senses the info and send the info to the cloud using Wi-Fi communication.

Node MCU is a low-cost open source IOT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module. Later, support for the ESP32 32-bit MCU was added.

Node MCU is an open source firmware for which open source prototyping board designs are available. The name "Node MCU" combines "node" and "MCU" (micro-controller unit).^[8]. The term "Node MCU" strictly speaking refers to the firmware rather than the associated development kits.

Both the firmware and prototyping board designs are open source.

The firmware uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson^[10] and SPIFFS. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially was based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications (see related projects).

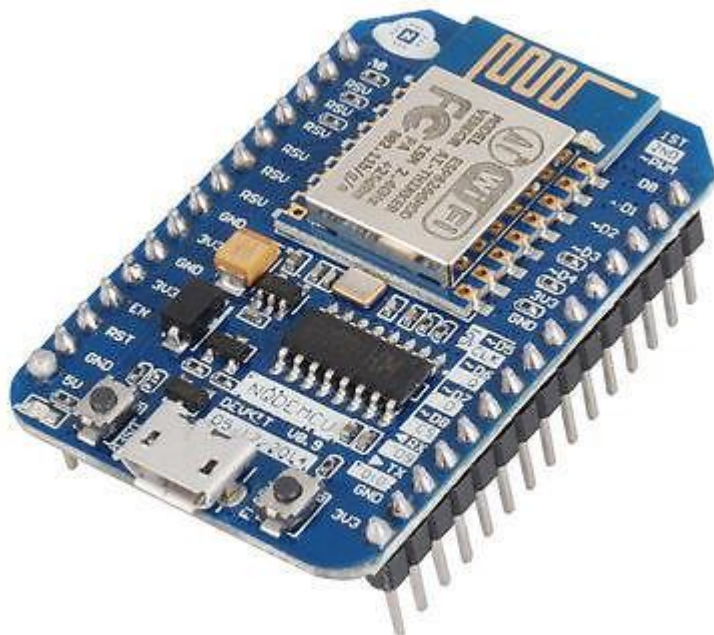
Node MCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems^[6] began production of the ESP8266, Node MCU started on 13 Oct 2014, when Hong committed the first file of node mcu-firmware to GitHub. Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9. Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform and committed to Node MCU project, then Node MCU was able to support the MQTT IOT protocol, using Lua to access the MQTT broker. Another

important update was made on 30 Jan 2015, when Devsaurus ported the u8glib^[16] to the Node MCU project,^[17] enabling Node MCU to easily drive LCD, Screen, OLED, even VGA displays.

In the summer of 2015 the original creators abandoned the firmware project and a group of independent contributors took over. By the summer of 2016 the Node MCU included more than 40 different modules.



Node MCU is an open source LUA based firmware developed for ESP8266 wifi chip. By exploring functionality with ESP8266 chip, Node MCU firmware comes with ESP8266 Development board/kit i.e. Node MCU Development board.



Node MCU Development Board/kit v0.9 (Version1)

Since Node MCU is open source platform, their hardware design is open for edit/modify/build.

Node MCU Dev Kit/board consist of ESP8266 wifi enabled chip. The **ESP8266** is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. For more information about ESP8266, you can refer ESP8266 WiFi Module. There is Version2 (V2) available for Node MCU Dev Kit i.e. **Node MCU Development Board v1.0 (Version2)**, which usually comes in black coloured PCB.



Node MCU Development Board/kit v1.0 (Version2)

For more information about Node MCU Boards available in market refer Node MCU Development Boards. Node MCU Dev Kit has **Arduino like** Analog (i.e. A0) and Digital (D0-D8) pins on its board. It supports serial communication protocols i.e. UART, SPI, I2C etc. Using such serial protocols we can connect it with serial devices like I2C enabled LCD display, Magnetometer HMC5883, MPU-6050 Gyro meter + Accelerometer, RTC chips, GPS modules, touch screen displays, SD cards etc.

How to start with Node MCU?

Node MCU Development board is featured with wifi capability, analog pin, digital pins and serial communication protocols. To get start with using Node MCU for IOT applications first we need to know about how to write/download Node MCU firmware in Node MCU Development Boards. And before that where this Node MCU firmware will get as per our requirement. There is online Node MCU custom builds available using which we can easily get our custom Node MCU firmware as per our requirement. To know more about how to build custom Node MCU firmware online and download it refer [Getting started with Node MCU](#)

How to write codes for Node MCU?

After setting up ESP8266 with Node-MCU firmware, let's see the IDE (Integrated Development Environment) required for development of Node MCU.

Node MCU with ESPlorer IDE

[Lua](#) scripts are generally used to code the Node MCU. Lua is an open source, lightweight, embeddable scripting language built on top of C programming language.

For more information about how to write Lua script for Node MCU refer [Getting started with Node MCU using ESPlorerIDE](#)

Node MCU with Arduino IDE

Here is another way of developing Node MCU with a well-known IDE i.e. Arduino IDE. We can also develop applications on Node MCU using Arduino development environment. This makes easy for Arduino developers than learning new language and IDE for Node MCU.

For more information about how to write Arduino sketch for Node MCU refer [Getting started with Node MCU using Arduino IDE](#)

Difference in using ESPlorer and Arduino IDE

Well, there is a programming language difference we can say while developing application for Node MCU using ESPlorer IDE and Arduino IDE.

We need to code in C/C++ programming language if we are using Arduino IDE for developing Node MCU applications and Lua language if we are using ESPlorer IDE.

Basically, Node MCU is Lua Interpreter, so it can understand Lua script easily. When we write Lua scripts for Node MCU and send/upload it to Node MCU, then they will get executes

sequentially. It will not build binary firmware file of code for Node MCU to write. It will send Lua script as it is to Node MCU to get execute.

In Arduino IDE when we write and compile code, ESP8266 tool chain in background creates binary firmware file of code we wrote. And when we upload it to Node MCU then it will flash all Node MCU firmware with newly generated binary firmware code. In fact, it writes the complete firmware.

That's the reason why Node MCU not accept further Lua scripts/code after it is getting flashed by Arduino IDE. After getting flashed by Arduino sketch/code it will be no more Lua interpreter and we got error if we try to upload Lua scripts. To again start with Lua script, we need to flash it with Node MCU firmware.

Since Arduino IDE compile and upload/writes complete firmware, it takes more time than ESPlorer IDE.

TEMPERATURE SENSOR (LM35)

FEATURES DESCRIPTION

- Calibrated Directly in ° Celsius (Centigrade)
- Linear + 10 mV/°C Scale Factor
- 0.5°C Ensured Accuracy (at +25°C) LM35 has an advantage over linear temperature
- Rated for Full -55°C to +150°C Range
- Suitable for Remote Applications
- Low Cost Due to Wafer-Level Trimming
- Less than 60-μA Current Drain
- Low Self-Heating, 0.08°C in Still Air
- Nonlinearity Only $\pm\frac{1}{4}^{\circ}\text{C}$ Typical
- Low Impedance Output, 0.1 Ω for 1 mA Load

DESCRIPTION

The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. Thus the LM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a

large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm\frac{1}{4}^{\circ}\text{C}$ at room temperature and $\pm\frac{3}{4}^{\circ}\text{C}$ over a full -55°C to $+150^{\circ}\text{C}$ temperature range. Low cost is assured by trimming and calibration at the wafer level. The low output impedance, linear output, and precise inherent calibration of the LM35 make interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 draws only $60\text{ }\mu\text{A}$ from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 is rated to operate over a -55°C to $+150^{\circ}\text{C}$ temperature range, while the LM35C is rated for a -40°C to $+110^{\circ}\text{C}$ range (-10° with improved accuracy). The LM35 series is available packaged in hermetic TO transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35Dis also available in an 8-lead surface-mount small outline package and a plastic TO-220 package.

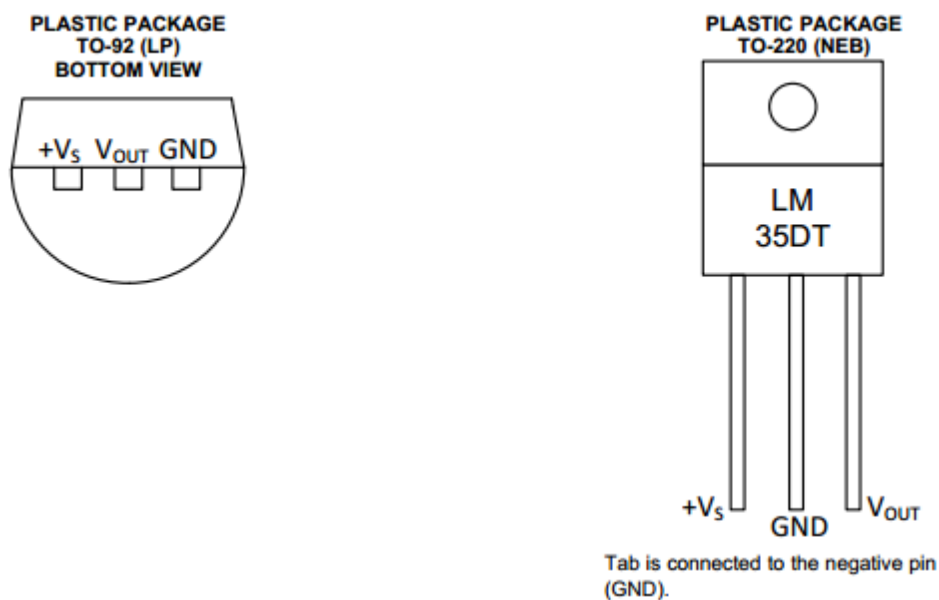


Figure. View of Temperature sensor

Micro-electromechanical systems (MEMS)

Micro-electromechanical systems (MEMS) is a technology that combines computers with tiny mechanical devices such as sensors, valves, gears, mirrors, and actuators embedded in semiconductor chips. MEMS or what he calls analogy computing will be "the foundational technology of the next decade." MEMS is also sometimes called smart matter.



MEMS are already used as accelerometers in automobile air-bags. They've replaced a less reliable device at lower cost and show promise of being able to inflate a bag not only on the basis of sensed deceleration but also on the basis of the size of the person they are protecting. Basically, a MEMS device contains micro-circuitry on a tiny silicon chip into which some mechanical device such as a mirror or a sensor has been manufactured. Potentially, such chips can be built in large quantities at low cost, making them cost-effective for many uses.

Among the presently available uses of MEMS or those under study are:

- Global position system sensors that can be included with courier parcels for constant tracking and that can also sense parcel treatment en route
- Sensors built into the fabric of an airplane wing so that it can sense and react to air flow by changing the wing surface resistance; effectively creating a myriad of tiny wing flaps
- Optical switching devices that can switch light signals over different paths at 20-nanosecond switching speeds
- Sensor-driven heating and cooling systems that dramatically improve energy savings

- Building supports with imbedded sensors that can alter the flexibility properties of a material based on atmospheric stress sensing

Applications:

- Vibrations measurement and Tilt inclination (to adjust rotation speed, circuit breaker security, fault prediction),
- Professional and domestic Alarms
- Maintenance management and Asset Tracking for shocks monitoring
- Alarm and Anti Tamper function

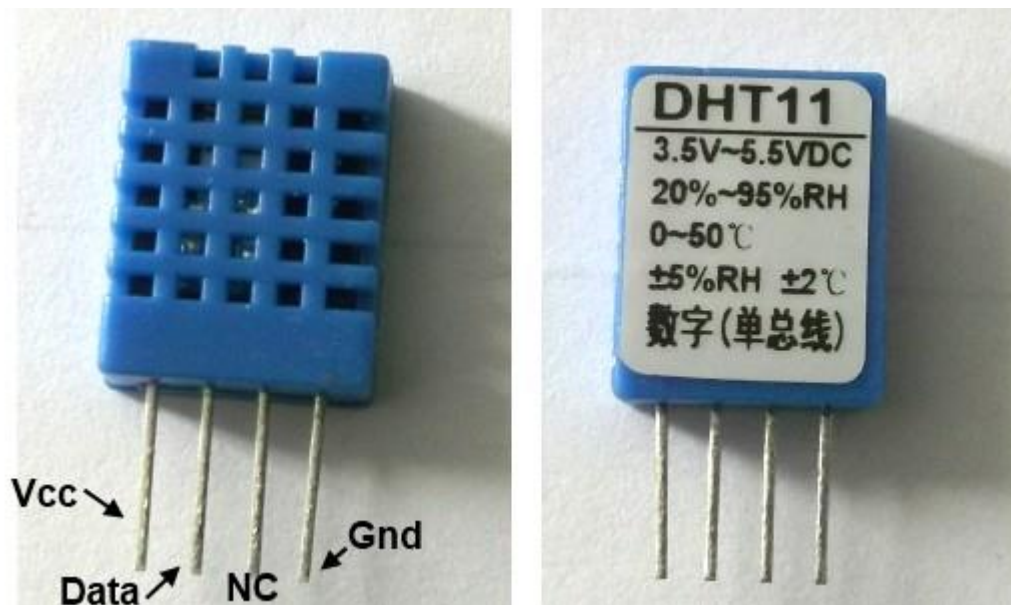
Humidity sensor

Measurement and control of temperature and relative humidity finds applications in numerous areas. These days devices are available which have both temperature and humidity sensors with signal conditioning, ADC, calibration and communication interface all built inside them. The use of such smart sensors greatly simplify the design and reduces the overall cost. These sensors are capable of measuring both temperature and relative humidity and provide fully calibrated digital outputs. While SHT1x/SHT7x are very accurate sensors, they are still expensive for hobbyists use. This article discusses the DHT11 sensor which also provides calibrated digital outputs for temperature and humidity but is relatively lot cheaper than the Sensirion sensors. The DHT11 sensor uses a proprietary 1-wire protocol which we will be exploring here and implementing with the PIC16F628A microcontroller that will receive the temperature and humidity values from the sensor and display them on a 16×2 character LCD.

About DHT11 sensor

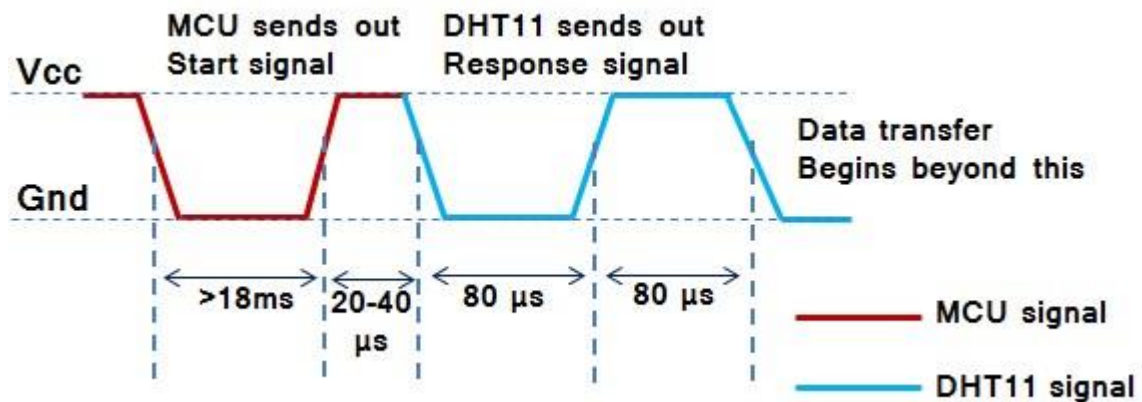
The DHT11 sensor comes in a single row 4-pin package and operates from 3.5 to 5.5V power supply. It can measure temperature from 0-50 °C with an accuracy of $\pm 2^{\circ}\text{C}$ and relative humidity ranging from 20-95% with an accuracy of $\pm 5\%$. The sensor provides fully calibrated

digital outputs for the two measurements. It has got its own proprietary 1-wire protocol, and therefore, the communication between the sensor and a microcontroller is not possible through a direct interface with any of its peripherals. The protocol must be implemented in the firmware of the MCU with precise timing required by the sensor. The following timing diagrams describe the data transfer protocol between a MCU and the DHT11 sensor. The MCU initiates data transmission by issuing a “Start” signal. The MCU pin must be configured as output for this purpose. The MCU first pulls the data line low for at least 18 ms and then pulls it high for next 20-40 μ s before it releases it.



DHT11 sensor comes in a single row 4-pin package

Next, the sensor responds to the MCU “Start” signal by pulling the line low for 80 μ s followed by a logic high signal that also lasts for 80 μ s. Remember that the MCU pin must be configured to input after finishing the “Start” signal. Once detecting the response signal from the sensor, the MCU should be ready to receive data from the sensor. The sensor then sends 40 bits (5 bytes) of data continuously in the data line. Note that while transmitting bytes, the sensor sends the most significant bit first.



"Start" and "Response" signals

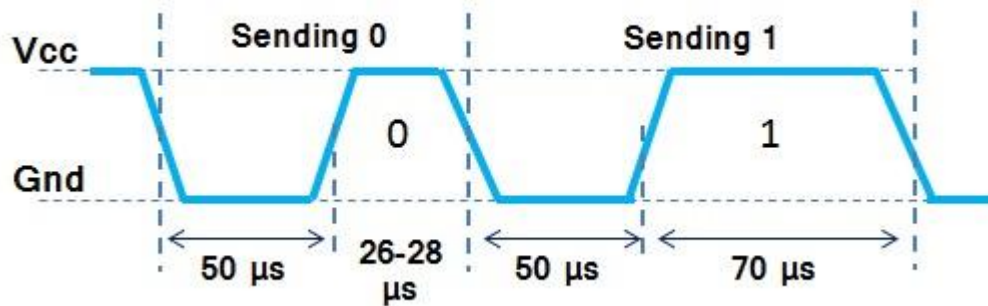
The 40-bit data from the sensor has the following structure.

Data (40-bit) = Integer Byte of RH + Decimal Byte of RH + Integer Byte of Temp. + Decimal Byte of Temp. + Checksum Byte

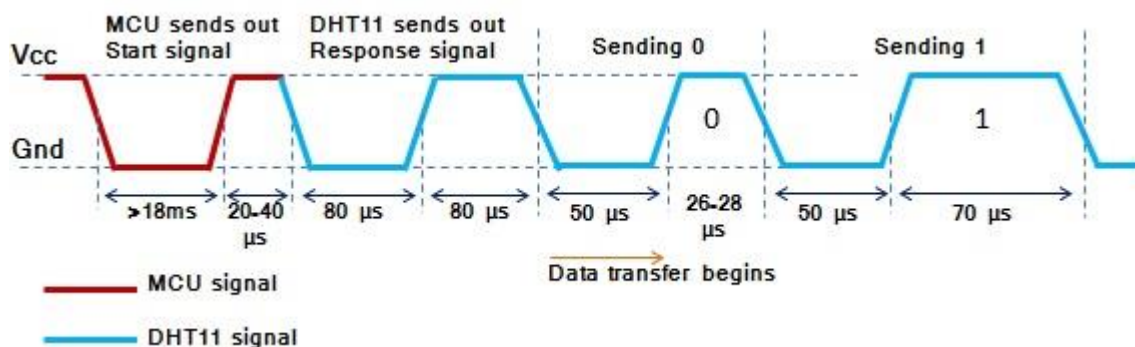
For DHT11 sensor, the decimal bytes of temperature and humidity measurements are always zero. Therefore, the first and third bytes of received data actually give the numeric values of the measured relative humidity (%) and temperature ($^{\circ}\text{C}$). The last byte is the checksum byte which is used to make sure that the data transfer has happened without any error. If all the five bytes are transferred successfully then the checksum byte must be equal to the last 8 bits of the sum of the first four bytes, i.e.,

Checksum = Last 8 bits of (Integer Byte of RH + Decimal Byte of RH + Integer Byte of Temp. + Decimal Byte of Temp.)

Now let's talk about the most important thing, which is signalling for transmitting "0" and "1". In order to send a bit of data, the sensor first pulls the line low for 50 μs . Then it raises the line to high for 26-28 μs if it has to send "0", or for 70 μs if the bit to be transmitted is "1". So it is the width of the positive pulse that carries information about 1 and 0.



Timing difference for transmitting "1s" and "0s"



Start, Response and Data signals in sequence

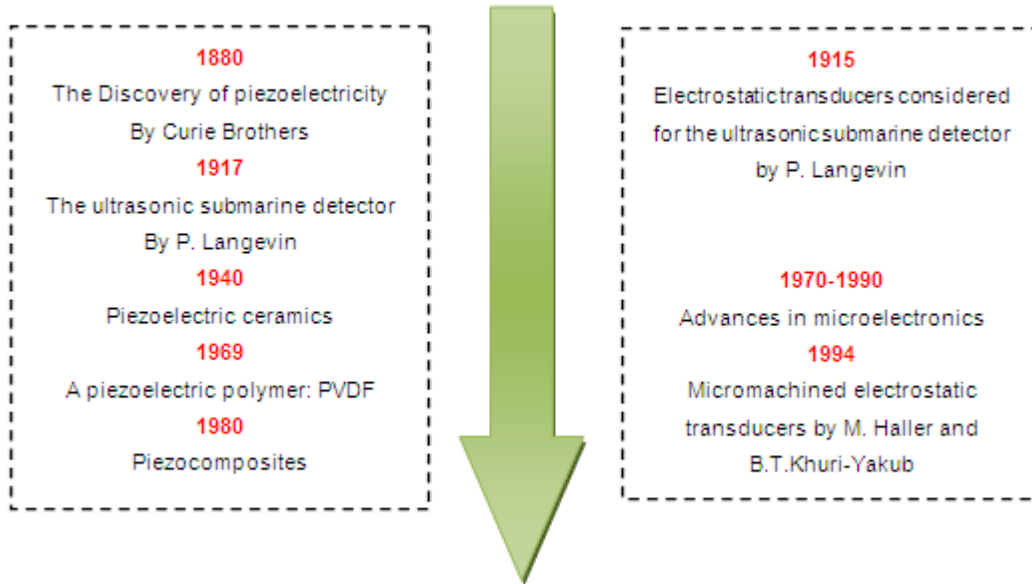
At the end of the last transmitted bit, the sensor pulls the data line low for 50 μs and then releases it. The DHT11 sensor requires an external pull-up resistor to be connected between its Vcc and the data line so that under idle condition, the data line is always pulled high. After finishing the data transmission and releasing the data line, the DHT11 sensor goes to the low-power consumption mode until a new "Start" signal arrives from the MCU.

Ultrasonic (UV) Sensors or Ultrasound Sensors

Bats are wonderful creatures. Blind from the eyes and yet a vision so precise that could distinguish between a moth and a broken leaf even when flying at full speed. No doubt the vision is sharper than ours and is much beyond human capabilities of seeing, but is certainly not beyond our understanding. **Ultrasonic ranging** is the technique used by bats and many other creatures of the animal kingdom for navigational purposes. In a bid to imitate the ways of nature to obtain an edge over everything, we humans have not only understood it but have successfully imitated some of these manifestations and harnessed their potential to the greatest extent.

History

Ultrasonic Transducers: Historical Perspective

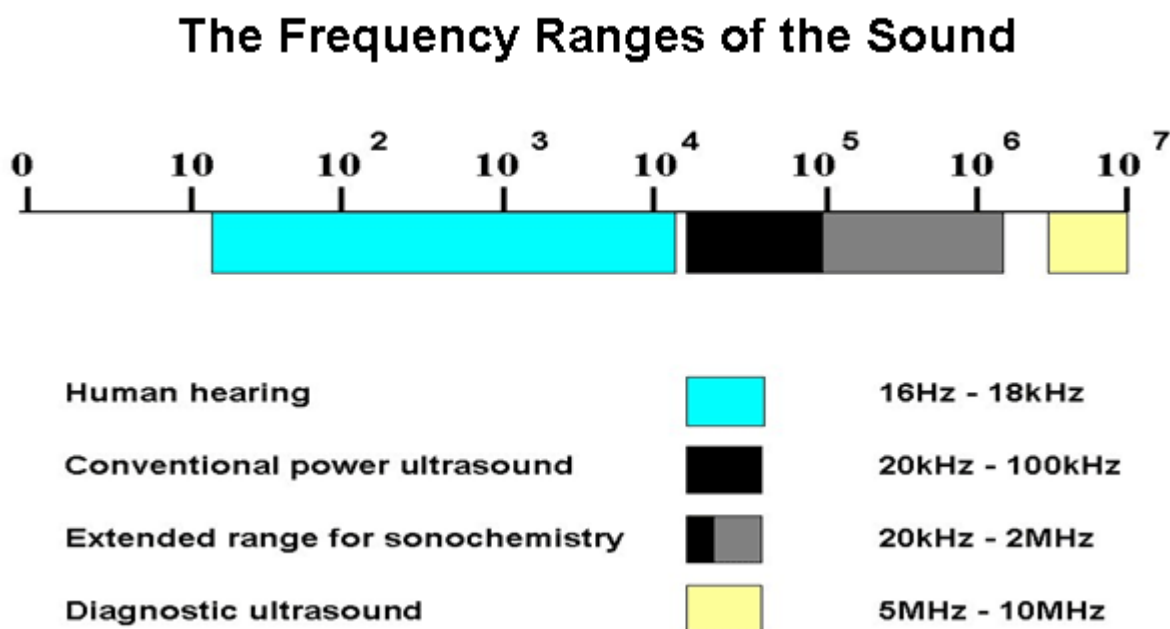


The history dates back to 1790, when Lazzaro Spallanzani first discovered that bats maneuvered in flight using their hearing rather than sight. Jean-Daniel Colladon in 1826 discovered sonography using an underwater bell, successfully and accurately determining the speed of sound in water. Thereafter, the study and research work in this field went on slowly until 1881 when Pierre Curie's discovery set the stage for modern ultrasound transducers. He found out the relationship between electrical voltage and pressure on crystalline material. The unfortunate Titanic accident spurred rigorous interest into this field as a result of which Paul Langevin invented the hydrophone to detect icebergs. It was the first ultrasonic transducer. The hydrophone could send and receive low frequency sound waves and was later used in the detection of submarines in the World War 1. On a note parallel to the SONAR, medical research also started taking interest in ultrasonics. In late 1930's Dr. Karl Dussik used a technique called hyperphonography which recorded echoes of ultrasonic waves on a sensitive paper. This technique was used to produce ultrasound pictures of the brain to help detect tumors and marked the birth of ultrasound imaging. After that, many scientists like Ian Donald, Douglas Howry, Joseph Holmes, John Wild and John Reid improved upon the various aspects of ultrasonic sensors in the medical field which enabled diagnosis of stomach cancers, ovarian cysts, detection of twin pregnancies, tumors etc. Industry too did not waste time in jumping on to

the bandwagon and soon developed techniques like ultrasonic welding and non destructive testing at the outset of the 1960s.

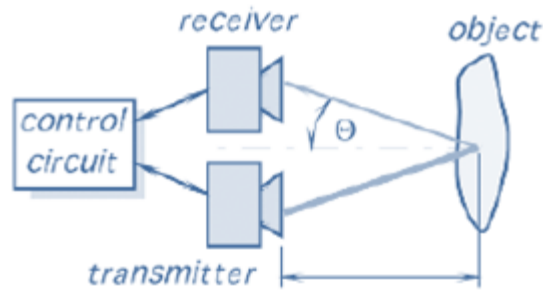
How Ultrasonic Sensors work?

Ultrasonic sensors are devices that use electrical–mechanical energy transformation, the mechanical energy being in the form of ultrasonic waves, to measure distance from the sensor to the target object. Ultrasonic waves are longitudinal mechanical waves which travel as a succession of compressions and rarefactions along the direction of wave propagation through the medium. Any sound wave above the human auditory range of 20,000 Hz is called ultrasound. Depending on the type of application, the range of frequencies has been broadly categorized as shown in the figure below:



When ultrasonic waves are incident on an object, diffused reflection of the energy takes place over a wide solid angle which might be as high as 180 degrees. Thus some fraction of the incident energy is reflected back to the transducer in the form of echoes and is detected. The distance to the object (L) can then be calculated through the speed of ultrasonic waves (v) in the medium by the relation

$$L = \frac{v t \cos \theta}{2}$$



Where 't' is the time taken by the wave to reach back to the sensor and 'θ' is the angle between the horizontal and the path taken as shown in the figure. If the object is in motion, instruments based on Doppler shift are used. Get all the details about internal structure and working of an ultrasound sensor at [Insight-How Ultrasonic Sensors Work](#).

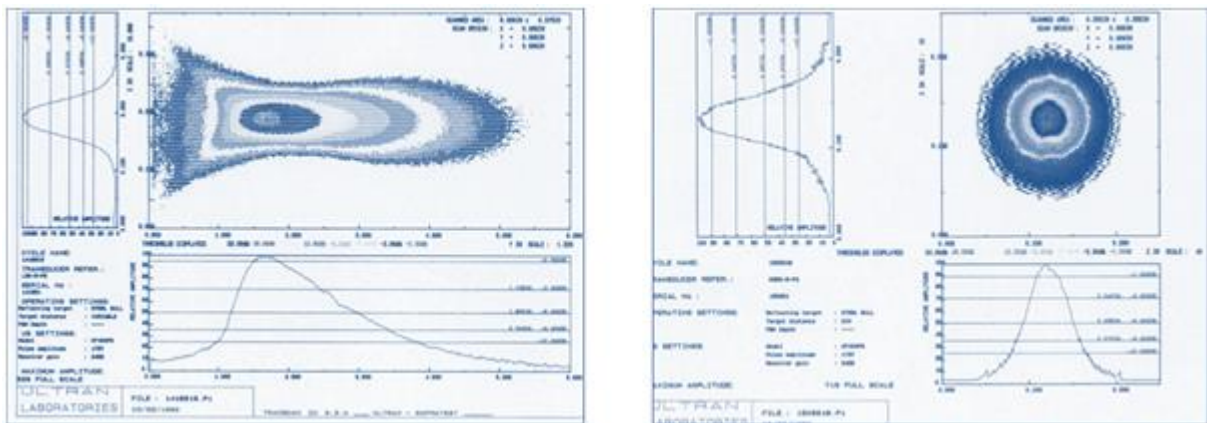
Generating Ultrasonic Waves

For the generation of such mechanical waves, movement of some surface like a diaphragm is required which can then induce the motion to the medium in front of it in the form of compression and rarefaction. Piezoelectric materials operating in the motor mode and magnetostrictive materials have been widely employed in the generation of ultrasonic waves at frequency ranges of 1-20 MHz and 20-40 kHz respectively. The sensors employ piezoelectric ceramic transducers which flex when an electric signal is applied to them. These are connected to an electronic oscillator whose output generates the oscillating voltages at the required frequency. Materials like Lead Zirconate Titanate are popular piezoelectric materials used in medical ultrasound imaging. For best results, the frequency of the applied oscillations must be equal to the natural frequency of the ceramic, which produces oscillations readily through resonance. It offers maximum sensitivity and efficiency when operated at resonance.

Piezoelectricity being a reversible phenomenon produces electrical voltages when ultrasonic waves reflect back from the target and impinge upon the ceramic structure. In this way, a transducer may work both as a transmitter and a receiver in pulsed mode. When continuous measurement of distances is required, separate transducers may be used for transmission and

reception. The sensors when used in industry are generally employed in arrays which may be mechanical arrays consisting of oscillating or rotating sensors, or electronic arrays which may be linear, curved or phased. To visualize the output of an ultrasonic sensor, displays of different kind are used whose shape depends on the type of transducer array used and the function. A sectorized Field of View is produced by mechanical arrays and curved and phased electronic arrays, while a linear field is generated by linear arrays. The display modes may be linear graphical plotting with amplitude on y-axis and time on x-axis called Amplitude mode or A-mode, or intensity modulated B-scans where the brightness of a spot indicates the amplitude of reflected waves. Other modes include M-mode, Doppler (D) Mode etc.

The parameterization of these sensors is generally done by monitoring the reflected and transmitted signals from the lateral and axial motion of transducer while keeping the target fixed in a specific medium (water in general). The sound beam diverges rapidly, hence care is taken that the transducer produces the smallest possible beams. The narrower the beam pattern, the more sensitive the sensor is. However, the angle possible between the transducer and the surface increases with the beam width. The beam patterns of the kind shown below are observed:



Axial and Cross Sectional beam profiles

The parameters on which the performance of an ultrasonic sensor is measured include bandwidth, attenuation, dynamic range and resolution like grayscale, axial and lateral resolution. Other parameters are Nominal Frequency, Peak Frequency, Bandwidth center Frequency, Pulse Width, sensitivity and Signal to Noise Ratio (SNR).

Importance of Ultrasonic Sensors

There are a variety of sensors based on other physical transduction principles like the optical range finding sensors and the microwave based devices too. Then why should one use ultrasonic transducers in the first place, given that the speed of sound is very slow than the speed of electromagnetic waves? The answer lies in the question itself. Because the EM waves based devices are too fast. Being slower than the EM waves, the time taken by ultrasonic waves is much longer than that taken by the latter and hence its measurement can be done more easily and less expensively. Because these are based on sound waves rather than EM waves, these would work in places where the latter would not.

For example, in the case of clear object detection and measurement of liquid levels or high glare environments, light based sensors would suffer greatly because of the transmittance of the target or the translucence of the propagating media. Ultrasonic devices being based upon sound propagation would remain practically unaffected. These also function well in wet environments where optical beams may suffer from refraction from the water droplets in the environment. On account of range and accuracy, the ultrasonic sensors may lie in between two EM wave based sensors, the Infrared rangefinders on the lower end and the LIDARs on the upper end. Not as accurate or long distance as the LIDARs, the Ultrasonic rangefinders fare better than the IR rangefinders which are highly susceptible to ambient conditions and require recalibration when environment changes. Further these devices offer advantage in medical imaging as compared to MRI or X-Ray scans due to inexpensiveness and portability. No harmful effects of ultrasonic waves at the intensity levels used have been detected in contrast to X-rays or radioactivity based methods and is particularly suited for imaging soft tissues.

Problems & Concerns

However, Ultrasonic sensors too aren't free of all the problems. The speed of sound in a medium increases as the temperature of the medium increases. Thus even when the target

has remained in the same place, it may now seem that it has shifted to a place closer to the sensor. Air currents due to varied reasons may disturb the path of the wave which could lead to 'Missed Detection' or a wrong measurement. Acoustic noise like high pitched sounds created due to whistling or hissing of valves and pneumatic devices at the frequency close to the operating frequency may interfere with the output of the sensor. Electrical noise also affects the performance of the sensor. These may generate artifacts which are not a true representation of the imaged object. Just like the vision starts to blur when the distance of the object from the eye gets too small for the eyes to see it, ultrasonic devices also have a 'dead zone' where the sensor cannot reliably make measurements. This happens due to a phenomenon called ringing which is the continuous vibration of the transducer after emitting the pulse. Thus when the distance is too small, the transducer has not yet come to rest to be able to differentiate between the vibration due to the incident radiation or the oscillation from the electrical excitation. The dangers of Ultrasonic waves are also well founded. If the intensity is too high, it can cause human tissues to heat and may cause ruptures in people exposed to it.

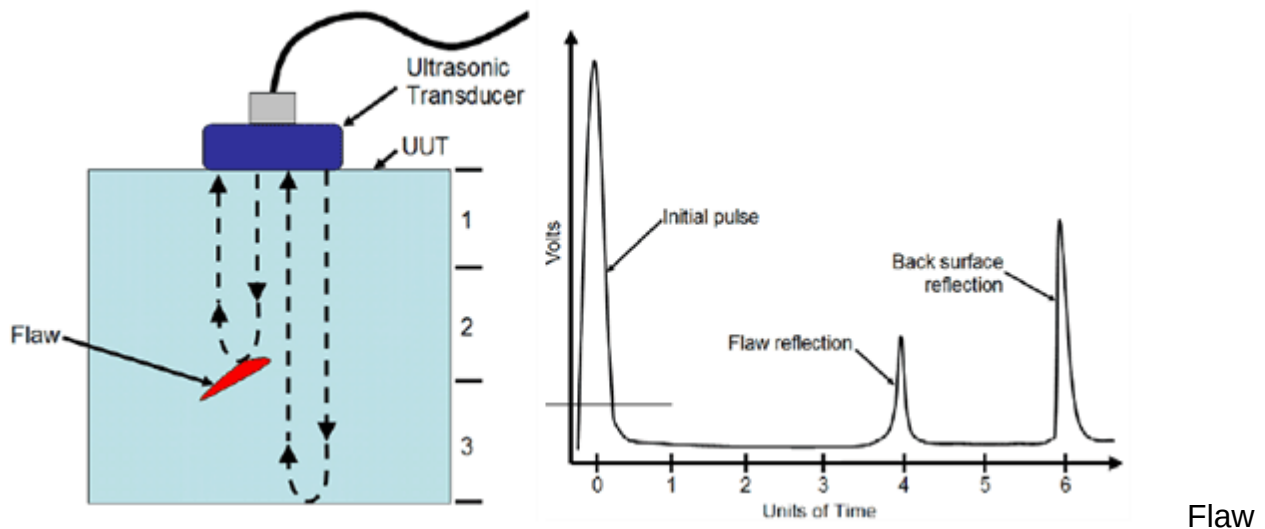
Applications

The applications of ultrasonic sensors can be classified on the basis of the property that they exploit. These can be summarized as:

Domain	Parameter	Applications
Time	Time-of-Flight, Velocity	Density, Thickness, Flaw Detection, Anisotropy, Robotics, Remote Sensing etc.
Attenuation	Fluctuations in reflected and Transmitted Signals	Defect characterization, microstructures, interface analysis
Frequency	Ultrasonic Spectroscopy	Microstructure, grain size, porosity, phase analysis.
Image	Time-of-Flight, velocity, attenuation mapping in Raster C-Scan or SARs	Surface and internal Defect imaging, density, velocity, 2D and 3D imaging.

Research has been going on to overcome the problems of ultrasonic sensors, particularly in medical imaging where it is known as ultrasound. The artifacts of ultrasonic sensors like Acoustic shadowing and Acoustic Enhancement are being exploited to characterize tissues which allow

the differentiation between solid and cystic tissues. The industry too has reaped the benefits from ultrasonic sensors in applications like plastic welding, jewelry cleaning, remote sensing and telemetry, assisted parking systems etc. Robotics has been known to use ultrasonic rangefinders as a favorite tool for distance ranging and mapping. Even the fashion industry is using ultrasonic sensors in hair styling like hair extension implants.



Detection Using Ultrasonic Sensors

Non destructive testing and flaw detection uses ultrasonic waves in various modes like the Longitudinal (L-wave) mode and the Shear (S-wave) mode to detect flaws in materials. With the advances in Science, new materials offering increased performance at lower voltages like the capacitive micro machined ultrasonic transducers (CMUTs) are being developed which are expected to have higher bandwidth and greater potential for integration with electronic circuits.

These devices provide non-invasive measures for the detection of problems in all kinds of materials, be it a living tissue or non-living manufactured goods. With a healthy history of being able to detect many problems which otherwise left the doctors dazed and the problem untreated, ultrasonic sensors do offer a lot of promise even in the coming times. The environmental and psychological effects of exposure to EM-radiation being rigorously being put under the scanner, ultrasonic applications are expected to thrive and offer a substantial alternative to the contemporary technologies.

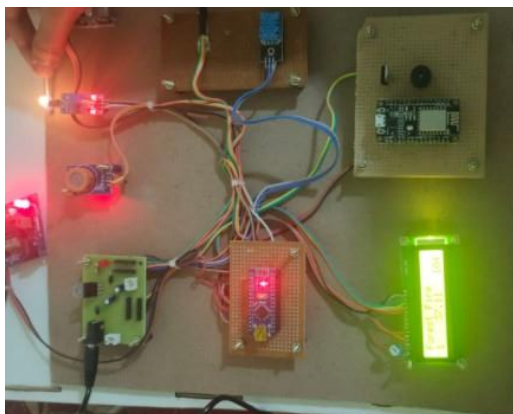
CHAPTER IV

RESULTS AND DISCUSION

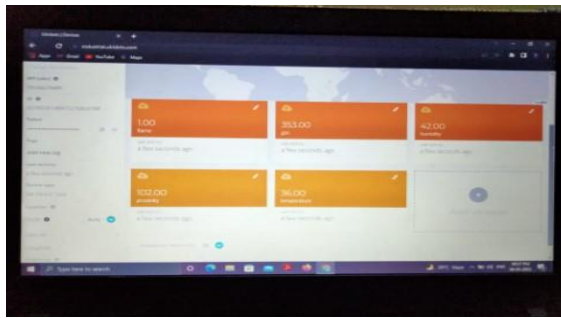
In this paper we discuss how the circuit is designed and implemented. We have conducted this experiment in various stages in order to check the working of various sensors and to make the system fault tolerant. We have also performed this experiment at places where the speed of the internet / Wi-Fi is significantly low to make sure that the data is being transmitted even at low data rates. the experimented results and values for all the sensors, the data transmitted to cloud and also the image or video which was displayed in the webpage we created for monitoring are listed below. explains the live streaming of video footage to webpage and how we can remotely control the devices connected to the system

OUTPUT PICTURES

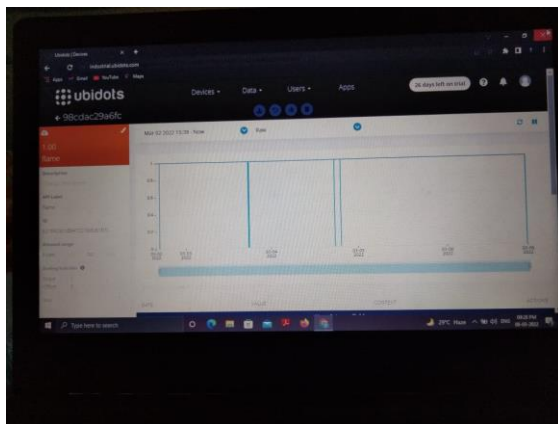
Sensor testing



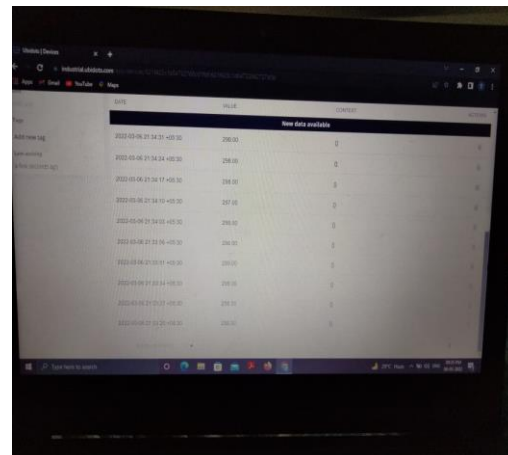
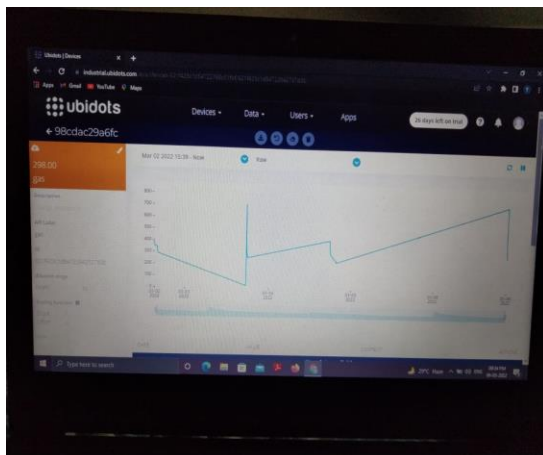
Software ubidots



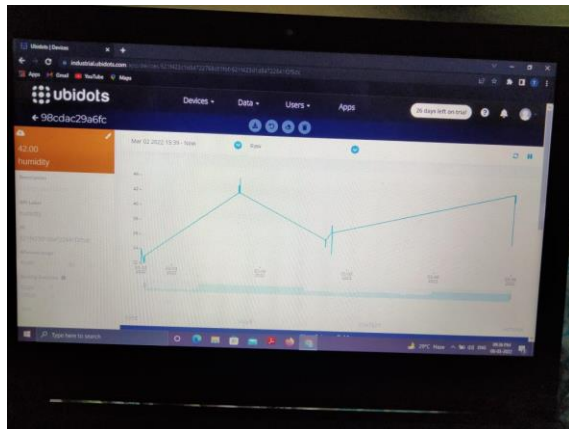
Flame sensor



Gas sensor

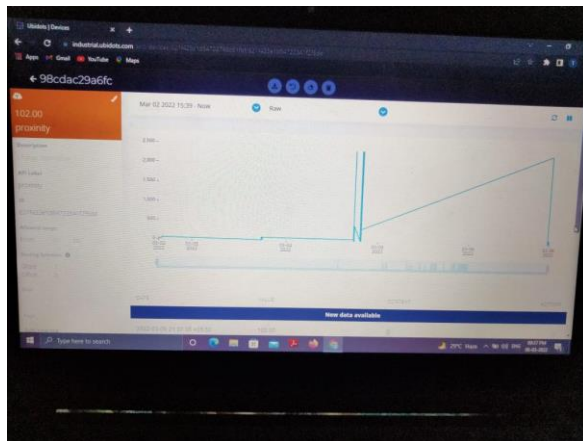


Humidity sensor



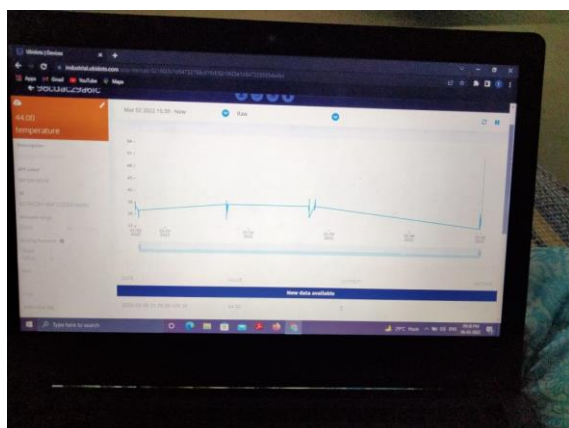
DATE	VALUE	CONTEXT
2022-03-06 21:30:42 +05:30	42.00	0
2022-03-06 21:30:50 +05:30	42.00	0
2022-03-06 21:30:58 +05:30	42.00	0
2022-03-06 21:31:06 +05:30	42.00	0
2022-03-06 21:31:14 +05:30	42.00	0
2022-03-06 21:31:22 +05:30	42.00	0
2022-03-06 21:31:30 +05:30	42.00	0
2022-03-06 21:31:38 +05:30	42.00	0
2022-03-06 21:31:46 +05:30	42.00	0
2022-03-06 21:31:54 +05:30	42.00	0
2022-03-06 21:32:02 +05:30	42.00	0

Ultrasonic sensor



DATE	VALUE	CONTEXT
2022-03-06 21:37:35 +05:30	102.00	0
2022-03-06 21:37:39 +05:30	9.00	0
2022-03-06 21:37:43 +05:30	103.00	0
2022-03-06 21:37:47 +05:30	104.00	0
2022-03-06 21:37:51 +05:30	103.00	0
2022-03-06 21:37:55 +05:30	102.00	0
2022-03-06 21:38:00 +05:30	104.00	0
2022-03-06 21:38:05 +05:30	104.00	0
2022-03-06 21:38:10 +05:30	104.00	0
2022-03-06 21:38:15 +05:30	92.00	0
2022-03-06 21:38:20 +05:30	104.00	0

Temperature sensor



DATE	VALUE	CONTEXT
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2022-03-06 21:37:13 +05:30	40.00	0
2022-03-06 21:37:18 +05:30	32.00	0
2022-03-06 21:37:23 +05:30	26.00	0
2022-03-06 21:37:28 +05:30	26.00	0
2022-03-06 21:37:33 +05:30	26.00	0
2022-03-06 21:37:38 +05:30	36.00	0
2022-03-06 21:37:43 +05:30	36.00	0
2022-03-06 21:37:48 +05:30	36.00	0

CHAPTER V

CONCLUSION

The proposal presented in this paper describes a new information system that has been developed taking into account innovative technologies, IOT devices and the use of sensors with the aim of helping to improve the management of emergencies. Specifically, devices based on Arduino have been used. During the development of this solution, multiple challenges, such as the use of data transmission protocols (4G), interaction with hardware devices, integration of sensors and the transformation of registered data into useful information for the visualization of users have been solved. Furthermore, the integration of different technologies (mobile devices, Web service and IOT devices), the synchronization of all system data among different platforms (new alerts, measurements, etc.) and more considerations have been done. Given the importance of confidentiality and authenticity, the system has been provided with security services. Specifically, OWASP guidelines and AES CBC encryption have been applied. This proposal is a work in progress, so several lines of work are still open. First, we will try to incorporate new sensors in the system that allow to control new environment variables, in order to improve prevention, detection and management of emergency situations. Secondly, we will try to increase interaction possibilities with emergency teams and workforce that are situated in the zone affected by forest fire, in order to gather more data as multimedia real time information. Finally, we will try to introduce and combine more layers and content types in the system for improving development of action protocols and forest fires extinction

FUTURESCOPE:

In this work, the system is designed and tested for its reliability and scalability due to improved sensor technology. The new technology can help to mitigate serious accidents caused by fire. We can also add more sensors and train this system to detect animal movements, loggers and hunters in restricted areas of forest.

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