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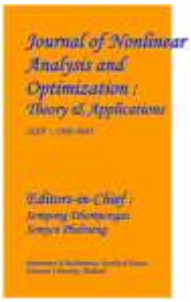

DOMESTIC FIRE FIGHTING ROBOT

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Abstract — The firefighting robots could revolutionize emergency responses in dangerous situations where fires threaten lives. These robots excel at reducing interference and risks, thus protecting human life. The project combines advanced technology with strategic design to create a sophisticated firefighting robot using NodeMcu and Arduino microcontrollers, augmented by flame sensors to identify fires,GSM module for better communication.

This robot outperform human firefighters by navigatingcomplex environments more efficiently and accurately. Byquickly detecting fires early on, they help prevent disasters from escalating. This shift to robotic assistance marks a move away from relying solely on human resources, signaling a saferfuture.

Assigning hazardous tasks to robots reduces immediaterisks to human responders and strengthens defenses against potential tragedies. Fire security becomes a moral obligation beyond mere technological advancement, emphasizing the importance of protecting human life. Initiatives like these reinforce a commitment to safety, envisioning a future where robots help overcome challenges posed by fires.

Keywords—
compact size; flame sensor; mobile control; risk reduction; NodeMcu; Arduino microcontroller; GSM module**.**

I. INTRODUCTION

Over the last few years, amongst those studying firefighting has seen a momentous evolution paired with advent offirefighting robots on wheels. These innovative machines represent a paradigm shift in firefighting strategies, offeringenhanced capabilities and efficiency in combating fires and mitigating risks. This journal explores the diverse landscape of firefighting robots on wheels, shedding light on their various types, functionalities, and contributions to modern firefighting practices.

From autonomous robots capable of navigating hazardous environments to remote-controlled units that extend the reach offirefighting personnel, the versatility of these machines knows nobounds. The project is equipped with sensors, algorithms, micro controllers and firefighting equipment, they stand poised to revolutionize emergency response operations by augmenting the

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capabilities of human firefighters and reducing their exposure todanger.

Moreover, the development of modular and multi-purpose firefighting robots underscores the adaptability and scalability of this technology, enabling tailored solutions for different firefighting scenarios. Whether deployed in urban settings, industrial facilities, or natural disaster zones, these robots exemplify the fusion ofinnovation and pragmatism in safeguarding lives and property.

As the threat of fires continues to loom large in our communities, the role of firefighting robots on wheels becomes increasingly indispensable. This journal serves as a comprehensive exploration of their potential, challenges, and future prospects, presenting valuable observations on the continuous solution of firefighting methods in the modern era.

This paper introduces a novel firefighting robot with aprimary function of manual control, capable of alerting users via SMS when fire is detected. While various firefightingvehicles exist for home, industrial, and forest fire scenarios, ourrobot is uniquely designed for remote operation. By employing such technology, fire detection and rescue operations can be executed with enhanced safety, minimizing the need for firefighters to enter hazardous environments. Furthermore, thecompact size and full control capabilities of the robot enable itsdeployment in confined spaces with challenging conditions.

Autonomous, Remote Controlled, Multi Purpose, SmallScale and Modular Fire Fighting Robot are five currently available as fire fighter robots also. This firefighting robot, controlled remotely, has a range of up to 30 meters. Nozzzle used in this project can deliver up to 15 LPM of water (4 GPM),this nozzle is also suitable foam too. This robot measure 38 cmin length, 20 cm in width, and 15 cm in height, wheels diameter10 cm and width 4.5 cm. 4 DC Motors are used in this robot with 18000 rpm and torque 0.00828 NM. Mainly this robot is divided into two main parts I. Room Kit -Two Flames, Arduino UNO, GSM 900A, SIM card, 12v Adaptor . II. Robot Kit – NodeMCU, Motor drive, 18000 rpm Motors, Two channel Relay, Soleniod Valve, 12v Batteries. This robot is engineered for deployment in high-risk environments, including housefires, office fires, small warehouse fires, and small-scale industrial settings, among others.

A Domestic firefighting vehicle operated by a mobile control. It suppresses fires autonomously, utilizing high-pressure water sprays capable of reaching distances of up to 20 meters, eliminating the need for direct intervention by firefighters.. Robot carry water pipe along with it. The fireproof materials incorporated into the firefighting robot enable it to endure temperatures as high as 200ºC and withstand thermal radiation levels of 18 kW/m for up to 15 minutes.

In this investigation, we have designed and developed a diminutive firefighter robot, succinctly referred to as a Rescue Robot. Moreover, this robot enhances productivity, safety, efficiency, and task quality. Its compact design sets it apart from other models like Thermite and FireRob, making it capable of accessing confined spaces and narrow entrance with ease.

II. METHODOLOGICAL APPROACH

The methodology comprises three sections. Initially, the project delves into the mechanical schematics, proceeds with a comprehensive hardware description, and culminates with the programming design. Subsequently, these components were seamlessly integrated, leading to subsequent experimentation aimed at determining the most effective extinguishing distance for the Domestic Fire Fighting Robot.

A. Structural Aspects of Mechanical Design

We employed traditional drawing methods to design the robot's main structure, which features two wheels at the rear andtwo at the front to achieve the desired movement and speed. These wheels provide stability and allow for 360° rotation. The metal chassis incorporates a rear door for easy access to hardwarecomponents.

Flame sensors were strategically positioned within the room to detect fires, while a GSM module interfaces with a smartphone. Refer to Figures 1 and 2 for the detailed structure of the fire extinguishing robot.

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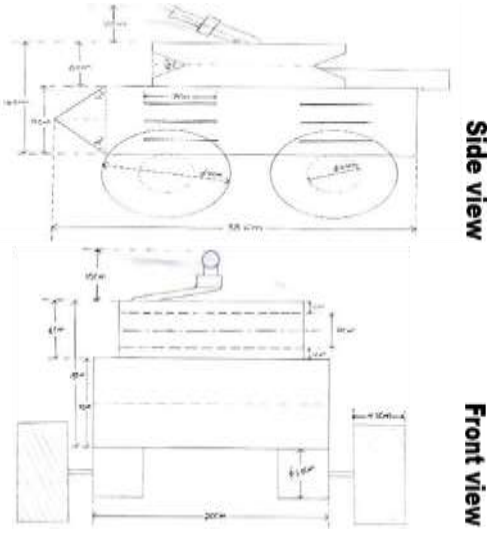

Fig. 1. Dimensioned Side & Front Prespectives.

Fig. 2. Domestic Fire fighting Robot .

B. Hardware Integration

the electronic component plays a crucial role in the advancement of Domestic Fire Fighting Robots. It encompasses various sensors, microcontrollers, DC motors with wheels, a GSM module, and mobile control functionality. Arduino Uno serves as the microcontroller integrated into the Room kit, while NodeMCU functions as the microcontroller for the Robot kit; both are interfaced with other system components. A L298N Motor Driver facilitates the movement of the gear motor, while Mobile Supervision provides system feedback. Water flow and fire extinguisher mechanisms are positioned near water supplies or pipes and are activated by the operator. Additionally, the operatorcan remotely control the robot's movements using a smartphone.

a. Room Kit :-

1) Flame sensor: In this project there are 2 flame senorsare used. For an example of Room 1 & Room 2 . In the majority of firefighting robots, fire sensors play a crucial role in investigations, aiding in the detection and localization of fire sources within rooms. These sensors are designed to identify flames across a spectrum ranging from NIR 700 nm to FIR 1 mm,with a detection angle of 60 degrees and a distance range spanningfrom approximately 2 cm to 100 cm, depending on flame intensity. Equipped with three signal pins—Digital Output (DO), Ground (GND), and Power supply (VCC)—the flame sensor provides vitalinformation about the presence or absence of flames through the DO

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pin, while the GND pin ensures proper circuit connection by grounding, and the VCC pin facilitates the provision of positive supply voltage, typically ranging from 3.3V to 5V

2) Arduino UNO & GSM module: The Arduino UNO, a microcontroller board built around the ATmega328P chip, provides a versatile platform with 14 digital input/output pins, including 6 PWM outputs, and 6 analog inputs. Its hardware includes a 16 MHz ceramic resonator for precise timing, a USB interface for connectivity, a power jack for external power supply, an ICSP header for programming, and a reset button for device initialization. Integral to its functionality, the GSMmodule facilitates vital tasks, such as establishing and maintaining communication links between devices and networks, as well as handling data encryption and decryption for enhanced security. This module enables remotecommunication for status updates and control. Both the Arduino and GSM module are powered by a 12V adapter, while the 5V pin and ground (GND) in the Arduino connect tothe Vcc and GND in the 2 flame sensors, respectively. Flame sensors 1 and 2 utilize digital outputs connected to Arduino digital I/O pins 5 and 6. Moreover, Arduino pin 3 interfaces with RxD, and pin 2 connects to TxD in the GSM module, withthe GSM ground linked to the Arduino ground. Finally, a SIMcard is necessary for the GSM module to deliver SMS alerts tothe operator's mobile device.

3) Adaptor: 12v Adaptor Is used for power supply to the Room Kit.

b. Robot Kit :-

1) DC motor equipped with a wheel: A DC geared motor, selected for its compatibility with a 4 WD car chassis, is a key component of this project. Operating at 12V DC with an optimal current of 73.2 mA, it efficiently propels the robot toward the fire.

2) Motor Drive L298N: The L298N Module is specifically engineered for DC and Stepper Motors, featuring an integrated L298 motor driver and a 78M05 5V regulator. With capacity for up to 4 DC motors, it seamlessly interfaces with NodeMCU, utilizing shared power and input pins.

3) Two channel Relay: A two-channel relay interface board enables control of high-current appliances and equipment. It features two fixed contacts: one normally closed and one normally open. The normally open contact remains inactive until the coil is energized, while the normally closed contact stays active. It is utilized to switch the solenoid valve on and off, with connections for GND, Vcc, and Input to the relay.

4) Soleniod Valve: Activated by the relay to release the fire-extinguishing substance.

5) Battery: A 12V battery with a capacity of 1.3Ah(ampere-hour) is a rechargeable battery.

6) Moblie Control: In this project the robot is controlled through wireless, the mobile hotspot is connected to WiFi in NodeMCU. After connected in hotspot a IP address display ,copy that IP address and paste it in chorme page in offline. Then operating interface is displayed. The interface is shown in Fig. 3.

Fig.3 . Robot controlling Interface

In this Robot controlling interface five buttons. From Fig.3 FRONT – Robo moves forward, BACK

– Robo moves backward, LEFT – Left side wheels rotates backward and Rigthside wheels rotates forward then robo rotates 360° left side, RIGHT - Rigth side wheels rotates backward and left side wheelsrotates forward then robo rotates 360° right side.

C. Software Implementation

The NodeMCU meticulously monitors and controls all sensor data, as depicted in Fig. 4, where the program ensures declaration of essential input and output pins. Fig. 5 portrays the comprehensive flowchart outlining the operation of the Domestic Fire Fighting Robot employing GSM 900L, NodeMCU, Arduino, Motor Drive, and flame sensor. These essential codes will dictate the programmedmovements of the Domestic Fire Fighting Robot.

```
// Assign output variables to GPIO pins
const int output12 = D0;
const int output13 = D1;
const int output14 = D2;
const int output15 = D3;
const int output16 = D5;

WiFiServer server(80);

String header;
String output12State = "OPEN";
String output13State = "OPEN";
String output14State = "off";
String output15State = "off";
String output16State = "off";
String output17State = "off";
String output18State = "off";
String output19State = "off";
String output20State = "off";
```

```
void setup() {
Serial.begin(115200);
// Initialize the output variables as outputs
pinMode(output12, OUTPUT);
pinMode(output13, OUTPUT);
pinMode(output14, OUTPUT);
pinMode(output15, OUTPUT);
pinMode(output16, OUTPUT);

// Set outputs to high because we are using
active low type relay module
digitalWrite(output12, HIGH);
digitalWrite(output13, HIGH);
digitalWrite(output14, HIGH);
digitalWrite(output15, HIGH);
digitalWrite(output16, HIGH);
```

Fig.4 . Input and Output pin in NodeMCU

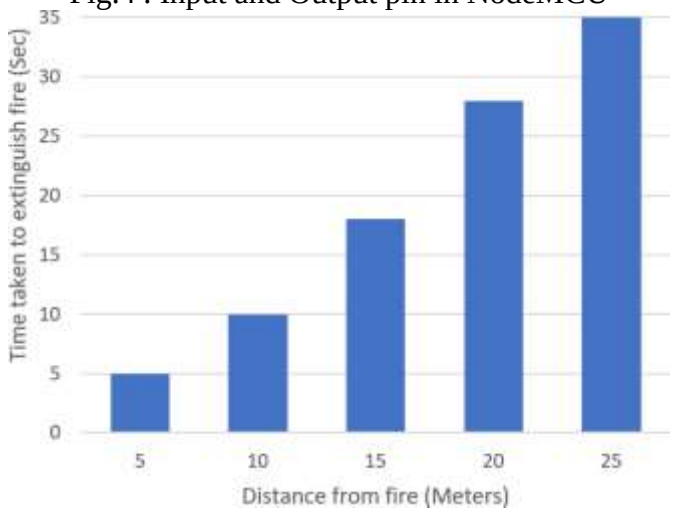

Fig.5 .Flow Diagram of Domestic Firefighting Robot

III. RESULT

A Domestic Firefighting robot has been designed for identifying fires in close proximity and send SMS alerts to the user's mobile device using GSM 900A. Both the flame sensor and GSM 900A are integrated with the Arduino Uno in the Room Kit. When theflame sensor detects a fire, the operator can remotely extinguishit using mobile control from a distance.

A. The proximity of the domestic firefighting robot to the fire source directly influences the extinguishing time.

The Domestic Fire Fighting Robot effectively detects fires andextinguishes them under operator control. In Fig. 8, we observe that the duration required for fire extinguishment fluctuates according to the proximity of the robot to the fire's origin.

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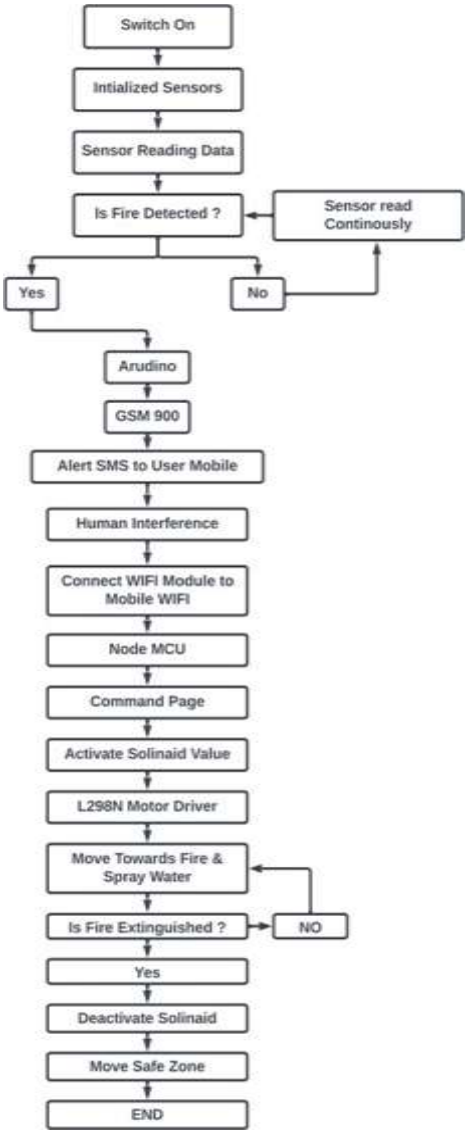

Fig. 6. The effectiveness of fire suppression by a domestic firefighting robot varies depending on its distance from the fire.

Analysis of the experimental findings reveals a direct correlation: As the gap widens between Domestic Fire Fighting Robot and the flames increases, the duration required to extinguish the flame also escalates. Consequently, it becomes imperative for future strategies to ascertain the ideal proximity between the Domestic Fire-fighting robot and their response to flame. This determination is vital to strike a balance, ensuring that the robot remains sufficiently distanced from the fire to mitigate risks, yet close enough to swiftly extinguish the flames.

B. Ability of Domestic Fire Fighting Robot to alert SMS to operator Mobile Number

The Domestic Fire Fighting Robot features a GSM 900A Module to alert the user on a predefined mobile number. The SMS alert was sent after fire detected by the flame sensor in the Room Kit. The alert SMS is “Fire detected at room number 01 or 02…! Take action immediately”. Fig.7 shows that real time SMS alert to user defined mobile number.

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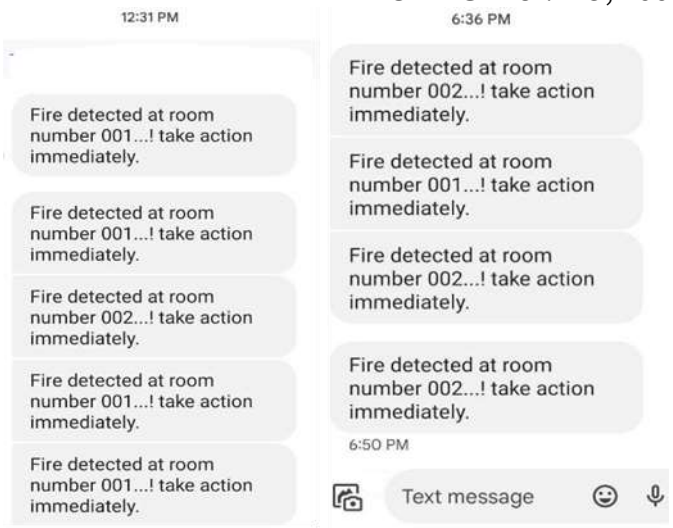

Fig. 7. SMS alert from GSM 900A to operator mobile number after fire detected

Fig. 7 indicates that after fire detected GSM 900A sent real time SMS alert to user define mobile number .The SMS alert isdepends upon the signals of the SIM card.

IV. DISCUSSION

Here, we delve into refining the control sequence of our fire-fighting robot, a central aspect of our project. The following outcomes demonstrate the successful achievement of this project:

1) Integration of the Flame Sensor

a) If no fire is detected by the sensor, the SMS alert will not be sent.

b) This sensor is connecting with Arduino UNO.

c) After fire detected by flame sensors, Arduino UNOsend command to GSM 900A.

d) GSM 900A send SMS alert to user defined Mobilenumber.

2) DC Powered Motor

a) Connect this motor to the driver motor.

b) Motor moves when operator click buttons in Mobile interference, it moves Front, Back and 360° from both sides.

3) Nozzle

a) Nozzzle is delivered 15 LPM of water (4GPM).

b) Nozzle is suitable for both water and foamtoo.

V. CONCLUSION

In its entirety, the development of a Domestic Fire-Fighting Robot enables remote control via the operator's mobilenumber and sends SMS alerts to user-defined mobile numbers upon fire detection by the flame sensor. This innovation boasts advantageous features, including real-time SMS alerts, a compact size, and a water spray range of up to 25 meters. Operators can extinguish fires remotely using mobile control, even from considerable distances. Based on experimental results, the robot effectively and swiftly tackles fires. In summary, the project titled 'Domestic Fire Fighting Robot' has successfully accomplished its aims and objectives.

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