Semi-Automated Fire control Robot Using Android Application

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***Abstract*:** Human involvement in identifying and controlling hazardous situations like fire accidents is not always a safe approach. In all these situations, detection of fire at an early stage will avoid loss without harming the people who is intended for that task. Normally fire causes huge damage because of incapability of human being to control fire. If fire can be detected and extinguished at an early stage, one can avoid loss of life and property. Robotics has gained popularity due to the advancement of many technologies and man-machine interface provides effective results. In the current work, the fundamental idea would be to develop a special kind of menu driven control for the robot, in which the menu will probably be device driven. In device driven approach, the choice will be between identifying either the gestures or the application keys of relevant platform. Using an android application, one can restrict the input domain space in the robot. Once fire accident is informed, equipped robot will be instructed to extinguish fire. The robot will be mounted with sprinkler. Once the control signals were received, the sprinkler on the robot will perform the designated function.

Keywords: *SoC, Raspberry Pi, Temperature Sensor, Multi tasking.*

I. INTRODUCTION

Many hazardous accidents these days are due to the involvement of fire. This occurs due to the rapid oxidation of a material in the exothermic chemical process of combustion, releasing heat, light, and various reaction products. Now-a-days fire accidents cause lot of damage to life, property and environment. Fire accidents are occurring in many places like urban areas, Industries, Vehicles and Forests with or without human intervention. Fire accidents in urban areas make severe causalities with simultaneous damage of the personal property while industrial fire accidents cause huge explosions and releases harmful chemicals affecting the production process as well as surrounding environment. Forest fire, the reason for whose occurrence is not known causes biodiversity destruction along with ecological imbalances. Irrespective of their nature, all kinds of fire severely have significant impact on the human life either directly or indirectly.

In order to tackle these fire accidents, fire personnel employs a lot of techniques like fire extinguishers, fire engines, aerial sprinkling etc but they will take a lot of time to extinguish the fire because these methods will control the fire from surroundings and not from the epicentre of fire. Manually extinguishing the fire is not preferable always as the personnel involved may be affected in the process. Hence, it is not appropriate to deploy humans in these areas and alternate methods must be sought. Automated methods that can detect and extinguish fire, always play a crucial role in the current circumstances.

Due to the technological advancements in robotics, robots can be equipped with required apparatus such as sprinklers and sensors to control the fire effectively. Sensors are fundamentally meant for identifying the existence of fire as well as severity of the same. However, terrains are difficult to be perceived by robots because of the unevenness in the surface, man-machine synergy proves to be more efficient than the individual involvements by robots and humans.

In the current work, a semi automated fire extinguishing robot is developed that is intended to exhaust the fire in places where there is a possibility of more damage (or) loss. This is made feasible by partial human involvement by changing the direction of the robot based on the requirement. Section II briefly reviews existing approaches while in section III, the proposed system is described. A brief discussion on the result obtained is presented in section IV.

II. EXISTING WORK

Much work has been carried out on this burning topic by incorporating the advancements in technology. Dhiraj singh patel et al.[2013] formed a mobile operated spy robot using DTMF communication. The Dual Tone Multi Frequency system consists of 12 DTMF signals which are made up of 2 tones, one each from low and high groups. The robot consists of a DTMF decoder which gives 4-bit data at output of decoder, Motor drivers, CCD camera which operates on 12V battery. The data from camera can be viewed in PC with a tuner card. The robot is moved with the help of commands from a Mobile phone through a Microcontroller.

Dr.Wael R Abdulmajeed et al.[2013] devised a fire fighting robot that is capable of operating in automatic and manual modes. The robot has a special 3-axis sprinkler which can operate in 2 rotational (clockwise and anticlockwise), 1 Cartesian direction. The robot has camera which was modified as Thermal Image Capturing (TIC) camera. The images are processed by using MATLAB and a Graphical User Interface is created so that the robot can be operated effectively. The Robot uses 4 Wind shield DC motors instead of two motors for flexible movement. The robot proves to be effective in automated mode than in manual mode due to the use of image processing.

V. Vimala Bharathi et al.[2013] has worked towards developing a device that can control and stop the fire. Four thermistors are incorporated for the purpose of continuously observing the changes in temperature due to the occurrence of mishap. The flame can be detected at the beginning by taking the support from the ultra violet sensor. An SMS will be sent to the control room or the person liable to the location. Various sensors collect information for further action with the help of key hardware elements through microcontroller. Microcontroller controls all the parts of the robot by the use of programming. Water was used as a medium for extinguishing fire through the sprinkler.

Ankita patel et al.[2014] constructed a multipurpose spy robot which is controlled by touch screen and Zigbee communication which works at 2.4Ghz frequency. The transmitter comprises of PIC Microcontroller, Zigbee transmitter, Tuner card to receive camera signals. Touch screen sensor is a panel of two metallic, electrically conductive layers which acts as pair of voltage dividers when force is applied on outer surface. These electrical signals are processed by Microcontroller as inputs. The receiver consists of PIC Microcontroller, Zigbee receiver, Motor drivers, Camera for live transmission, Metal detector and Gas detector thus forming a comprehensive spy robot.

Jan Nadvornik and pavel smutny [2014] designed and implemented a mobile application in android operating system using JAVA programming language for controlling a robot through user-interface display (or) voice. Bluetooth is used as communication between android device and robot. The application is developed in android SDK (software development kit) which consists of a comprehensive set of development tools. The robot is equipped with a ultra sonic sensor to find the distance travelled by robot. When Android device is connected to internet, Voice commands can be used to control the robot.

Madhavi pednekar et al., [2015] constructed an intelligent fire fighting robot operated by voice instructions. The robot is divided into 3 components visual basics, transmitter and receiver section using XBEE communication. The transmitter module consists of XBEE transmitter which sends voice commands to the robot. The robot consists of a Microcontroller which receives the instructions from transmitter, IR sensors, temperature sensor, pump motor, motor drivers, wheels which operates according to previously defined instructions in visual basics software which is used for speech to text conversion.

Rahul kumar singh et al.[2015] developed a gesture controlled by robot which is controlled by Bluetooth communication. It's transmitter is implemented in 2 approaches. The first approach uses a Smartphone's built-in Accelerometer and Bluetooth connection on which an application named "BLUEBOT" is developed to control the robot. The second approach uses external Accelerometer and gyroscope to capture the desired gestures of the user which are analyzed using signal processing techniques and in this approach the robot can be equipped with grippers to hold small objects. The robot consists of Bluetooth receiver, microcontroller, motors and wheels.

Prof.S.Kini et al.[2016] created a fire fighting robot which is controlled by android application using wireless communication(Wi-Fi). The Robot consists of Microcontroller which receives commands from android device using wireless communication. It consists of a light sensor to detect the light from fire and temperature sensor is used to detect the temperature. The robot consists of tank for storage of extinguisher (water). Two motors are used for movement of robot and a motor is used as arm of the tank to exhaust the fire.

Renuka chuimurkar et al.[2016] has developed a smart security monitoring system using Raspberry Pi which is accredit card sized computer. The updates can be monitored from a smart phone with an internet connection. The system consists of Raspberry Pi connected with PIR sensor to detect movement of human, camera with IR filter removed to facilitate night vision mode. The system uses Raspbian operating system and with the help of 3G dongle the footage of camera can be viewed in the smart phone with the help of VNC server software.

III. PROPOSED SYSTEM

The current work aimed at extinguishing the fire with minimum damage to property and life is implemented on Raspberry Pi based system. The reason for going to this system is improved capability of multi tasking as well as more amount of storage capacity. The block diagram of proposed system is shown in Figure 1. Along with SoC (Raspberry Pi), the major components involved are the camera and temperature sensor.

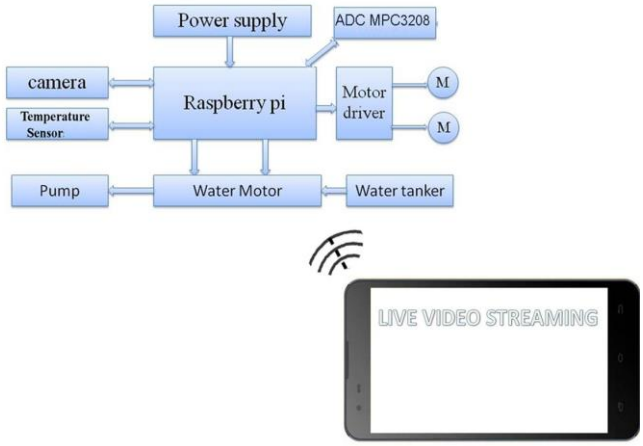


Fig.1.Semiautomated system for fire control.

A. Features of Raspberry Pi

Raspberry Pi board is a miniaturized system meant for performing numerous tasks. Capable of performing multi tasking, it can replace the functionality of a personal computer. This further reduced the area occupied. A designed version of the operating system called Raspbian OS is used for it's working and used as a functioning video

game emulator or media streamer with a bit of effort. Various features of the board are as mentioned below.

Broadcom2837 is a SoC that is constructed with Quad-core ARM A53 (ARMV8) Architecture with 1.2Ghz processor and 1GB Ram which forms the core of Raspberry pi with 2,4-lane CSI and DSI displays,TV,DAC,USB2,GPIO pins.

BCM43143 is a IEEE b/g 802.11 WLAN with Secure Digital Input Output (SDIO), USB and MIMO System on Chip (SoC) with 2.4Ghz power amplifier. It supports internal receiver diversity by providing two antennas. Further it is having an 8 General purpose IO ports with multiplexed JTAG interface assembled in 56-pin Quad Full No leads package. The data rate offered stands at 150 Mbps at 2.4 GHz frequency.

High Definition Multimedia Interface (HDMI) is an Audio/Video pin Interface for transmitting uncompressed video data and compressed digital/audio data from a HDMI supported device. It follows Transition-Minimized Differential Signaling (TDMS) protocols with a data rate up to 48Gbs in HDMI 2.1 version. HDMI connectors are available in A/B/C/D/E types with type-B supporting 29-pin package and remaining with 19-pin package.

The most popularly used interface MIPI CSI-2 is a simple, high-speed protocol developed by MIPI Alliance, mainly used for transmission of video and image between cameras and host devices. This Interface can be implemented on either of two physical layers, MIPI C-PHY (or) MIPI D-PHY. It is enhanced with color depth for that improves High definition range(HDR) and signal to noise ratio(SNR) for advanced vision ,Latency Reduction and Transport Efficiency (LRTE) provides increased image sensor aggregation provides real-time perception, processing and decision-making; and optimizes transport to reduce the number of wires, toggle rate and power consumption.

B. Other major components

In addition to the above described major components in the board, Temperature sensor, USB camera along with Motor driver are incorporated to perform the desired task as mentioned below.

AH5020B23-S1-2Z1 is an USB Video Class (UVC) compliant camera module with video feature, designed for portable notebook, PC image applications. It is made up of the following components, CMOS sensor, lens, holder, backend, PCB, image processing circuit and connector, to come out a digital video device. It Support still image capture and Video Streaming with a video resolution of 5.0M pixel which provides Black Clamping-Gamma Correction ,Gain and offset adjustment in RGB space , Window image statistics collection for Auto Exposure and Auto White Balance with an input supply of 3.3~5V.

The LM35 is a precision integrated-circuit temperature device with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an edge over linear temperature sensors, which are calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 operating temperature range is −55°C to +150°C. The operating voltage is from 4 to 30V which is suitable for remote applications.

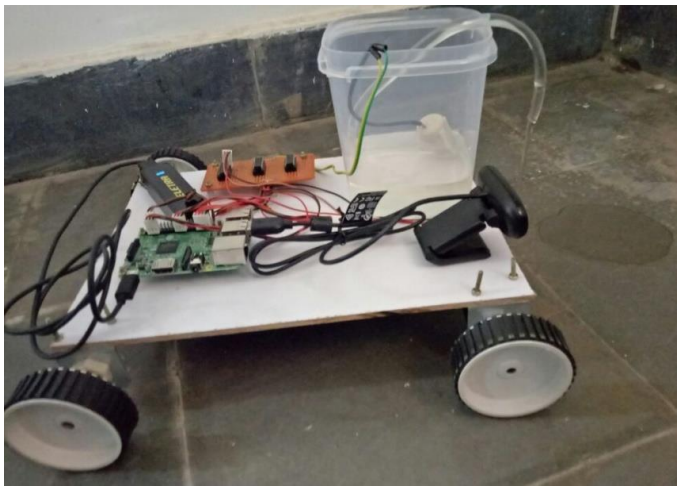
IC L293D works on the principle of Dual H-Bridge oscillator circuit so that we can interface two DC motors with single IC which can be controlled effectively in Clockwise and Anti-Clockwise directions. The IC can drive motors up-to a voltage of 36V.

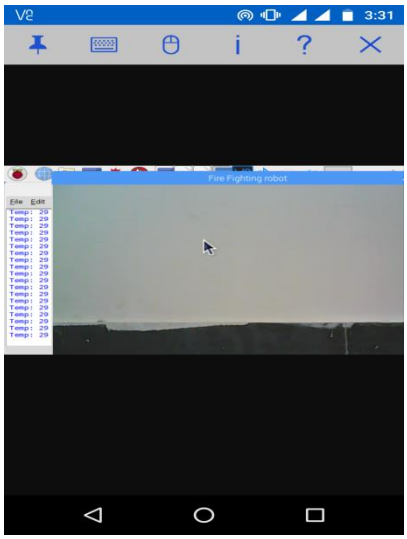
MCP3208 is a 12-bit Analog to Digital Converter which is used to interface the temperature sensor (LM35) to display the temperature in the Android Application. It is used in sensor interface, process control, data acquisition applications. It's operating voltage is 2.7~5.5V and temperature range is -40°C to +85°C.

C. Working of the proposed system

The fundamental step in the proposed work is to establish a connection between the automated system and the control device which can rather be a mobile or a PC. This is indeed required as there exists a data or information transfer between the before mentioned. All the relevant hard ware as well as the interfacing required is incorporated onto the system on chip. Along with these minimum Hardware camera as well as temperature sensors are also integrated on to the system. The way these devices are interfaced is not unique but based on the nature of the devices connected.

Upon getting information about the occurrence of fire, the control device departs the fire controlling robot to the spot after getting proper authentication regarding the establishment of connection. Once this happens, the temperature information around the affected area is conveyed to the control device. This is further supported by live streaming the respective location by using camera. The movement of the robot is controlled by selecting relevant key meant for specific control and direction by using predefined program. The implemented system is presented in figure 2(a). When activated, the measured temperature by LM 35 is shown in figure 2(b).





2 (a) The constructional setup of proposed system
(b) Live visual and measured temperature

IV. RESULTS & CONCLUSIONS

In the current work an effort is made to develop an autonomous system for fire controlling using VNC viewer. Even though it is a prototype model, it is capable of extinguishing the fire up to a specific distance satisfactorily. Further temperature can also be sensed, measured and transmitted to the control station, which is the inherent enhancement of our work when compared to existing works. The significance of this is that robot can be moved to that direction and stop the fire preventing the damage to valuable assets. However, this is possible up to certain temperature only. Beyond this human intervention can be made to take the relevant action. The presence of camera gives the information regarding the whereabouts of items with in the fire area. The work can be extended by incorporating a GSM module on the system to enable the transmission of required data over longer distances. Usage of night vision camera facilitates the visibility during power failures.

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