International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

IoT Based Fire Extinguishing System with Visual Surveillance

J. RAJESWARI[1], V. BALAJI[2], M. BALAVIGNESHWARAN[3], T.J. SANTHOSH KUMAR[4]

[1]Assistant Professor, Dept. of Electrical and Electronics Engineering, Velammal College of Engineering and Technology, Madurai, Tamil Nadu, India.
[2,3,4]UG Students, Dept. of Electrical and Electronics Engineering, Velammal College of Engineering and Technology, Madurai, Tamil Nadu, India.

Abstract - *In the Digital era, the concept of using technology and robots in our life become familiar for a common man. In our everyday life, fire accidents have become common and sometimes it becomes difficult to avoid and may lead to hazards that make it hard for the firemen. In such cases, we can use firefighting robot to quench the fire in industries. It aims at monitoring the industrial floor with various sensors that are spread over the entire region. Here each and every sensor will be allotted with a specific identification number. If any hazard occurs, the corresponding information will be sent to the robot through RF transmission. Based on the sensor code, the robot can identify the spot of accident. As the robot is pre-programmed in Arduino with all the pathways, the robot immediately starts to the location and camera is turned on using relay and we can see the live feed in the app until the fire is quenched. Once it reaches the location, temperature sensor will indicate at what distance the robot should operate, so that the components of the robot will remain safe. It will start splashing the water, quench the fire completely and again return to the starting location. Communication between the mobile phone and robot will take place through Wi-Fi dongle, which will able to control the movement of robot by using IoT, so that the robot can be switched to any location to quench the fire.*

***Key Words*: Arduino; RF Transmission; Wi-Fi; Camera;**

1. INTRODUCTION

Fire breakout is a global problem that has the most diverse causes and devastating effects mainly because they can cause loss of lives, environmental pollution and destruction of properties. Fire damages are some of the accidents that occur most of the times and their causes can be attributed to (although not limited to) faulty electrical wiring or outlets, negligence like gas leakage, improper handling of inflammable materials (cigarettes, fuel, matches, etc.), inappropriate or unsafe use of appliances and arson usually to cover up criminal activities [9]. The advantageous purposes of fire can cause people to keep its sources around them, so unfortunately, the occurrence of fire-related accidents are often unavoidable, despite there are some presence of fire safety measures and because of this intervention methods and firefighting robots are necessary. So, it is inevitable to design a cheaper, more precise and smarter fire quenching mechanism that can detect fire in its early stages, go to the source of the fire and put off it.

During an event of a fire outbreak, the fire is identified first by the flame or smoke sensor, the microcontroller acts on the values of flame or smoke sensor to activate the vehicle motors which tracks the fire and put off it. The fire burst sensed by the flame or smoke sensor is transmitted through RF [Radio Frequency] transmitter. The RF receiver [2] receives the signal and sends to the Arduino. These sensors values are interpreted by the microcontroller and it activates the motor to move the vehicle in the direction of the sensor with the highest value and thereby quenches the fire

2. SYSTEM SUMUP

Fire quenching mechanism consists of two sections namely transmitting section, receiving section. The transmitting section comprises of flame sensors with RF transmitter. The receiver section holds the robot that quenches the fire [6]. The robot can be operated in two modes of operation that is automatic and manual mode. The flame sensors are placed in fire prompt zones. The path to these zones is pre-programmed in the Arduino in automatic mode. When the fire is detected by the sensor, the comparator enhances the drift current to transmit the signal to the encoder. The encoder encodes the parallel signal to serial signal which is compatible for the RF transmitter to transmit the signal. The decoder in the receiving section decodes the transmitted signal from serial to parallel signal. The Arduino in the receiver is activated when it receives the flame signal. The robot starts moving to the desire place where fire bursts has occurred and quenches the fire**.** After entire quenching process has been done it moves to its original location by tracing the path. Whereas, in manual mode we can send commands to robot through IoT application using Wi-Fi module which is mounted on robot itself. At the same time robot can also detect the obstacles and can avoid them by using IR sensors. The whole operation can be visualized using the camera fitted on to the robot [5]. On the same occasion the transmitted signal is received in a fire station so that evacuation of people and spreading of fire can be reduced by shutdown the supply.

3. TRANSMITTING END

The transmitter performs the inceptive process of detecting the fire. The block diagram of the transmitter section is shown in Fig: 1. It consists of battery, flame sensors, RF transmitter and receiver module [3] which has the inbuilt of encoder/decoder pair and comparator. The smoke and gas sensors can also be used along with the flame sensor. The flame sensors are placed in different fire prompt locations. As soon as the fire bursts is recognized by the flame sensor, the comparator provides the essential drain current to the transmitter module for transmitting the data. The encoder encodes the signal from flame sensor to the desired serial signal as only these signals can be transmitted.

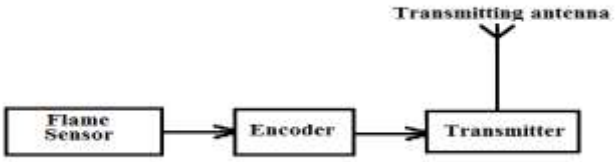

Fig -1: Block Diagram of transmitter section

3.1 Flame sensor (LM358)

The Flame sensor LM358 is shown in Fig: 2. Flame sensor is used to detect the fire or other light sources which are in the range of wavelength of 760nm to 1100nm. It is of thermostat type. The thermostat short circuit the unit to enable the RF transmitter.

Fig -2: LM358 Flame Sensor

It consists of potentiometer, photo transistor, LED (Light Emitting Diode) indicator. Photo transistor allows only yellow light which is of filtered type. LED turns red at the moment when fire is detected. It is sensitive to flame but it can also detect ordinary light. It measures the ambient light intensity.

3.2 RF Transmitter & Receiver Module

An RF module is a small electronic device used to transmit and/or receive radio signals between two devices. RF communications [10] incorporate a transmitter and a receiver. The radio frequency about 30KHz to 300GHz can be utilized. The RF transmitter/receiver pair is operated at the frequency of 434MHz [1]. An RF transmitter shown in Fig: 3

receives serial data and transmits it wirelessly through RF with its antenna connected at pin4. In the RF system, the output digital data is represented as variations in the amplitude of carrier wave.

Fig- 3: RF Transmitter & Receiver Module

4. RECEIVING END

The receiver section consists of the RF receiver, Arduino, relay drivers, relay, DC gear motors, the flame signal transmitted is received by the RF receiver operating at the same frequency of transmitter. The RF module comprises of the encoder/decoder pair. They enable the transmission to the deliberated level that is the encoder in the transmitter encodes the parallel signal to serial while the decoder in the receiver functions vice-versa. HT12E-HT12D is the commonly used encoder/decoder pair IC. This kind of modulation is known as ASK (Amplitude Shift Keying). RF transmission is preferred over IR because it is operated in line-of-sight mode, whereas RF signals can travel even when there is an obstruction between transmitter & receiver. Submersible pump motor, IR sensor and flame sensor and LCD. The block diagram of working robot is shown in Fig: 4.

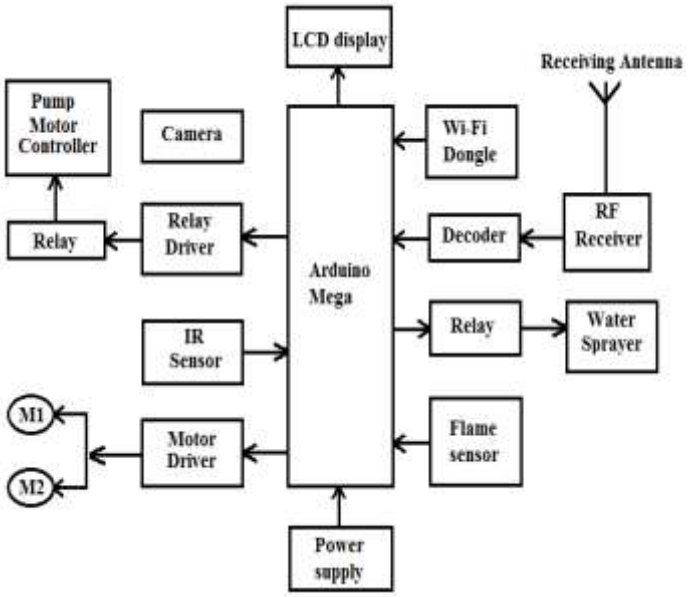

Fig- 4: Block Diagram of Working Robot

When the flame signal is received by the RF receiver, the signal is decoded using decoder (HT12D) from serial to parallel signal. On receiving the parallel signal, the arduino is activated. The controller controls the entire process of the robot. The IR sensors are placed to detect the obstacles in the path of the robot. The block diagram of fire station is shown in Fig: 5. At the fire station, PIC Microcontroller is used for shutdown the power using relay and glows the LEDs for evacuation of people in the industries or other premises.

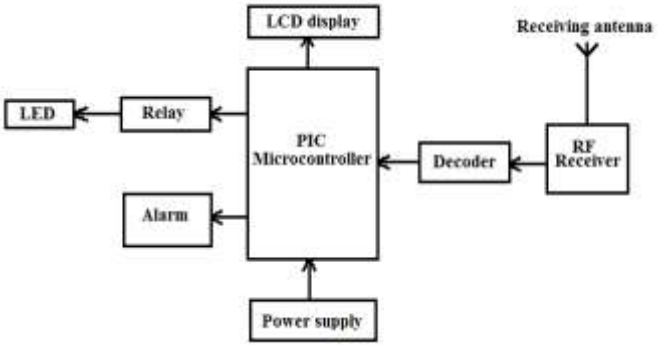

Fig- 5: Block Diagram of Fire Station

4.1 Arduino

Arduino ATmega2560 is based on microcontroller board [2]. The ATmega2560 is shown in Fig: 6, has 256 KB of flash memory for storing code, 8 KB of SRAM and 4 KB of EEPROM. With 54 digital I/O pins, 16 analog inputs. This board can be operated with an external supply of 6 to 20 volts.

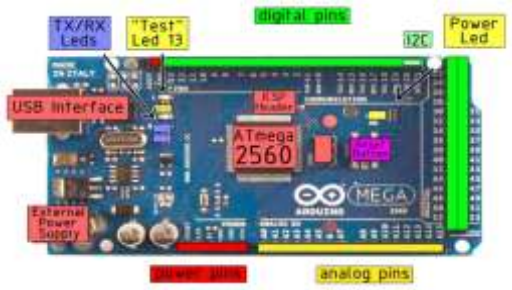

Fig-6: Arduino AT mega 2560

4.2 PIC Microcontroller

Micro controllers are used for more specific applications. PIC16F877A microcontroller is shown in Fig: 7 widely used because of various reasons like its large memory capacity and adequate input/output ports etc. it consists of 44 pins and is a dual-in-package 8-bit processor. It has high performance RISC CPU and single word instructions to learn [8]. Also possess direct, indirect and relative addressing modes. The watchdog timer is enabled with its own on-chip RC oscillator for reliable operation. It is employed for commercial, industrial and extended temperature changes.

Fig- 7: PIC16F877A Microcontroller

4.3 Wi-Fi Module

ESP8266EX is shown in Fig: 8 integrates a ten silica L106 32-bit RISC processor, which achieves low power consumption and can reach a maximum clock speed of 160MHz. It is standard digital peripheral interfaces, antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules. All these are included in one small package, our ESP8266EX.

Fig- 8: Wi-Fi module (ESP8266)

4.4 Relay Drivers

These drivers are utilized for interfacing low level logic circuitry with multiple peripheral power loads. The high-voltage, high-current Darlington arrays ULN20xxA/L shown in Fig: 9, feature continuous load current ratings of about 500 mA for each of the seven drivers. Based on the ambient temperature and number of drivers, the loads totaling over 230W can be controlled. ULN2003A/L and ULN2023A/L have series input resistors for operating directly with 5V TTL or CMOS.

Both ULN2003A/L and ULN2004A/L are used as the standard Darlington arrays. The output of the driver is capable of sinking about 500 mA that can withstand 50 V in the OFF state. The load devices are rated for operation over the temperature range of -20◦C to +85◦C.

Fig- 9: Relay Driver IC

4.5 Relay

A relay is an electrical switch which can be used for tripping off the circuit under undesirable conditions. The undesirable conditions include over voltage during lightening, over load and fire accident. The relay uses an electromagnet for open and close contact mechanism. It can also be considered as the form of electrical amplifier because a relay is able to control an output circuit of higher power than the input circuit. In an automotive style

miniature relay, shown in Fig 10, the contacts can be either normally open or normally closed or change over contacts. To activate the relay, the circuit must be connected during open contacts, the circuit is disconnected when the relay is inactive

Fig- 10: Automotive Style Miniature Relay

The relay is activated when circuit is disconnected at closed contacts and vice-versa at relay being inactive. Change-over contacts perform the controlling operation of two circuits, both normally- open contact and one normally-closed contact.

4.6 DC Gear Motors

A motor is a machine which converts energy into rotating motion. The hub or drive shaft is the rotating output of the shown in Fig: 11, motor. A DC motor is a motor that uses direct electrical current as the source of its energy. A gear motor [7] is a motor with an attached set of gears driving a secondary drive shaft. Practical motor designs result in motors that spin too fast for most uses. As a result, almost all gear sets are used to gear down the motor. The geared down drive shaft spins slower than the direct motor drive shaft. The geared down drive shaft also spins harder. Motor speed is generally measured in Revolutions Per Minute (RPM). Gearing down a motor reduces its RPMs (speed) but increases its torque and vice-versa.

Fig- 11: DC Gear Motors

4.7 Submersible Pump Motor

It is placed inside the water holding tank in order to sprinkle the water at the fire. It is switched using the relay circuit. The pump shown in Fig: 12, will be operating in an efficient way and can be long lasting only if they are submerged in water [6]. Their speed of sprinkling depends upon the torque of the motor

Fig- 12: Submersible Pump Motor

4.8 Camera

V380-Q3 is shown in Fig: 13, a plug-and-play HD wireless camera offers 720p videos in HD, supports 360-degree angle video monitoring, night vision, 64GB storage, motion detection. V380 app where we can see the live feed of the process. Also, it consists of microphone and speaker so that the voice can be heard and we can also speak with the v380 camera.

Fig-13: CameraV380-Q3

5. RESULTS AND DISCUSSION

The flame sensors [4], are placed in two zones namely zone 1 and zone 2. When the fire is sensed by the flame sensor, the RF transmitter module is enabled by short circuiting the circuit. The encoder (HT12E) in the transmitter converts parallel data into serial data so that transmitter can transmit the encoded serial signal. A comparator is used to enhance the drain current required by the transmitter module is shown in Fig:14, as the drain current provided by the flame sensor is not enough. The firing moment that has taken place is indicated to both the primary and secondary section. The primary section refers to the main control room where all the supply to the entire location is present. The secondary section is regarding the robotic movement.

Fig -14: Transmitter Module

The receiving end comprises of two divisions. One is Main Control Room is shown in Fig :15, and the another one is Robot. The transmitted signal about the fire burst is received by both the main control room and the Robot. The

RF receiver receives the decoded parallel signal in both the sections. The decoder in the RF receiver module decodes the serial signal to parallel signal. When the decoded signal is received by the receiver the relay in the main control room cut of the supply to other devices in LEDs are placed in the right direction of the industries to know the exit path so that persons can escape from the fire zones.

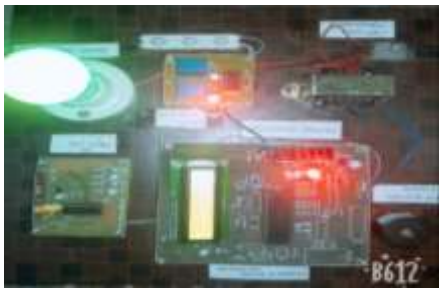

Fig -15: Main Control Room

The working prototype of robot is shown in Fig:16, is enabled by receiving the signal. In auto mode, based on the location of either zone 1 or zone 2, the robot reaches the respective place of fire burst and quenches the fire. After quenching the fire, the robot moves to its original place by tracing the path [6]. During manual mode, we can move the robot to the respective zones with the help of camera and can quench the fire. In case of any object present in the path of the robot, it stops moving and the buzzer alarms and we can move the robot by changing the direction by manual control.

Fig-16: Working prototype of Robot

6. CONCLUSION

It is a low cost, and energy efficient prototype of an automated fire quenching system. The prototype system consists of the transmitter and receiver modules interfaced with sensors and controller. It has been designed using wireless transmission capable application processor modules because wireless transmissions are more flexible and we can avoid the working problem. Also, it helps in improving the efficiency of transmitting the signal and performance of the system and also reduces the cost of extending the system. It is more preferably used for quenching the fire at the initial stage itself. It can also be designed using heat and water-resistant materials to quench the fire with sprinkling system and protecting from corrosion along with guarding the internal circuits respectively. For wireless transmission the most efficient and updated technology is Lora which is made use of most industries globally. It helps in efficient transmission of signal comparing other technologies. To pull the robot with more water high torque dc motors can be utilized. This system can also be modified and used for detecting thieves in a locked home.

REFERENCES

[1] C.Hemalatha, M.Karpagavalli, S.Sushmitha, J.Rajeswari, on "'Automated Fire Quenching Robot with visual surveillance" published in journal(IJSRD) - International Journal for Scientific Research & Development, Volume 6,Issue 2, in April 2018.

[2] Abdulkadir Cakir, Nyan Farooq Ezzuldin, "Fire Extinguishing Robot Design by using Arduino" IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 18, Issue 6, Ver. V,PP113-119 www.iosrjournals.org published on 2016.

[3] M Magno, T.Polonelli, L.Benini, and E.Popovici , "A low cost, highly scalable wireless sensor network solution to achieve smart LED light control for green buildings," IEEE Sensors, Journal, vol.15, no.5, pp.2963-2973,2016.

[4] Jordi Palacin, Eduard clotet, Dani Martizez, "Automatic supervision of temperature, humidity and luminance with an assistant personal robot" Journal of Sensors Volume 2017 published on 2017.

[5] R.Du.C.Chen, B.Yang, N_Lu, X_Guan, and X_Shen, "Effective urban traffic monitoring by vehicular sensor networks", IEEE Transactions on Vehicular Technology, vol.64, no.1, pp.273-286, 2015.

[6] Joe Davis, Ray Klundt, Paul Limpisathian 2, "Fire Fighting Robot" The Department of Electrical and Computer Engineering, The university of Akron IJSRD - International Journal for Scientific Research & Development| Vol. 4, Issue 01, 2016

[7] Dalla personal robotics group,"Brief H-Bridge theory operation" retrieved July-7th-2015.

[8] A.Marvuglia, A.Messineo, and G.Nicolosi "Coupling a neural network temperature predictor and a fuzzy logic controller to perform thermal comfort regulation in an office building", Building and Environment, vol.72, pp.287-299, 2014.

[9] N.N.Brushlinsky, M.Ahrens, S.V.Sokolov, P.Wanger, "World Fire Statistics", International Association of Fire and Rescue Services, pp 55,2014.

[10] U.JyostnaS.P and M.V.D. Prasad "Automatic Fire Sensing and Extinguishing Robot Embedded With GSM Modem". International Journal of Engineering and Advanced Technology, PP 221-224, 2013.