FIRE FIGHTNING ROBOT USING IoT

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ABSTRACT: Detecting fire and extinguishing it is a dangerous job that puts life of a fire fighter at risk. There are many fire accidents which fire fighter had to loose their lives in the line of duty each year throughout the world. The research and development in the field of Artificial Intelligence has given rise to Robotics. Robots are implemented in various areas like Industries, Manufacturing, Medicines etc. Hence, Robotics can be used to assist fire fighters to perform this task of fire fighting and thus reduce the risk of their lives. Fire Fighter is a robot designed to use in such extreme conditions. It can be operated and controlled by internet and has the ability to extinguish fire after locating the source of fire. It is equipped with a monitoring system and operates through a wireless communication system. The fire detection system is designed using the sensors mounted on the fire fighter robot. The robot is controlled autonomously using Arduino. Arduino developed by internet of things among software developers due to its powerful capabilities. Arduino provides many resources and already integrates lot of sensors. This concept helps to generate interest as well as innovation in field of robotics while working towards a practical and obtainable solution to save lives and mitigate the risk of property damage.

Keywords: Fire-Extinguishing, Robot Design, Arduino.

1 Introduction

The flat form for this project is based on Embedded System. An Embedded system is a special-purpose system in which the computer is completely encapsulated by the device it controls. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few pre-defined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded systems are often mass-produced, so the cost savings may be multiplied by millions of items.

An embedded system is a special-purpose computer system designed to perform a dedicated function. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few pre-defined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded system comprises of both hardware and software. Embedded system is fast growing technology in various fields like industrial automation, home appliances, automobiles, aeronautics etc. Embedded technology is implemented to perform a specified task and the programming is done using assembly language programming or embedded C. Ours being a developing country the power consumption is increasing on large scale to meet the growing need of the people. Power generation is widely based on the non-renewable sources and these sources being depleting some means have to be found for power saving [1-10].

2. Literature Survey

J. Reinhart V. Khandwala (2003) discussed about design and the implementation of the fire-fighting robot. The key design elements of the robot to be discussed include: the assembly and construction of the
robot hardware, the processing algorithm based on the sensors response, and the navigation algorithm that will enable the robot to find an efficient path in and out of the house model [1] Lynette Miller Daniel Rodriguez (2003) was et all discusses the development of each component of the robot that is designed to find a small fire represented by a light emitting diode in a model home and extinguish it. This paper will talk about each component of the robot from the start signal to the robot platform to the line following and room finding and finishing with the fire detection [2]. Sahil.S.Shah (2013) was et all discussed about design a FIRE FIGHTING ROBOT using embedded system. A robot capable of fighting a simulated household fire will be designed and built. It must be able to autonomously navigate through a modeled floor plan while actively scanning for a flame. The robot can even act as a path guider in normal case and as a fire extinguisher in emergency. Robots designed to find a fire, before it rages out of control, can one day work with fire-fighters greatly reducing the risk of injury to victims.

3. Working

It is a movable or both at consists of gas sensor for detecting the fire, gear motor and motor driver for the movement of the Robot, relay driver for pump control and air receiver which are used for the Detecting and extinguishing the fire. Usually, the robot moves at a steady Speed. When the gas sensor detects the fire in the environment, the signal indicating the presence of fire will be sent to the Arduino through which the extinguishing is done. In the extinguishing process, whenever the detection of fire is positive the robot will stop at the place of fire occurred and starts the pump and sprinkle water through a sprinkler until the smoke is put off. The entire control is achieved using Arduino which is interfaced with the infrared sensor, so that the control of the robot can be achieved automatic all.
Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.

You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on wiring), and the Arduino Software (IDE), based on Processing.

4. IR Sensor

An infrared sensor circuit is one of the basic and popular sensor modules in an electronic device. This sensor is analogous to human’s visionary senses, which can be used to detect obstacles and it is one of the common applications in real time. This circuit comprises of the following components

- LM358 IC 2 IR transmitter and receiver pair
- Resistors of the range of kilo ohms.
- Variable resistors.
- LED (Light Emitting Diode).

In this project, the transmitter section includes an IR sensor, which transmits continuous IR rays to be received by an IR receiver module. An IR output terminal of the receiver varies depending upon its receiving of IR rays. Since this variation cannot be analyzed as such, therefore this output can be fed to a comparator circuit.

Here an operational amplifier (op-amp) of LM 339 is used as comparator circuit.

When the IR receiver does not receive a signal, the potential at the inverting input goes higher than that non-inverting input of the comparator IC (LM339). Thus the output of the comparator goes low, but the LED does not glow. When the IR receiver module receives signal to the potential at the inverting input goes low. Thus the output of the comparator (LM 339) goes high and the LED starts glowing. Resistor R1 (100 ), R2 (10k ) and R3 (330) are used to ensure that minimum 10 mA current passes through the IR LED Devices like Photodiode and normal LEDs respectively. Resistor VR2 (preset=5k ) is used to adjust the output terminals. Resistor VR1 (preset=10k ) is used to set the sensitivity of the circuit. Diagram. Read more about IR sensors.
5. Relay

A Relay based DC motor controller works with an H-bridge arrangement. With an H-bridge circuit, the polarity across a load can be altered in both directions. In Dual SPDT motor driver circuit, the DC motor terminals are connected between the common poles of the two relays. The normally closed terminal of both relays is connected to negative or ground. And the normally open terminals are connected to the positive terminal. The coil terminals of the relay are connected to the supply with a push switch. The Switch S1 and S2 control the relay 1 and relay 2 respectively.

In the circuit diagram shown, the switch S1 is ON and switch S2 is OFF. So, the motor terminals will have a positive polarity on the left side and a negative polarity at the right side. Thus, the motor turns in a clockwise direction. Similarly, when the S2 is ON and S1 is OFF, the motor turns in an anticlockwise direction.

<table>
<thead>
<tr>
<th>S1</th>
<th>S2</th>
<th>Motor Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Motor brakes</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>Motor moves right</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Motor moves left</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Motor brakes</td>
</tr>
</tbody>
</table>

When two switches are open, both the relays are will be in a normally closed position. Which makes the ground or negative across the motor terminals that are the same polarity on both sides? Similarly, when both switches are closed (here both terminals will have positive voltage) the same polarity will obtain at two sides. On both conditions, the motor terminals are shorted and the motor brakes.

In a relay H-bridge, the motor terminals have no any free floating terminal states. So a coast mode will not occur at any instant.

6. Temperature Sensor

The most frequently measured environmental quantity is “Temperature”. This might be expected since most of the systems are affected by temperature like physical, chemical, electronic, mechanical, and biological systems. Certain chemical effects, biological processes, and even electronic circuits execute best in limited temperature ranges. Temperature is one of the most frequently calculated variables and sensing can be made either through straight contact with the heating basis or remotely, without straight contact with the basis using radiated energy in its place. There is ample variety of temperature sensor on the market today, including Thermocouples, Resistance Temperature Detectors (RTDs), Thermistors, Infrared, and Semiconductor Sensors. The LM35 is one kind of commonly used temperature sensor that can be used to measure temperature with an electrical o/p comparative to the temperature (in °C). It can measure temperature more correctly compare with a thermistor. This sensor generates a high output voltage than thermocouples and may not need that the output voltage is amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C.

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif Systems.[1] The chip first came to the attention of western makers in August 2014 with the ESP-01 module, made by a third-party manufacturer, Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at the time there was almost no English-language documentation on the chip and the commands it accepted. [2] The very low price and the fact that there were very few external components on the
module which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation.[3] The ESP8285 is an ESP8266 with 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.[4]

**ESP8266**

![ESP-01 module by Ai-Thinker](image)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Espressif Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>32-bit microcontroller</td>
</tr>
<tr>
<td><strong>CPU</strong></td>
<td>@ 80 MHz (default) or 160 MHz</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>32 KiB instruction, 80 KiB user data</td>
</tr>
<tr>
<td><strong>Input</strong></td>
<td>16 GPIO pins</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>3.3 V DC</td>
</tr>
</tbody>
</table>

![LM35 Temperature Sensor](image)
The LM35 does not need any exterior calibration and maintains an exactness of +/-0.4°C at room temperature and +/-0.8°C over a range of 0°C to +100°C. One more significant characteristic of this sensor is that it draws just 60 microamps from its supply and acquires a low self-heating capacity. The LM35 temperature sensor available in many different packages like T0-46 metal can transistor-like package, TO-92 plastic transistor-like package, 8-lead surface mount SO-8 small outline package.

DC MOTOR:
A DC motor is any motor within a class of electrical machines whereby direct current electrical power is converted into mechanical power. Most often, this type of motor relies on forces that magnetic fields produce. Regardless of the type, DC motors have some kind of internal mechanism, which is electronic or electromechanical. In both cases, the direction of current flow in part of the motor is changed periodically. The speed of a DC motor is controlled using a variable supply voltage or by changing the strength of the current within its field windings. While smaller DC motors are commonly used in the making of

ZIGBEE
Zigbee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios, such as for home automation, medical device data collection, and other low-power low-bandwidth needs, designed for small scale projects which need wireless connection. Hence, Zigbee is a low-power, low data rate, and close proximity (i.e., personal area) wireless ad hoc network. The technology defined by the Zigbee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or more general wireless networking such as Wi-Fi. Applications include wireless light switches, home energy monitors, traffic management systems, and other consumer and industrial equipment that require short-range low-rate wireless data transfer.

7. Research and Developments
Fire Fighting is an extremely dangerous task that has caused severe loss of life and property because of lack in technological advancement. The current firefighting methods mostly employing humans are inadequate, inefficient and are subjected to errors. This paper presents the design and development of a Fire Fighting Robot that monitors a hazardous fire prone area with the feature of continuous scanning for any occurrence of fire. When a fire is spotted it locates the exact source of fire and extinguishes the fire with an extinguisher mounted on the robot. Monitoring a critical area is done by line following mechanism using Infra-red (IR) sensors. Fire detection is also carried out using IR detectors. This robot will find application in monitoring critical fire hazardous site ensuring minimum damage with maximum human safety.

8. Application
1. Can be used in server rooms.
2. Useable in power plant control rooms, flight control centers.
3. Extinguishes fire where probability of explosion is high.
4. To the worst case of accidents, fire causes heavy loss both financially and by taking lives.

These robots are the best possible way, in orders to guard of life.

9. Conclusion and Future Works
Fire causes tremendous damage and loss of human life and property. It is sometimes impossible for the fire fighter personnel to access the sight of fire because of explosive materials, smoke and high temperature. Through this we can conclude that robot can be placed where human lives are at risk. The robot can operate in the environment which is out of human reach in very short time. In such environments, fire fighting robots can be useful for extinguishing fire. These robots should be controlled remote operators who are located far away from the fire site using remote communication systems. The robot accurately and efficiently finds the fire within minimum time after the fire is detected. In future work Project aims to promote technology innovation to achieve a reliable and efficient outcome. Mobile robot that can
move through a model structure, find fire and extinguish it. The movement of the robot is controlled by the sensors which are fixed on the mobile platform. This is to provide security of home, laboratory, office, factory and building is important to human life. We develop an intelligent multisensory based security system that contains a fire fighting system in our daily life. We design the fire detection system using sensors in the system, and program the fire detection and fighting procedure using sensor based method.

References