IOT Project Report

Cloud Based Forest Fire Detection and Prevention Using IOT

A Project Report Submitted

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By

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Provide a brief descriptive title of your project:

Internet of Things is an essential course in computer science curriculum, which helps students to develop a mental model of how networks and connecting devices work with daily life applications and large-scale plants are often complex, non-deterministic which makes them difficult for students to understand.

In our project we are trying to achieve an optimal environment and perfect solution to prevent forest fires. Based on the recent activities in Australia wildfires, we have decided to build a robust system which will prevent the forest before catches by fire. The system is implemented using the Raspberry Pi3 model B microcontroller, NodeMCU.

In 50 words or less, please provide an abstract or summary of your project:

We are planning to design a robust wildfire detection and prevention system based on IOT. Where the entire project is divided into two sections: The detection unit, The control unit.

First, the detection unit will notify the control unit with GPS location if there is any fire in the particular location with the help of NodeMCU connected to temperature Sensor, smoke sensor, and real-time cloud-based web server with GPS sensor.

Second, the control unit will activate whenever the detection unit notifies it. After it gets activated, it immediately read the GPS location provided by the detection unit. Then the detection unit will send firefighting drones to the particular location in order to prevent it from getting fire.

State the problem or problems that motivated or required a solution provided by this project

In practice, IOT courses involve online classroom lectures describing high-level abstractions of the concepts, and students complete programming assignments to apply the material in a more concrete way. Depending on the programming assignments, this approach may leave students with only a theoretical understanding of IOT ideas, which may be different from the actual way these concepts are implemented in a microcontroller. What many students require is a practical knowledge of microcontroller implementation to supplement the high-level presentations of concepts taught in class or presented in a textbook.

The motivation for this project came to us while we are reading an article on internet about the wildfires in Australia which has occurred very recently in the pandemic year. Then, we hoped for a device which could “detect” and “prevent” the fires at forest.

List the specific problem which your project is solving:

Based on the recent activities on wildfires, many people have tried to prevent it while the forest got on fire. But if we can prevent the fire at the initial stage where the fire has got started, then we could able to prevent the entire forest. Our project model will solve this problem with the help of IOT concepts and knowledge which we have gained in this course. In the initial stages of the fire, we can use fire fighting drones to prevent it and notify to the nearby forest authorities. But even the fire gets more heavier, then it will update it as emergency in the real time cloud-based web application and call all the units of drones to reduce it.

Provide a detailed explanation of how this project solves the problem(s). In your description, include links to relevant online documents or figures including at least one drawing, All the description of the drawing with numbering must mentioned in the detail

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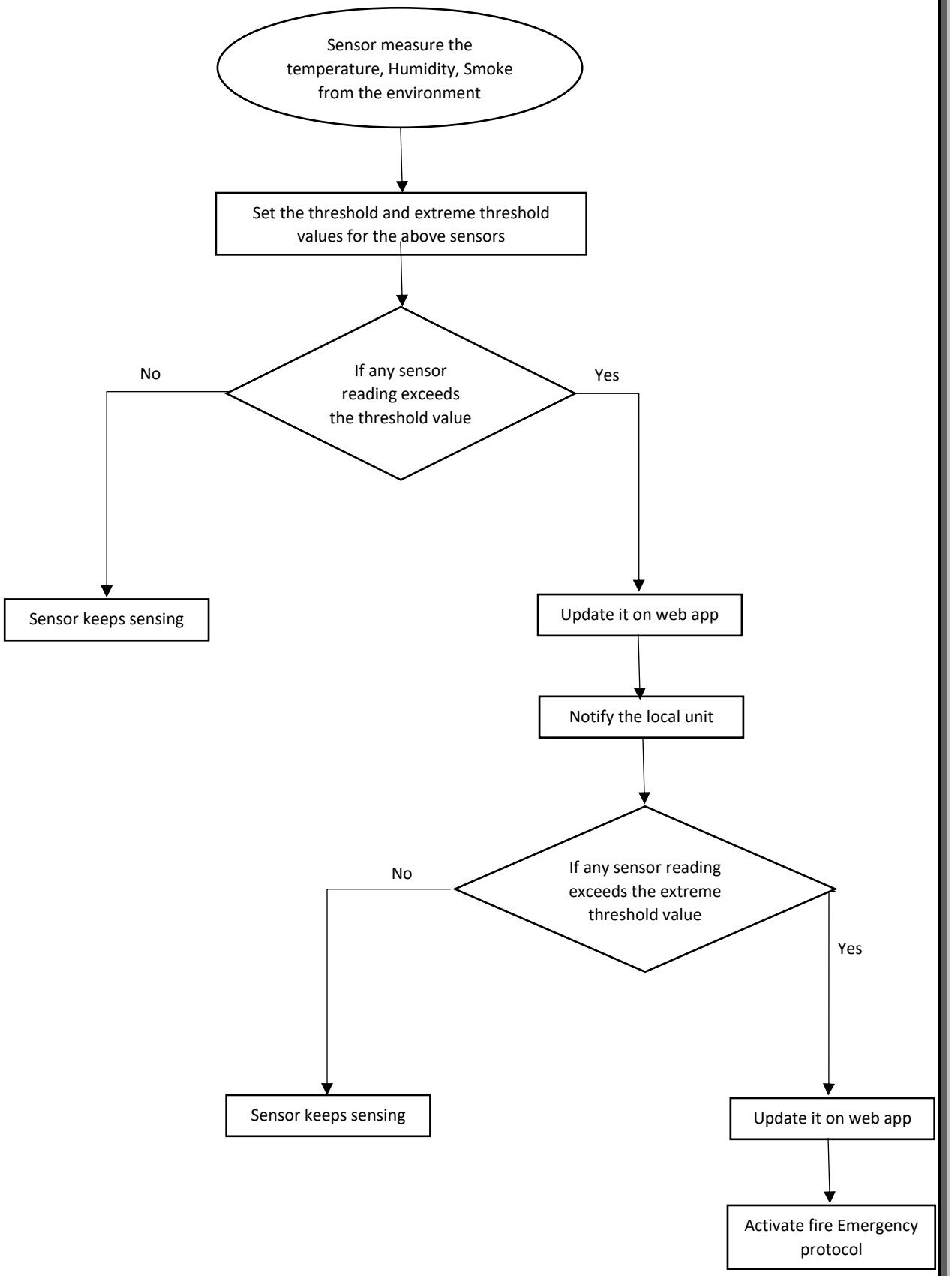
Detection Unit:

It will be in execution mode for all the time. To detect the forest fire as early as possible by measuring the level of temperature and CO2 level. Temperature sensor and smoke sensor are utilized that should be set at specific separations with the goal that a look can be kept on the whole forest territory keeping in mind the end goal to distinguish the start disturbing temperature and the level of carbon dioxide gas(CO2). These sensors will send the flag or the data to the microcontroller. These will all detect changes in the earth and respond naturally in case of a crisis. New advancements in programmed starting gadgets utilize cameras and PC calculations to examine obvious impacts of flame and development in ways that other discovery gadgets can't. Number of terminate sensors are to be utilized in handy circumstance that are should have been set at specific separations with the goal that a look can be kept on the whole forest region.

The entire forest is divided into some specific units based on the forest area. And each unit has one control unit and some amount of detection units as per the requirement in the unit. The major role of the detection unit is to detect the temperature and CO2 gas around the fire if it gets caught and sends the GPS location to the control unit.

If the measured temperature reaches the threshold temperature, Then the entire system will notify it to the local control unit by providing the GPS location and updating it to the webserver. Here in this case, NodeMCU is connected to temperature sensor, smoke sensor, webserver, router, ethernet shield, GPS sensor. Now, when the part of the forest gets caught on fire. If the temperature is beyond the extreme threshold temperature, then the detection unit first initiates the fire emergency protocol in the web-based application and notifies all the entire unit force in the forest by providing the GPS location.

Block diagram for detection unit:



Control Unit:

It will be in execution mode only when detection unit notifies it. Raspberry Pi get the information detected and gathered by the temperature sensor and gas sensor. At that point, the controller plays out the customized activity to it and pass them to the transmitter for transmitting the information to the accepting station.

On getting the information from the controller, the local control unit where the raspberry pi integrated drones are placed are controlled by the flight controller. Where, a fire fighting drone is integrated with Raspberry Pi, camera, GSM module, GPS sensor.

The drone is sent to the particular location and reduces the fire by adding brown sand/ Nitrogen to it. In this scenario, firefighting drone is mainly equipped with a robot (release mechanism) and gun spray, camera, one ultrasonic sensor and four flame sensors. At the beginning and after reaching fire's location, the system will be semiautomated in such a way that only take-off and landing will need to be controlled but once in the air at the desired altitude from the take-off point, the system is able to continuously monitor the temperature. If the temperature increases beyond a predetermined threshold value (min_temp), drone will fly to the direction to which the temperature is recorded to be relatively maximum among the four sensors. Firefighter at the ground will be able to monitor the location of the fire using the installed camera. Once the drone is hovering over a fire, the system will drop the fire extinguishing ball, and fly it back to the firefighter, and let it to hover in the air so that the firefighter can either reload it with a new ball or land it without losing its stability.

Also, firefighting drone is mainly equipped with a gun, collision avoidance system, and a camera. Meanwhile drone will stay outside the area on fire. Automatic electric_ spring operated gun will launch the nitrogen gas or carbon dioxide.

Existing state-of-the-art: (Brief background of the existing knowledge.)

Numerous answers for identification of out of control fire are displayed and executed in recent years. Video Surveillance System is most generally utilized for identification of wildfire [1]. It is isolated into four classifications : Video Cameras delicate in unmistakable range in light of acknowledgment of smoke amid sunlight and fire blazes at night, Infrared(IR) Thermal Imaging cameras in view of discovery of warmth transition from the fire, IR Spectrometer which distinguish unearthly attributes of smoke gases and Light Detection and Ranging (LIDAR) system which measures the laser light back scattered by smoke particles. The limitation of these systems was high false alert rate as a result of climatic conditions, for instance, proximity of fog, shadows, clean particles etc.

Another strategy is the utilization of Visual Cameras that take depictions of the forest to identify the fire. These cameras were mounted on the highest point of correspondence towers [2,3]. A turning engine is introduced to give a full round perspective of the forest. The pictures got from the camera are prepared utilizing project or MATLAB code and are contrasted and the reference pictures taken at introductory stage. This framework additionally had impediment of high false caution rate. Additionally, the cost of establishment of visual cameras on correspondence towers was high Another technique is the utilization of

satellite framework to distinguish the wildfire. The primary segments of the framework are satellite(s) and the base station that gathers the information send by the satellite(s) and runs the dissecting calculation.

The crude information from the satellite(s) is handled and after that Best in class High Determination Radiometer (AVHRR) instrument is utilized to recognize nearness of Problem areas. However, the mists enormously influence the framework [4,5]. wildfire Reconnaissance Framework which comprises of WSN was likewise proposed for identification of wildfires in South Korea. The WSN decides the temperature and dampness after which middleware program and web application examines the gathered information.

However, in this approach of discovery of wildfire there was some loss of information amid correspondence [6]. WSN comprising three various types of sensors which can distinguish temperature, fire and smoke levels of methane, carbon monoxide and carbon dioxide was additionally proposed for wildfire recognition.

The information gained by sensors is transmitted utilizing radio recurrence module. The radio recurrence module used has limited bandwidth and picks up noise easily [7]. WSN comprising of temperature sensor setup and GPS module was likewise proposed for recognition of backwoods fire. In this temperature information was transmitted to base station through essential and principle receiving wire utilizing satellite.

A portion of the impediment of framework was establishment of an excessive number of reception apparatuses; consistent power was required to both temperature sensor setup and receiving wires. Notwithstanding this climatic/regular change can influence the framework [8].

List out the known ways about how others have tried to solve the same or similar problems? Indicate the disadvantages of these approaches. In addition, please identify any prior art documentation or other material that explains or provides examples of such prior art efforts.

S No.	Existing State of the art	Drawbacks in existing state of the art	Overcome
1	Wildfire risk assessment US8760285B2 United States	An inspection list of questions is presented to a user through a mobile computing device, and images are captured by a camera included in the mobile computing device. In an embodiment, an image can be captured using augmented visual assistance through a mobile application. A wildfire risk associated with the home can be determined at least based on answers to the questions in the inspection list and captured images. In another embodiment, a virtual reality game for simulating a wildfire behavior is provided.	The augmented visual assistance through a mobile application and risk associated with the home determined on answers to the question in the Inspection. Doesn't solve the problem completely. Rather it may detect the fire on based on the answers given to thee mobile computing device. Where in our case we are preventing it before it gets fired.
2	Wildfire arrest and prevention system US9833647B2 United states	Monitored information is received and analyzed to detect a presence of a fire event or a fire risk in the designated zone. A cargo unmanned aerial vehicle is directed to a vicinity of the fire event or the fire risk and instructed to deploy a fire retardant or a fire suppressant at a location of the fire event or the fire risk, if the presence of the fire event or the fire risk is detected.	This project needs Unmanned aerial vehicles for prevention and suppression, the detection information is received by the designated zone. It deploys the container which has the prevention for the fire. We are doing it with drones, which are always present at the local units.
3	Fire Extinguishing System for High-Rise Buildings and Rugged Mountainous Terrains	Non-Patent Literature, used quadrotor Unmanned Aerial Vehicle (QUAV) for high rise buildings and mountainous	We modified it little and used for inspection drones with camera and GPS installed it for

	Utilizing Quadrotor Unmanned Aerial Vehicle. I.J. Image, Graphics and Signal Processing, 2018, 1, 23-29	terrains which will deploy the water balls or eject the nitrogen from the spring gun which needs to be operated only when the takeoff time and landing time.	only inspection level purpose, In order to prevent it from fire.
4	Forest fire monitoring and early warning system based on IOT CN202472841U China	This system is based on sensing terminal nodes, a plurality of route nodes, a plurality of video monitoring nodes, a network transfer station, and a data server; wherein, at least one sensing terminal node, at least one route node, and at least one video monitoring node are arranged within any one area to be detected; an output end of the each sensing terminal node is connected with the corresponding route node through a wireless network; of the forest fire monitoring department and early warning center, in order to output early warning information.	Instead of performing only some specific area and informing the detected fire, we are preventing it without the human intervention. We can also perform ML/AI algorithm on the data provided by the Wi-Fi sensor and predict the severe situation if occurs any. And can be cautious about the impact which will get occur in the future.

List the Technical features and Elements of the project.

The Entire system is divided into two units, Detection unit and control unit.

Detection Unit	Comprises of NodeMCU connected to temperature Sensor, smoke sensor, and real-time cloud-based web server with GPS sensor
Control Unit	Comprises of Raspberry Pi, drones
Fire Emergency Protocol	Emergency alert to nearby forest department and fire station and activates protocol by notifying all units and updating on web application
Cloud based real time web application	Connects the two units and the operation team, who is monitoring the entire system
Firefighting drones	Firefighting drone is integrated with Raspberry Pi, camera, GSM module, GPS sensor

Draw the block diagram of your project

For Detection Unit:

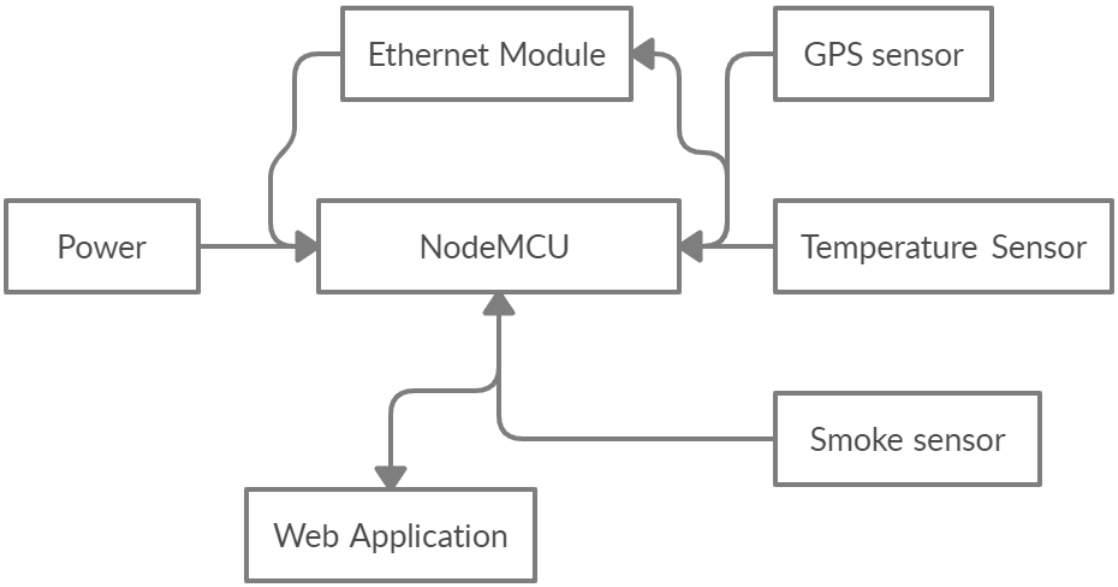


Figure 1 Block diagram for detection unit system

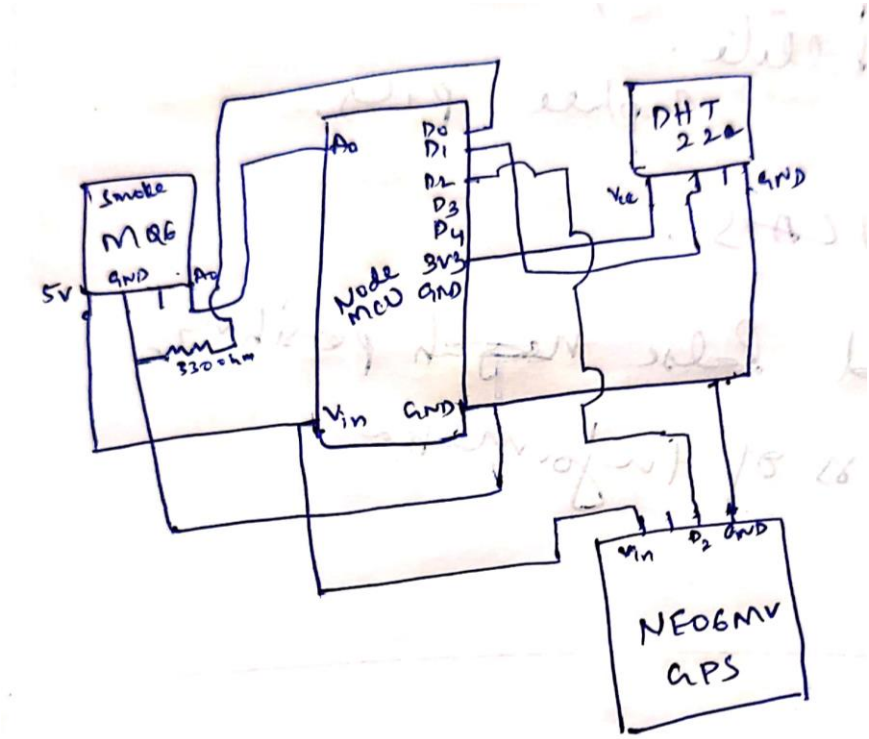


Figure 2Circuit diagram for detection unit using NodeMCU

For Control Unit:

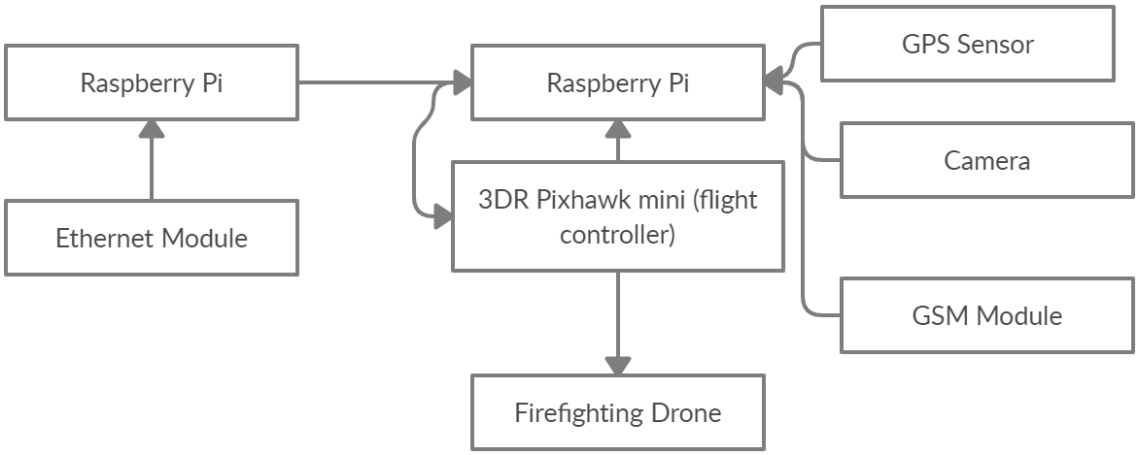


Figure 3 Block diagram for Control unit system

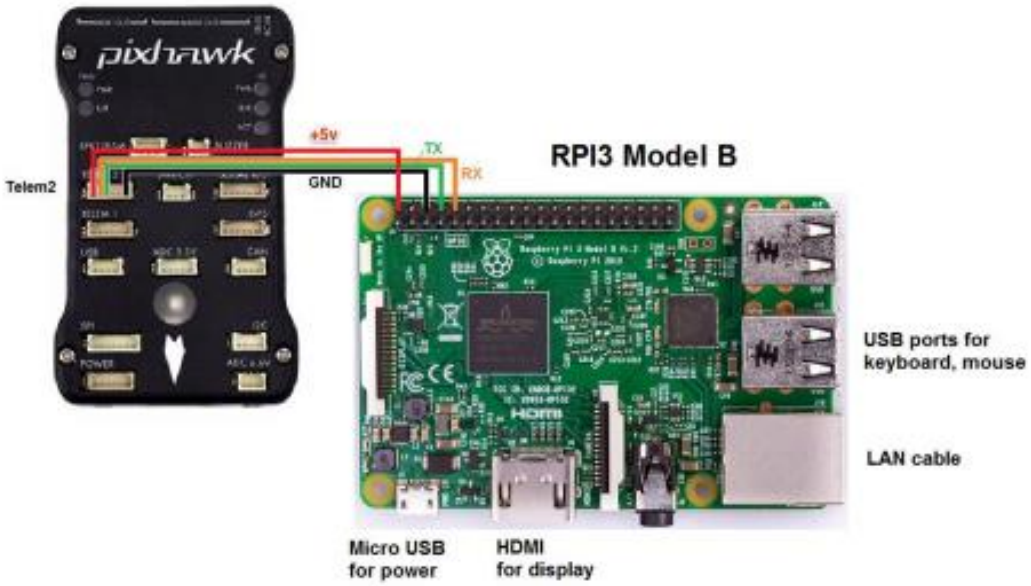


Figure 4 Interfacing Pixhawk with raspberry pi

List all the components (hardware and software used in your project)

- NodeMCU
- Smoke sensor MQ6
- Temperature sensor DHT22
- Ethernet Shield
- Router
- Sprayer
- GPS sensor NEO-6MV2
- Camera
- GPS module
- 3DR Pixhawk
- Drones

List out the features of your project which are believed to be new and distinguish them over the closest technology

In our project we are using drones which are integrated to raspberry pi which can be used to rescue the forest. Human intervention is needed only when fire emergency protocol is activated. There are some ways this project is implemented by others with human intervention and Unmanned Aerial Vehicle (UAV). We can distinguish our project by ignoring these two factors. Using Firefighting drones, we can prevent wildfires.

Are there alternative ways of implementing your project that is different from what you have disclosed? Specifically, if someone knew of your solution to the problem you solved (Question 3), would it be easy for them to come up with an alternative solution to the same problem that did not include details of your project?

Two alternate ways of implementing our project:

First, with the help of Unmanned Aerial Vehicles, A method for extinguishing fires includes the steps of loading an unmanned aerial vehicle (UAV) onto a transport aircraft and carrying the UAV to an altitude and location in proximity to a fire area. The UAV is launched from the transport aircraft and guided over the fire area using controllable fixed or deployable aerodynamic structures operably connected to the UAV. Once over the appropriate location, the UAV releases fire extinguishing or retardant material onto the fire or anticipated fire path.

Second, with the help of Dropping Balls at the fire location with the help of Quadrotor Unmanned Aerial Vehicle (QUAV), Robot (Release Mechanism), Automatic Electric Spring-Operated Gun, Fire Extinguishing Ball, Collision Avoidance System, and a Camera. Quadrotor will carry a specific payload and be capable of throwing an extinguishing ball in an area that is chosen by the operator. The proposed system has been implemented, constructed, and tested in an actual scenario. Experimental results demonstrate the feasibility of our drone in extinguishing fire in its initial stages and of being safe to hover over a fire, drop a fire extinguishing ball, fly back to the firefighter, and hover at 2.5 meters in the air so that it can be reloaded with a new ball without losing its stability.

Status of your project: been built or tested or implemented? If so, please provide the particulars of the first time it was successfully built or implemented (when, where, by whom, and evidence of this event including written or on-line pointers to documentary evidence)

Project is under working in progress, since we need to build the entire project and need to code it up and construct the required drones based upon the requirement. After building we need to test it for the local forest area.

Briefly state when and how you first conceived this idea?

When we were performing our programming assignments, this approach may leave students with only a theoretical understanding of IOT ideas, which may be different from the actual way these concepts are implemented in a microcontroller. What many students require is a practical knowledge of microcontroller implementation to supplement the high-level presentations of concepts taught in class or presented in a textbook.

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References:

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