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IOT Enabled Fire Fighting Robot

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ABSTRACT: The goal of this project is to create a design for an Arduino-based Firefighter Robot. Arduino is an open-source electronics platform built on user-friendly hardware and software. The Arduino board may be controlled by sending a series of instructions to the microcontroller. Fire and smoke sensors detect possible risks, prompting the robot to respond. When the robot detects a fire, it starts a water-pumping motor via a relay to extinguish the flames. The robot is meant to navigate autonomously, detect and assess fire characteristics, and successfully extinguish flames. Once a fire is detected, the extinguishing system is engaged. A firefighter robot suppresses and extinguishes fires to save lives and property. The IoT-enabled firefighting robot intends to reduce the hazards that human firefighters encounter, improve situational awareness, and maximize resource usage during emergency situations.

Keywords: **Arduino, Firefighting, IoT (Internet of Things), Adafruit, Sensors, Robot**

INTRODUCTION

As technology advances, so are the developments in response to crises that endanger human life. The robot industry is a model that is generated every day in a new branch as an alternative to the human element. Wheeled, flying and robotic. Among these are human-droid robots, underwater robots, and robots with legs. The increasing global population is contributing to an increase in involuntary difficulties. Among these issues, fires rank among the most critical. The robot industry is actively working in this field. Some of them are mobile rescue robots acting as search and rescue equipment, mobile locating robots used for fire detection, mobile extinguishing robots, and fixed mobile robots with various capabilities that are outfitted with various sensors that detect before the fire is extinguished in various kinds of forms developed to help firefighters combat the fire. The suggested system's objective is to use an Android application to control the robot. The robot will patrol a predetermined region. These robots will make replacing firefighters easier and more efficient. Time will be saved because the robot will work more quickly than the firefighters. The Android operating systems are feature-rich and portable. Therefore, we are going to be creating an Android application that will allow us to operate the robot. The system's goal is to carry out the fire extinguishing task. The robot will be made up of a water pump, nodeMCU, and other sensors.

Firefighter robots are primarily designed to lower mankind's carbon footprint and save human lives. There were three difficulties found. The first is the high danger lives of firefighters, who are exposed to death due to their everyday routine employment. The second issue is the time factor, which refers to how long a manual firefighting system takes to operate and how slow the situation occurs. The final issue is that the temperature of the fire has beyond the limit of the human senses. This article discusses the relevant aims for the problem described above. The first purpose is to use robots as one of the alternative paths for reducing firefighter dangerous life and improving firefighter abilities. The second goal is to warn that by developing firefighting robots, the time required to place the robot in a high-risk fire zone may be reduced. The final goal is to determine whether the robot is capable of performing its tasks in a hazardous zone with high temperatures.

LITERATURE SURVEY

[1] Vyshnavi MB, Shikha Suresh S: This paper describes how an IoT fireman robot, which can operate autonomously and remotely, detects and extinguishes fires while linked to a Remote Desktop program via the Internet. The application, run by an authority, assists the robot in determining the fire kind and using appropriate extinguishing procedures.

[2] Kshitiz Agarwal, Aishwarya Soni, Shilpi Mishra, Geetanjali JangidIn: In this paper, response to the unexpected nature of fire incidents, this study describes the development of an autonomous firefighting robot equipped with three flame sensors for fire detection and three infrared sensors for avoiding obstacles. The robot is controlled by Arduino and roams freely. If it detects a fire, it warns the operator and extinguishes the flames with its integrated water tank

[3] A R M Raafeek, N Satheeskanth, J Joy Mathavan and A Kunaraj: This study describes a suggested IoT-based firefighting vehicle prototype that uses sensor inputs and GSM modules to warn users when it discovers and puts out flames. Meanwhile, servo motors regulate the direction and water volume

[4] Kristi Kosasih, Erwani Merry Sartika, M. Jimmy Hasugian, Muliady Muliady: In this work, Technological

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progress, specifically in the field of robotics, has resulted in the creation of specialized robots. For example, firefighting robots are now armed with ultrasonic, compass, flame, thermal array, white, and micro switch sensors. These sensors are managed by a microcontroller that is specifically engineered to navigate and put out flames.

[5] S. Kavitha, Krishnarajendra sagar, Mohamed Tousif, Nishanth C.R. Likith. V: The robot in this study uses an ARM7 for both automatic and manual firefighting operations, concentrating on high-risk areas using a small robot that is fitted with a Wi-Fi module, many sensors, and an extinguisher, meeting the need and peril of combating fires.

EXISTING SYSTEM:

In existing system, Sprinklers, hand-held portable fire extinguishers, and fire brigades are among the standard traditional firefighting techniques. These traditional methods take a long time to get to the scene of the incident. For example, the fire department needs to dispatch personnel from the fire station, navigate traffic, and reach the area where the fire occurred. Portable extinguishers are also not free because they are typically located in hard-to-reach corners of buildings and require ongoing maintenance. Conversely, installing a sprinkler system with a smoke detector is a very unreliable solution since enormous areas might be covered by sprinkler pipes that are defective and may not produce adequate pressure.

PROPOSED SYSTEM:

The proposed project aims to create an Android application that can control the activities of a firefighting robot. Fire sensors are used to detect fires. We're employing three fire sensors here. The water pump is activated when a fire sensor detects a fire, and when a smoke sensor detects a smoke. The Passive Infrared sensor detects the presence of humans in the surrounding region. If the fire detection system detects a fire, the extinguishing system will be engaged. The IP Camera is utilized for live surveillance.

BLOCK DIAGRAM:

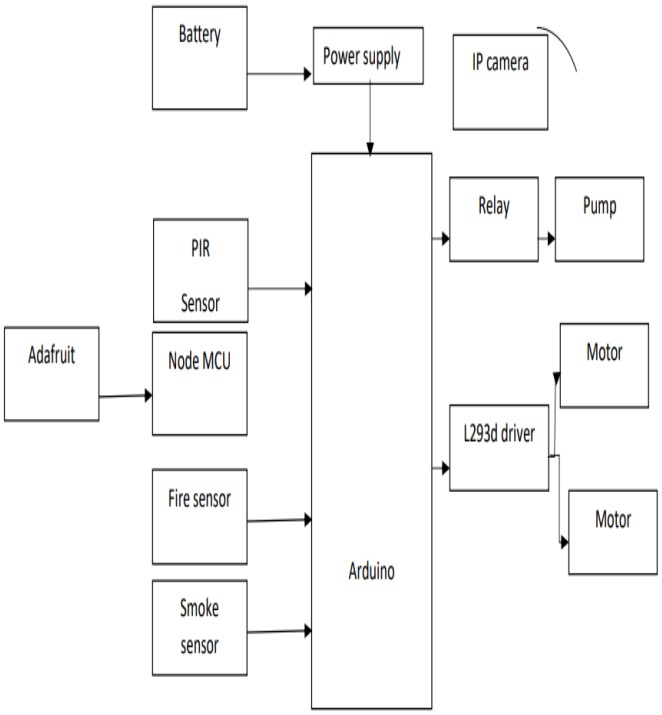

fig.1 Proposed Block Diagram

CIRCUIT DIAGRAM:

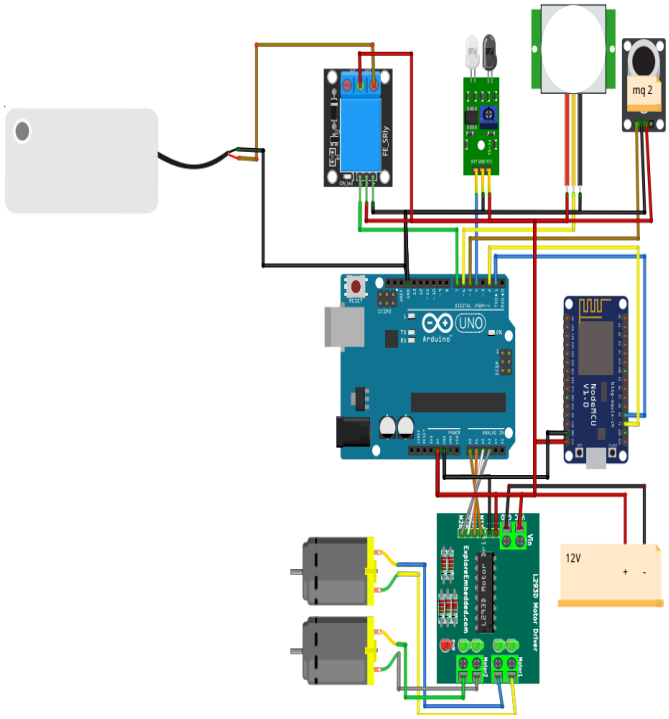

fig.2 Circuit Diagram

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FLOW CHART:

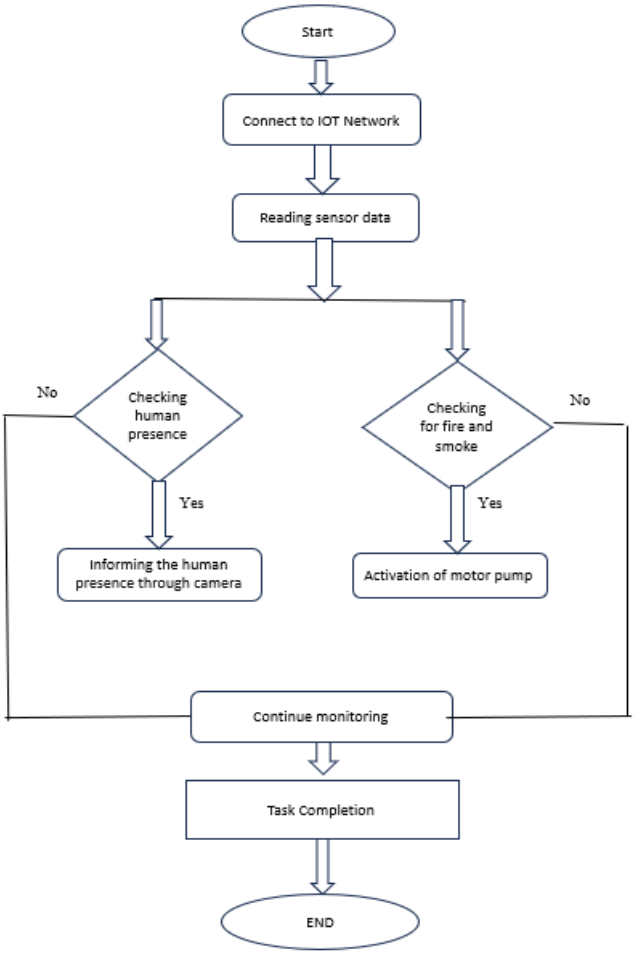

fig.3. Flow Chart

REQUIRED COMPONENTS

A) HARDWARE REQUIREMENTS

1. ARDUINO UNO:

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's strength lies in its capacity to interface with the outside world via its input-output (I/O) pins, rather than its ability to run code. The Arduino features 14 digital I/O pins designated 0-13, which may be used to control motors, lights, and switches. Each digital pin may sink or generate approximately 40 mA of electricity. This is sufficient for connecting to most devices; however, interface circuits are required to control devices beyond basic LEDs. To run a motor using an Arduino pin, it must be driven by an interface circuit, not directly. A subsequent portion of this article demonstrates how to connect to a tiny motor. The software uses C code to change digital pins to high or low values, resulting in +5 V or 0 V at the pin. The pin connects to external interface circuitry and controls the device's on/off state. The diagram depicts the sequence of events.

Fig.4. Arduino UNO

2. PIR SENSOR:

Living things with body temperatures over 0oC emit infrared radiation, commonly known as thermal radiation. This radiated energy is undetectable to the human sight. PIR sensors are specifically built to detect these signals. The term "passive" in passive infrared (PIR) sensor refers to the fact that the sensor does not produce or emit any energy in order to detect. PIR sensors identify and quantify infrared radiation that is emitted or reflected from objects rather than HEAT. They are easy to use, affordable, compact, and need little electricity. They are frequently seen in homes, hospitals, industries, etc. The PIR sensors are more sophisticated than the other sensors since they have two slots. These holes are constructed of a specific infrared-sensitive material. The Fresnel lens is utilized to ensure that the PIR's two slots can view beyond a certain distance. When the sensor is inactive, the two slots detect the same quantity of infrared. The quantity of radiation that
is emitted from the outside, walls, or room, among other things. When a human body or animal passes by, it intercepts the PIR sensor's first slot. This results in a positive difference between the two bisects. When a human body departs the detecting region, the sensor produces a negative difference between the two bisectors. The infrared sensor is encased in a hermetically sealed metal enclosure to increase humidity, temperature, noise, and immunity. The sensor element is protected by a window composed of usually coated silicon material.

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Fig.5. PIR Sensor

3. NODE MCU:

An open-source hardware platform and firmware called NodeMCU is built around the ESP8266 Wi-Fi module. The integration of integrated Wi-Fi capabilities with a microcontroller unit (MCU) facilitates the effortless and economical construction of Internet of Things (IoT) projects. NodeMCU is especially well-liked by developers and enthusiasts because of its ease of use and compatibility with the Arduino IDE. It is a flexible option for a range of Internet of Things applications since it allows users to remotely operate devices, gather data, and link their projects to the internet. Espressif, a Chinese firm, manufactures the ESP8266, a System on a Chip (SoC). It is made up of a Wi-Fi transceiver and a 32-bit Tensilica L106 micro controller unit (MCU). In addition to an analog input, it contains 11 GPIO pins.

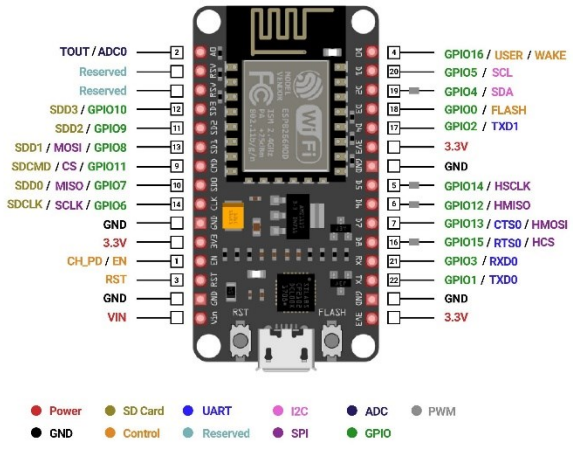

Fig.6 Node MCU

4. MOTOR DRIVER

A motor driver is an integrated circuit chip that is typically used to operate motors in autonomous robots. Motor drivers serve as an interface between Arduino and motors. The L293 series, including the L293D and L293NE, are the most often utilized motor driver ICs. These integrated circuits can control two DC motors at once. L293D consists of two H-bridges. The simplest circuit for controlling a motor with a low current rating is an H-bridge. We shall merely refer to the motor driver IC as L293D. L293D contains 16 pins.

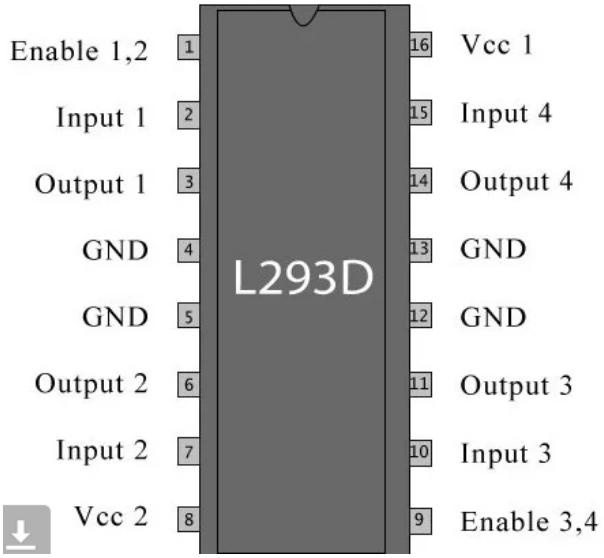

fig.7 L293D Motor Driver

5. RELAY:

A relay is an electromagnetic switch that is used to turn on and off a circuit using a low-power signal, or when several circuits must be controlled by the same signal. Relays are used in the majority of high-end industrial application equipment to ensure proper operation. Relays are basic switches that may be actuated electrically or manually. Relays are made up of both an electromagnet and a collection of contacts. The electro magnet powers the switching mechanism. There are additional operating principles that guide its operation. However, they differ depending on their use. Most gadgets use relays.

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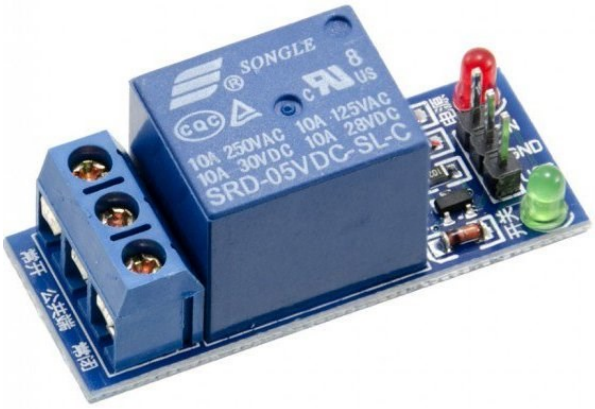

fig.8 Relay

6. GAS SENSOR

A gas sensor detects the presence and concentration of gases in the environment. Based on the gas concentration, the sensor generates a corresponding potential difference by altering the resistance of the material within the sensor, which may be detected as output voltage. Based on this voltage value, the gas's kind and concentration may be approximated.

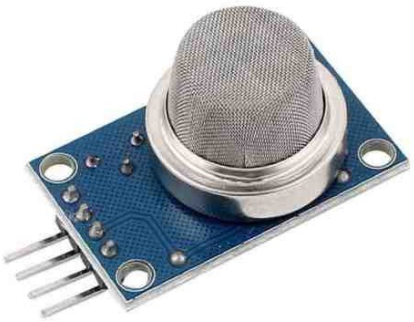

Fig.9 Gas Sensor

7. IP CAMERA:

An IP camera is a video camera that is networked via a Fast Ethernet connection. The IP camera transmits signals to the main server or computer screen via an Internet or network connection. It is most commonly used for IP surveillance, closed-circuit television (CCTV), and digital videography. IP cameras are rapidly replacing analog cameras owing to their digital zoom and remote surveillance capabilities over the Internet.

Fig.10 IP Camera

8. DC MOTOR:

A DC motor is a mechanism that transforms direct current (DC) electricity to mechanical power. It works on the idea that when a current-carrying conductor is put in magnetic field, it experiences mechanical force.

Fig.11 DC Motor

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9.PUMPING MOTOR

A submersible pump, often known as an electric submersible pump (ESP), is a device with a hermetically sealed moor that is closed-coupled to the pump body. The entire system is submerged in the fluid to be pumped. This pump avoids cavitation, which occurs when there is a significant elevation difference between the pump and the fluid surface. Submersible pumps push fluid to the surface, whereas jet pumps have to draw fluids. Submersibles are more efficient than jet pumps.

Fig.12 Pumping Motor

10.12V BATTERY

Rechargeable batteries store energy and may be recharged by providing DC current to their terminals after discharge. Rechargeable batteries offer numerous usages, decreasing waste and delivering a more cost-effective long-term investment in terms of device time. A rechargeable battery is a more rational and long-lasting alternative to one-time use batteries, which generate electricity via a chemical process that consumes a reactive anode. In a rechargeable battery, the anode is also consumed, albeit at a slower pace, allowing for several charges and discharges.

Fig.13 12V Battery

B) SOFTWARE REQUIREMENTS

1.ARDUINO IDE:

Arduino IDE (Integrated Development Environment) is an official program developed by Arduino.cc for creating, compiling, and uploading code to Arduino devices. Almost all Arduino modules are compatible with this open-source software, which can be installed and used to compile code while on the go.

2.ADAFRUIT IO:

Adafruit IO is a cloud service that lets users view, reply to, and interact with data from their projects. It's meant to be simple to use and requires minimal code. Adafruit IO is free to anybody with an Adafruit account. It's handy for makers, scientists, and anybody looking to create an internet-connected mailbox or automate their house with sensors. Adafruit IO maintains data private by default and does not sell or distribute information to other companies. Data feeds are private by default; however, users can limit or allow access to their data using an Adafruit IO Key.

RESULTS:

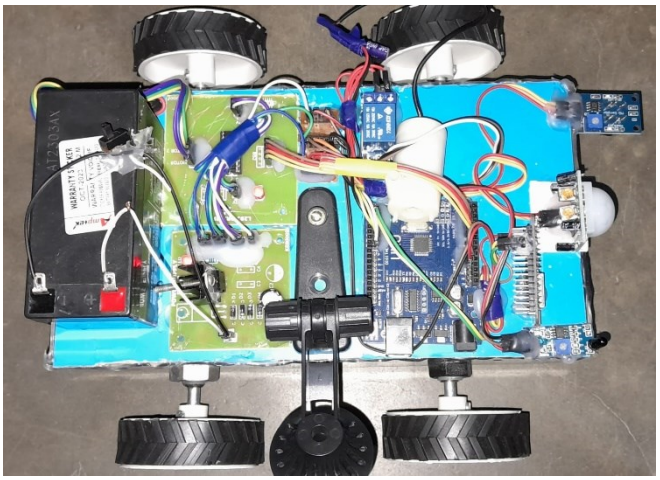

Fig.14 Final Hardware Implementation

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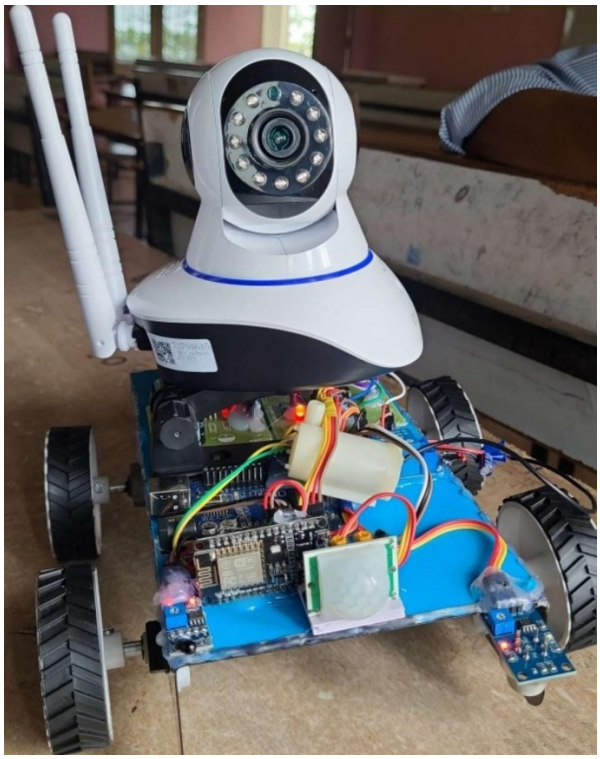

Fig.15 Final hardware implementation with IP Camera

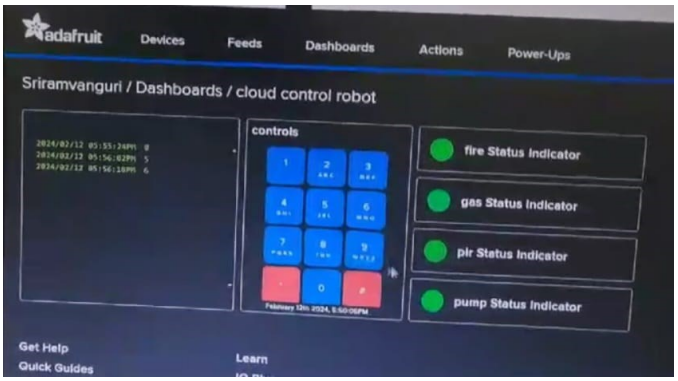

Fig.16 Adafruit Dashboard

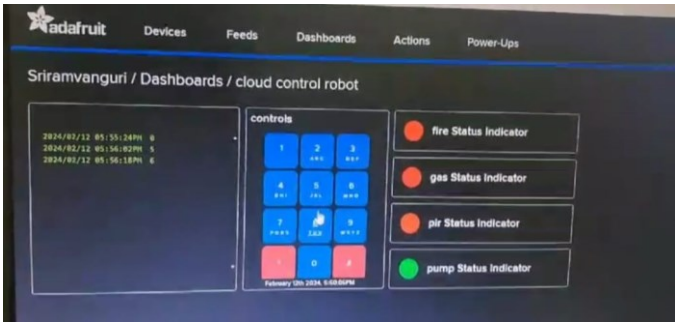

Fig.17 Fire and Gas status detected

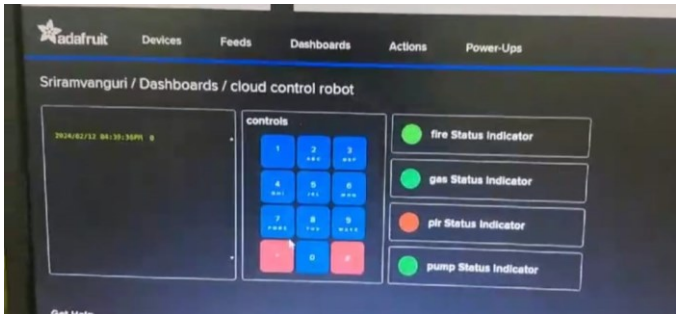

Fig.18 PIR Status detected

CONCLUSION:

In the domain of deploying firefighting robots to provide aid during critical scenarios, the proposed modular design methodology emerges as a highly viable approach. This innovative technique encompasses the development of a sophisticated robot that possesses the ability to halt its movement and navigate in multiple directions, including left, right, forward, and backward. By incorporating such advanced functionalities, the robot effectively reduces the dependence on human intervention while ensuring the protection of valuable assets. A key feature of this robot is its utilization of a specialized sprinkler pump system that swiftly extinguishes fires upon detection. In the execution of its firefighting tasks, the robot strategically maneuvers towards the targeted location to effectively combat the flames.

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