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Multi-use Intelligent Automaton for Fire-Detection

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Abstract: ***In some critical situations, human faces challenges especially in the field of nuclear power plants, gas stations, oil rigs etc to control fire. Manual handling will become a high-risk task and sometimes result may involve loss of life, property damage and also cause severe attack to environment. As technology develops, solution to protect human and environment is not a hectic task. Here a multi-purpose fire extinguishing robot is proposed which can carry out fire extinguishing operations as well as reconnaissance missions. Proposed system can search the area, locate the fire and extinguish the fire before it comes out of control. Robot is able to navigate through the building while actively scanning for the flame. It can send various data from the sensors to the cloud technologies and received data on mobile phone. With the help of Internet of Things, it can send alert and notifications to the user about the status of the fire. The robot proposed found its application in fire extinguishing operations during fire accidents where the possibility of the servicemen to enter the fire prone area is very less.***
Keywords: Fire extinguishing robot, Internet of things, Multi-purpose fire extinguishing robot, Cloud technologies

I. INTRODUCTION

Fire extinguishing is a very tough task for the human due to physical constraints and adverse circumstances during fire accidents. Fire robot can be used for such high risk situations. Over the past decade many fire fighting robots have been developed. Some devices invented were wirelessly controlled by the human. The proposed intelligent fire fighting robot can be functioned wirelessly from wherever in the world with the help of data's received from the sensors. Robots sends all the data from the sensors to the cloud and analysed. It is also capable of sending videos to the internet so that the user who is operating the robot wirelessly can view the situation of the fire inside the room and can accurately locate the position of the flames. Proposed system has the ability to scan the entire region for obstacles and it can locate the most dangerous fire so that it can be extinguished early which would reduce the possibility of the fire getting spread to other areas. Finally technology has filled the gap between firefighting and machines by allowing a more competent and effective method of fireside fighting. Hence designed to travel to a fireplace, before it rages out of control and hope they could one day work with fire fighters in reducing the risk of injury to victims and fire fighters.

II. LITERATURE SURVEY

Many researchers have contributed to various developments in the field of line following robots and firefighting robots. Fire brigade robots [1] were developed that worked on the basis of a web server. If the rate of fire increases with temperature, the sensor will detect the rate of fire of the temperature increase depending on whether the robot is running or not. Three different sensors were used in the robot. The smoke detector detects the amount of smoke generated by the fire, while obstacles in the path of the robot are detected by infrared.The water is pumped by a DC water pump by a robot. All the data is sent to the android device via bluetooth and then sent to the web server from that android device. Spray water onto the fire from a tank on top of the robot. Then, the advanced firefighting robot[2] was developed, which offered a new fire detection device in a highly complex urban environment such as an office building, a supermarket, a school, etc. Firefighting robots [3] were able to detect fires and largely smother the fires.The devices developed were by no means an exact solution to human physical limitations, and it is difficult to pinpoint the exact location of fire detection. Firefighting is dangerous work, so a robot has been developed that can find very useful fire areas and then drive to that location, greatly reducing the risk of injury to firefighters[4]. The fire brigade robot consists of three parts, namely the hardware part, the electronic part and the programming part. The design of the robot is based on MUROC principles. In the mechanical part, the robot is designed and the project inspired by CAD drawings using design software.Different sensors were used in the electronic part and finally starting point counters or a robot strategy switch were used in the programming part.Since robotics has spawned many new developments, it has become one of the most important areas in the field of firefighting robots[5]. Also called small autonomous fire brigade robot. It is designed for a small area. The size of this robot is very small and it completes its specific task quickly.The robot is made of galvanized steel or iron. Then the water pump is used to raise the water. A DC motor is used to convert electrical energy into mechanical energy. The adapter converter acts as an external power source for the robot. This robot can operate in small areas, reducing the risk to humans.

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The proposed robot consists of a waterproof coating. It performs accurate temperature change and also detects the presence of dangerous objects next to each other at the fire scene[6]. It has high detection intelligence and excellent structural reliability. These two are the main meanings of this robot. Use the technology of virtual prototypes.It's a small caterpillar robot. Detects the presence of toxic gases, smoke, dust and strong chemicals in the atmosphere. Next developed a fire brigade robot with Arduino. It is a development based on electricity. Use the XBEE module to control the robot remotely.The robotic vehicle is loaded with a water tank and works wirelessly[7]. The Arduino used is intended for the same desired operations. The remote control uses an RF transmitter with a wireless camera, and the robot is operated or controlled by a person using a remote control. Another sensation in this area is the fire brigade robot, which uses light barriers to detect obstacles in its path. Extinguish fires with flames detected by far-infrared sensors[8].In the software project, a swarm particle optimization algorithm is introduced to improve the sensitivity of the firefighting robot. The advantage of the robot lies in the simple control and simple construction. It uses intelligent technology with microelectronics and microprocessor technologies.firefighter robots with the ability to rotate 360 degrees in all directions. There is no need for a human to enter the chimney and this robot can be controlled from a greater distance with a remote control.Proposed System has main control block, the 89S52[9] microcontroller. The L293D, a motor driver, acts as a push-pull amplifier that gets its logic from a microcontroller. Provides high-speed power to the motor and pump. This robot has the ability to detect a fire and also put it out. It makes a person's life more comfortable and easier.It uses computers and nanotechnology.Intelligent Security Robotic Fire Detection System [10], developed using the adaptive sensor fusion method. They have developed an adaptive fusion method for fire detection and use a smoke sensor, a flame sensor and a temperature sensor for fire detection. Localization systems [11] and low-cost indoor positioning systems based on RSSI [12] have been developed.

III. INTELLIGENT FIRE-DETECTION AND EXTINGUISHER AUTOMATON

The Automan consists of arduino yun microcontroller and arduino uno microcontroller which acts as the heart of the robot for fetching the decisions and giving commands to the output devices. A flame sensor is used to detect the flame, temperature and humidity sensor to measure the temperature and humidity, ultrasonic sensor to scan for obstacle, servo motors for rotation, web cam for recording videos, H-bridge for driving dc motors, water pump and nozzle for extinguishing the fire. Ultrasonic sensor is placed along with the servo motor to scan the area to find the objects and obstacles. Web cam would capture the video and transmit to the arduino yun microcontroller to process the data. H-bridge is used for moving the robot in left, right, backward and forward direction. Nozzle is attached to the pump where small container with water is stored. The nozzle is affixed over servo motor so that it can spread water over the large area of fire. Also, this multi-purpose robot can be used in reconnaissance mission operations by replacing the surface mounted water hose assembly with necessary equipment or weapons. Automan can use any method to extinguish the candle that is not dangerous or destructive. It must be within 30 cm of the candle before attempting to extinguish the flame. A 30 cm circle will be placed around the candle for experimental purposes.

IV. SYSTEM IMPLEMENTATION

The figure1 shows the block diagram of the fire extinguishing Automan. Two microcontrollers arduino uno and arduino yun are used as the heart of the system.Ultrasonic sensor is placed over the servo motor to rotate in both directions. The reading from the ultrasonic sensor is given to the arduino uno which is connected to laptop via USB port.

Arduino uno controls the movement of the servo motor and the ultrasonic sensor. The reading of ultrasonic sensor is then mapped in the processing code which is running in the laptop to create display. The arduino yun is connected to the DHT 11(temperature and humidity sensor) sensor and webcam. Temperature and humidity reading from the DHT 11 sensor is processed in the processor before sending it to Google spreadsheet hosted on cloud. The temperature and humidity readings logged in the Google spreadsheet should be refreshed after every 5 seconds to receive the new data. The webcam and laptop is connected to arduino yun via USB A port. Laptop should run the Linux script which give commands to webcam to capture videos and send it to a particular web address. All the data from the sensors is send to cloud where it gets processed and the host computer can fetch all the sensors readings to take decision. The host computer can easily access the readings of the temperature sensor logged in the Google spreadsheet by opening the proper website. It can also access the video captured by the webcam by entering the same web address which has been used in the Linux script running on the laptop mounted over the chassis of the automan. To access the virtual display which is running on the screen of the laptop, the host computer needs to use software named as team viewer. The commands from the host computers send to automan wirelessly using console. The Console enables user to send the information from computer to Arduino Yun. Use SSH to create a secure connection between the Yun and the computer. If there is any modification in the sketch or algorithm, by using the console we can re-programme arduino yun wirelessly.

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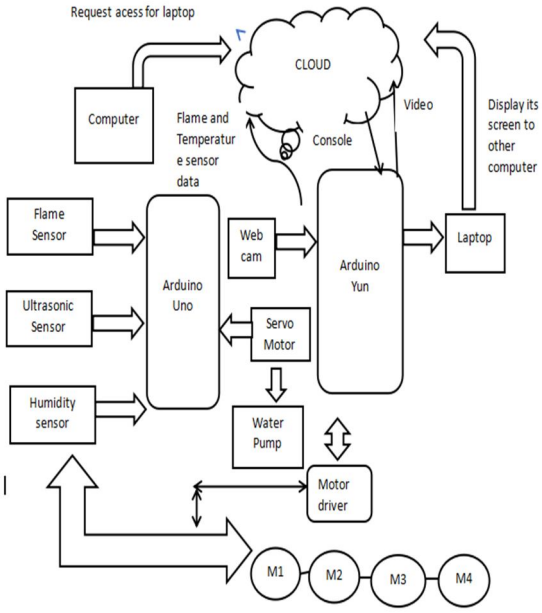


Fig. 1 Block Diagram of the system

V. WORKING OF AUTOMAN

Once the Automan is activated it sends a text message to the concerned user or authority.The text message is transmitted by the arduino yun with the help of Twilio application using Sendsmschoreo (https://temboo.com/ arduino/others/send-sms). After getting activated, ultrasonic sensor accurately detect the distance of the object from the robot. Servo motor starts rotating from 0 degree to 180 degree and vice-versa. Ultrasonic sensor can scan large area since it is mounted over the servo motor. The information from the ultrasonic sensor is moved to the arduino uno microcontroller. Processing software builds a radar like screen from the data received from arduino uno. This visual effect gives a clear idea about the objects or obstacles in front of the robot to the user. The distance information is mapped on y-axis of the radar and the obstacles are shown as circles. Since the arduino uno is connected to the laptop which is running processing software, the host PC cannot directly access this virtual radar. To solve this problem Team viewer software is used. Arduino yun USB-A port is connected to the webcam to capture videos. A Linux shell script is running on the arduino yun to controls the webcam. The camera captures the videos and sends it to arduino yun where it gets processed. After processing the video, arduino yun sends the video to the cloud from where the host PC can easily access the videos capture from webcam using web browser like Google chrome , Microsoft edge etc. If the video which is received by the host computer is lagging then it would be a major problem. After series of testing we found that the video which is being received by our host computer does not lag hence, we can get live stream of the video captured by the webcam.

The video captured from the webcam will help the user sitting on host PC to view the situation in the room caught in fire and can take decisions accordingly. The arduino yun receives the reading from the DHT 11 and flame sensor. It then maps the analog readings from the flame sensor to the digital reading of 0 and 1. 0 indicates that there is no flame detected by the flame sensor and 1 indicates that flame is detected by the flame sensor. The readings from DHT 11 sensor and the flame sensor are send to the Google spreadsheet hosted in the web server or cloud using Temboo. Arduino Yun uses the AppendRowChoreo (https://temboo.com/arduino/yun/update-google-spreadsheet) provided by Temboo to send data from the sensors to google spreadsheet. All the sensors data would be uploaded to the Google spreadsheet after every 5 seconds. The data logged in the spreadsheet can be easily accessed by the host PC using web browser. The data from the temperature and humidity sensor provides crucial information regarding the temperature and humidity of the area to the user controlling the robot. After receiving all the information regarding temperature, humidity, obstacles in front of robot, detection of flames and getting the detailed overview of the fire and the situation with the help of video captured by the webcam, the user sitting on the host computer can finally take decisions on the movement of the robot such that it doesn't collide with any obstacles and it extinguishes fire effectively.

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After analyzing the sensors data and the fire, the user on the host PC would give command to the robot regarding its movement and operations it needed to be performed .User can wirelessly control the movement of the robot from the host computer using Console Pixel. At the back of the robot there are 3 led which glows according to the direction in which robot is moving. For example if robot is turning right, then the right led would glow and vice-versa. The designed robot responds to the command send through the console window effectively without any delay. Following are the commands used for the movement of robot:

Table 1 Commands and action taken by the robot

Commands in console window	Action taken by the robot
W	Robot Moves Forward
B	Robot Moves Backward
D	Robot Moves Right
A	Robot Moves left
S	Robot Stops
P	Nozzle start rotating
N	Nozzle stop rotating
O	Pump connected to water container gets activated
I	Pump connected to water container gets deactivated

The robot is intelligent to overwrite any commands received from the user which possess threat to its existence or which can cause damage to the robot. For example if there is any obstacles detected by ultrasonic sensor in front of robot and the user commands the robot to move forward, then the robot would send warning to the host PC and would not move forward. After receiving inputs from the user via console the robot performs the required operations of extinguishing fire. When it is close to the flame, the flame sensor would show the reading of 1. With the help of video received from the webcam, the user can easily extinguish the fire by typing 'O' and 'P' in the console window. The command 'O' send by the user using console will start the pump connected to the water container mounted below the chassis of the robot and the water starts coming out of the nozzle. When command 'P' is received by the robot from the host pc via console, the servo motor over which nozzle is mounted starts rotating and water is sprinkled in the large region due to 180 degree movement of the servo motor. In this way the robot can navigate in the whole room to locate and extinguish the fire.

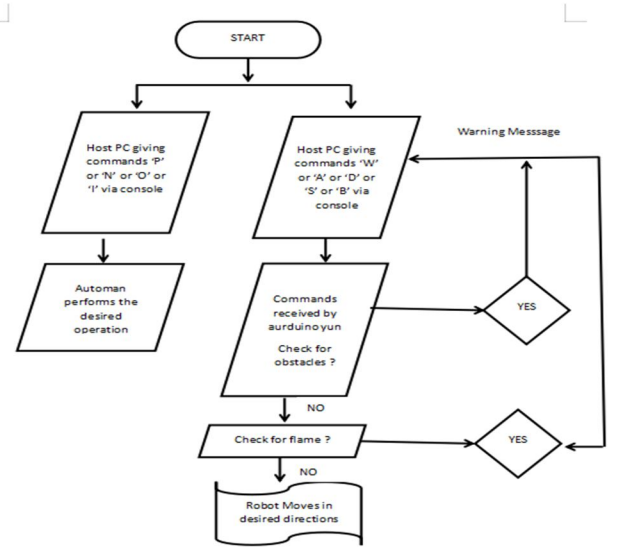


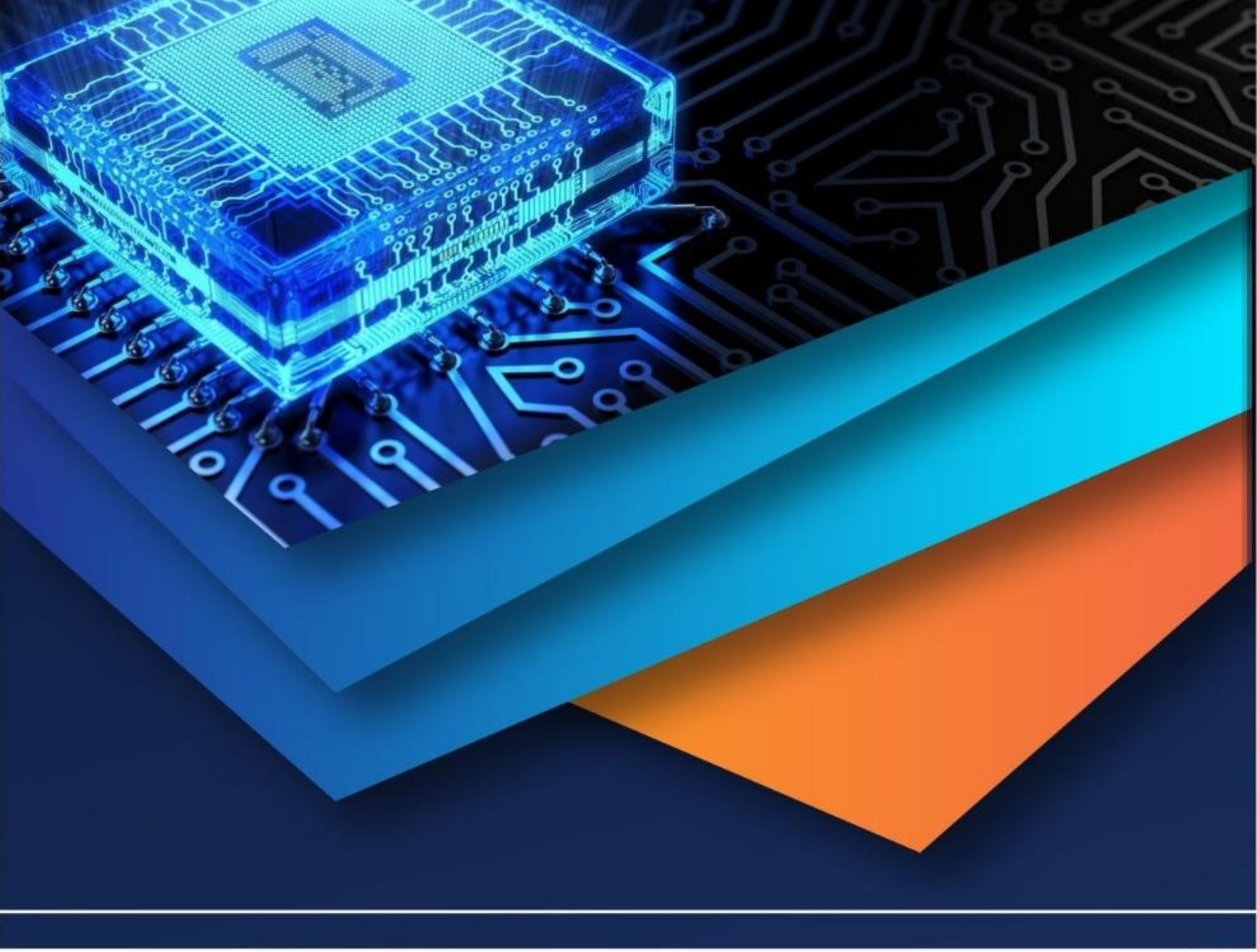
Figure 2. Operations performed by robot

VI. CONCLUSION

The need for a fire extinguisher device is important nowadays because, many house disasters due to fire arise when someone is either sleeping or not home. With the invention of this device, people and property can be saved at a much higher rate with relatively minimum damage. Intelligent automan is a prototype system that could autonomously detect and extinguish a fire. It navigate through a floor of a house in order to locate and extinguish a fire. The main purpose is to create an autonomous robot which could potentially put out fires to save people from a burning building without destroying the lives of others .The advantage of a fire fighting robot are it can go where humans fails, has an ability to reach location of fire rapidly besides having a compact body and rigid structure.The robot can perform its operation under adverse circumstances effectively. In future we want to integrate more sensors with the robot so that more readings can be analyzed by the user so that precise commands can be given to the robot to perform its operation effectively in lesser time and we want to combine laser range finder to get more exact and quickly environment mapping.

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