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SAFE-SERVE: A Multipurpose robot for fire safety and autonomous restaurant service

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Abstract: This project presents a cost-effective autonomous robot equipped for both firefighting and restaurant service, utilizing AI, ML, and camera integration. The robot's firefighting function detects and extinguishes fire through advanced sensors and a DC pump. In restaurant mode, it autonomously navigates, avoids obstacles, recognizes tables, and delivers orders, with data stored in a cloud database. AI and ML algorithms allow continuous learning, improving both fire response and service efficiency. This versatile robot enhances safety and operational efficiency by reducing human intervention across critical applications.

Keywords: AI, Machine Learning, autonomous path finding, obstacle avoidance, robotics, camera integration.

I.INTRODUCTION

SAFE-SERVE is a multipurpose robot designed to function both as a fully autonomous restaurant waiter and a fire extinguisher, aiming to minimize human risk and effort. The robot integrates artificial intelligence (AI) and machine learning (ML) algorithms with advanced camera recognition to support sophisticated navigation, decision-making, and task management. In firefighting mode, SAFE-SERVE autonomously detects fires using temperature sensors and extinguishes them with a DC pump, offering a safe alternative to human intervention in hazardous environments. In restaurant mode, the robot navigates autonomously, avoiding obstacles, recognizing tables, and efficiently serving customers by managing tasks such as order placement and billing. The system's machine learning capabilities allow it to continuously improve by learning from real-time data, refining its operations, and enhancing safety and precision over time. This innovation demonstrates how AI-driven robotics can revolutionize service industries and emergency response, contributing to safer, more efficient, and responsive environments across diverse applications. Additionally, SAFE-SERVE supports environmental and social goals by providing sustainable alternatives to traditional firefighting and service methods. Its firefighting capabilities reduce dependency on human resources in dangerous scenarios, while in the service sector, it enhances operational efficiency, ensuring prompt and accurate service delivery. By leveraging cutting-edge technology, SAFE-SERVE paves the way for intelligent automation, promoting sustainability and improved safety standards in critical and commercial domains.

II.METHODOLOGY

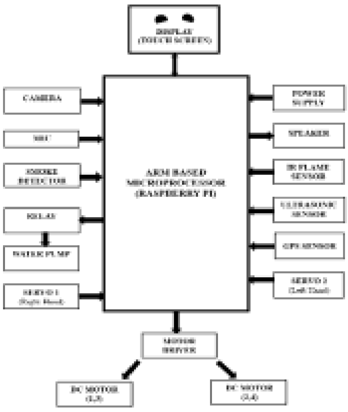

Fig 2.1 Block Diagram of Safe-Serve Robot

- **System-Design:**

SAFE-SERVE is designed using a modular approach, integrating hardware and software components to ensure flexibility

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and efficiency. The hardware includes sensors (temperature, infrared, ultrasonic), actuators (DC pumps, motors), and a microcontroller, while the software utilizes for navigation, object recognition, and decision-making.

- **Hardware-Implementation:**

Components such as sensors and actuators are integrated onto a mobile platform. The firefighting system consists of temperature sensors and a DC pump, while the restaurant mode employs obstacle detection and table recognition systems.

- **Software-Development:**

AI-based computer vision and ML algorithms are implemented for object detection, predefined Autonomous navigation, and real-time task management. Path planning algorithms are used for efficient movement.

- **Testing and Evaluation:**

The robot is tested in both firefighting and restaurant scenarios to assess accuracy, efficiency, and response time.
Iterative improvements are made based on test results.

- **Deployment:**

SAFE-SERVE is deployed in simulated environments to validate its performance, followed by real-world testing to ensure reliability and effectiveness.

III.IMPLEMENTATION

The implementation of both the Autonomous Restaurant Server and the Autonomous Fire Extinguisher involves a combination of robotics, artificial intelligence, and sensor integration.

Autonomous Restaurant Server: This robot is equipped with navigation sensors such as ultrasonic sensors for seamless movement within a restaurant. It uses voice recognition and a touchscreen interface for customer interaction, enabling an intuitive ordering process. The system can engage customers through interactive entertainment while waiting for their food and autonomously collect and deliver meals from the kitchen. Safety and ethical considerations, such as alcohol service restrictions, are implemented for responsible functionality.

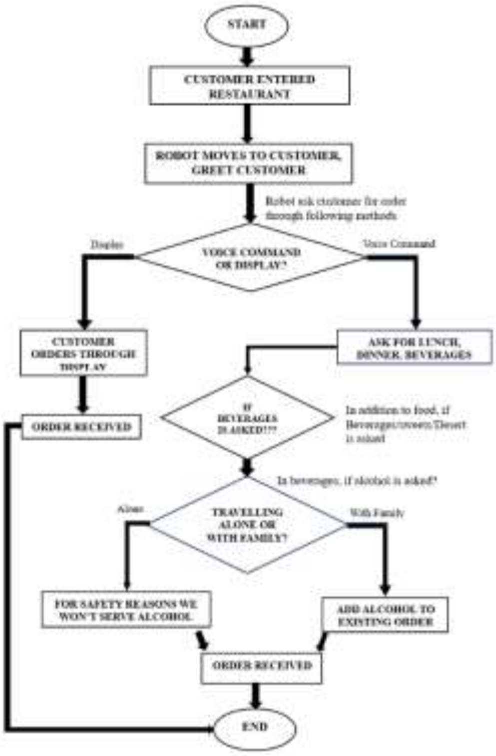

Figure 3.1 working of safe-serve robot in restaurant mode

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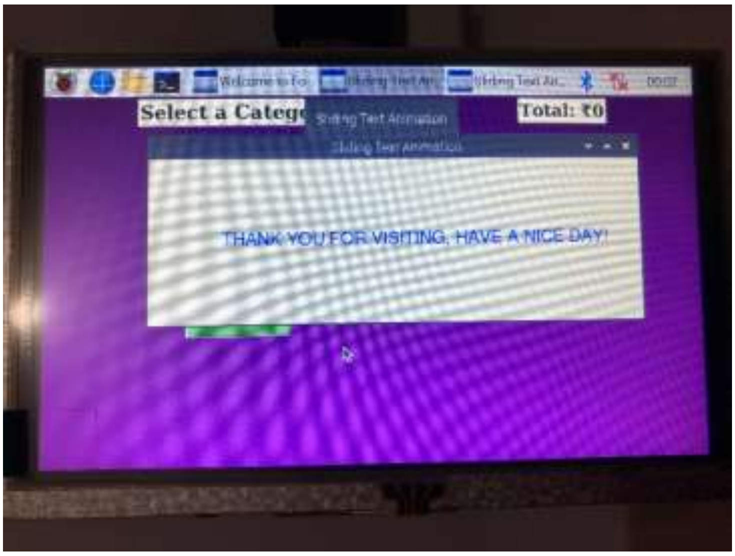
Fig 3.2 Flowchart for working of Robot in restaurant mode

Fig 3.3 Smart Menu for ordering food

Fig 3.4 Payment Page of the smart Menu

fig 3.5 Payment through UPI (qr code)



THANK YOU FOR VISITING, HAVE A NICE DAY!

Figure 3.6 After successful payment, Thank you Page

```
(my_virtualenv) safeserve@raspberrypi:~ $ python3 project.py
pygame 2.1.2 (SDL 2.26.5, Python 3.11.2)
Hello from the pygame community. https://www.pygame.org/contribute.html
Listening... Speak now.
```

Fig 3.7 Initialising the Conversation Between robot and customer

```
Listening.......................
You said: Order Paneer butter masala
safeserve:Thank for ordering, Your order will be prepared shortly
safeserve:would you like to play Game
You said: Yes
safeserve@raspberrypi:~ $
```

Fig 3.8 Interaction Between Robot and Customer

Autonomous Fire Extinguisher: Designed for fire detection and suppression, this robot is equipped with flame sensors, cameras, and gas sensors to detect hazardous conditions. It autonomously navigates towards the fire using predefined path algorithms and obstacle avoidance techniques. Upon detecting fire, it activates a suppression mechanism, such as a water to extinguish fire, and to handle the situation effectively. The system ensures minimal human intervention while improving safety in hazardous environments. Each function uses Raspberry Pi, integrating motor drivers for movement and control. Artificial intelligence is leveraged for decision-making processes, optimizing performance for real-world applications. These autonomous systems showcase advancements in robotics, enhancing automation in restaurant services and fire safety.

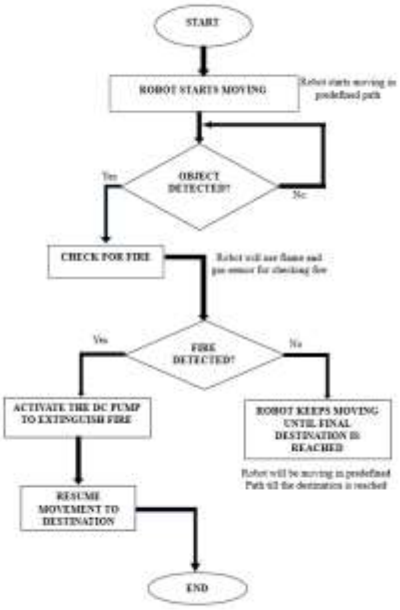


Fig 3.9 Flowchart for working of Fire Extinguisher Robot

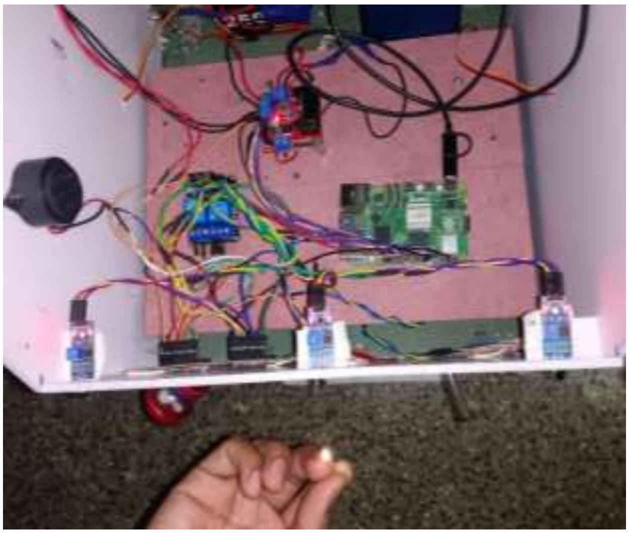
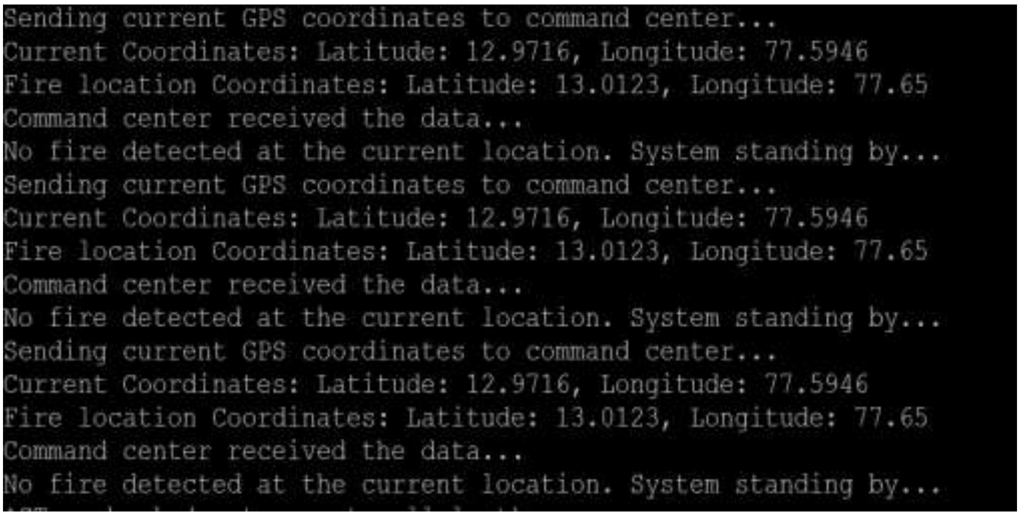
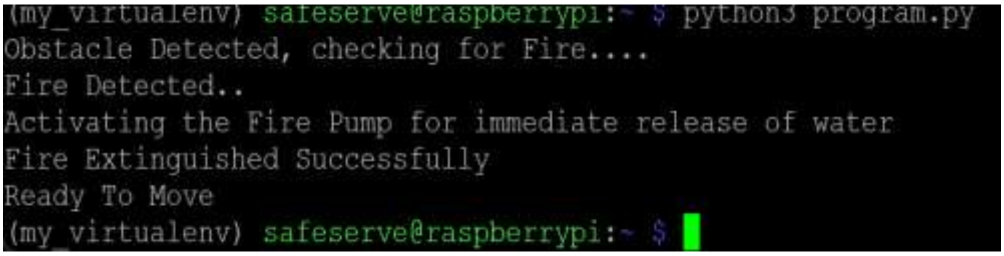


Fig 3.11 Working of Robot in Fire Extinguisher Mode



```
Sending current GPS coordinates to command center...
Current Coordinates: Latitude: 12.9716, Longitude: 77.5946
Fire location Coordinates: Latitude: 13.0123, Longitude: 77.65
Command center received the data...
No fire detected at the current location. System standing by...
Sending current GPS coordinates to command center...
Current Coordinates: Latitude: 12.9716, Longitude: 77.5946
Fire location Coordinates: Latitude: 13.0123, Longitude: 77.65
Command center received the data...
No fire detected at the current location. System standing by...
Sending current GPS coordinates to command center...
Current Coordinates: Latitude: 12.9716, Longitude: 77.5946
Fire location Coordinates: Latitude: 13.0123, Longitude: 77.65
Command center received the data...
No fire detected at the current location. System standing by...
```

Figure 3.10 Fire detection using flame Sensor



```
(my_virtualenv) safeserve@raspberrypi:~ $ python3 program.py
Obstacle Detected, checking for Fire....
Fire Detected..
Activating the Fire Pump for immediate release of water
Fire Extinguished Successfully
Ready To Move
(my_virtualenv) safeserve@raspberrypi:~ $
```

Fig 3.12 GPS sensor Working

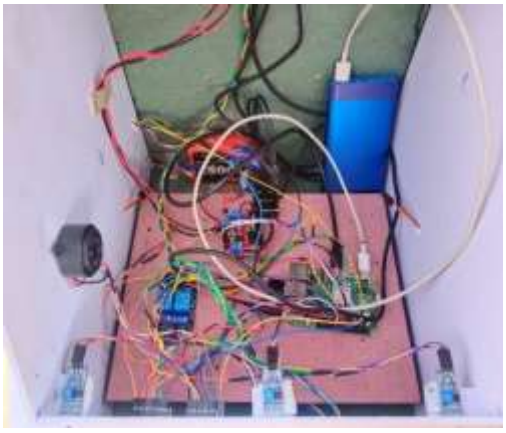


Fig 3.13 Wiring Connections of the Safe-Serve Robot

Fig 3.14 Water Container for Fire Extinguisher System

IV.RESULT

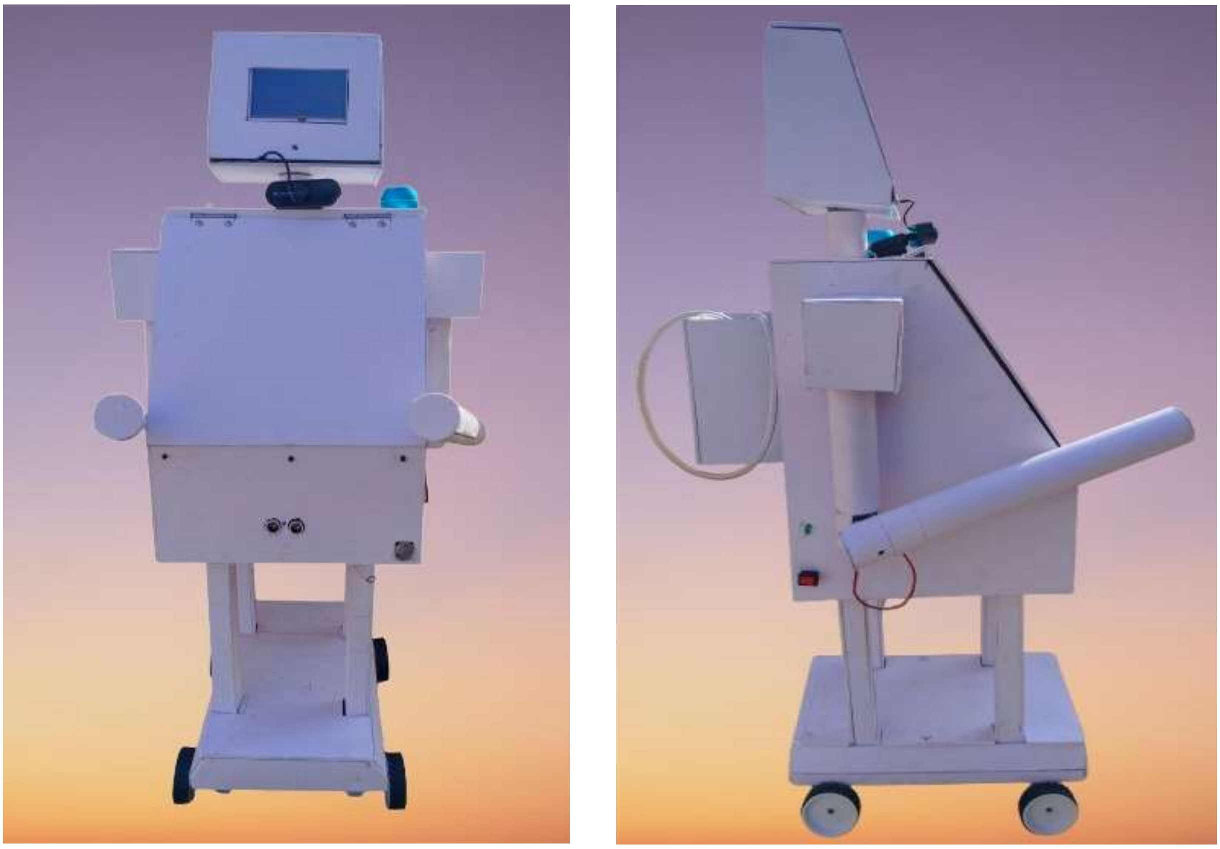


Fig 4.1 Prototype of Safe-Serve Robot

This Safe-Serve robot is a multifunctional robot, which can work on two functionalities, one is working as an autonomous restaurant server and another one as fire fighter robot. Each function works very smoothly and Help in many ways, this can be used in the restaurants and also in fire stations for effective usage of the safe-serve Robot.

CONCLUSION

The development of autonomous robotic systems for restaurant service and fire safety represents a significant leap in automation and AI-driven assistance. The Autonomous Restaurant Server enhances customer experience by providing efficient service, reducing wait times, and offering interactive engagement, while the Autonomous Fire Extinguisher ensures rapid response and mitigation of fire hazards with minimal human intervention. Both systems leverage advanced sensors, AI-driven decision-making, and robust navigation capabilities to function effectively in dynamic environments. As technology continues to evolve, further improvements in machine learning, real-time adaptability, and enhanced safety protocols will drive the broader adoption of such autonomous solutions across various industries, contributing to efficiency, convenience, and overall safety.

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REFERENCES

[1]. Nagarajan D, Akilan M, Lino K V, Vibin M, Vimal A, “IoT based Surveillance and Automatic Fire Extinguisher Robot,”2023 3rd International Conference on Pervasive Computing and Social Networking (ICPCSN), Coimbatore, Tamil Nadu, India,2023, DOI 10.1109/ICPCSN58827.2023.00242.

[2]. Developing a YOLO based Object Detection Application using OpenCV by Mannem Ponika, Kopalli Janavhi,2023, Institute of Electrical and Electronics Engineers (IEEE).

[3]. Integration of IoT and Robotics for Smart Fire Safety Systems by Ahmed Ali, Fatima Khan,2021, International Journal of Advanced Robotic Systems.

[4]. Tajim Md. Niamat Ullah Akhund, Mohd. Sacituzumab Nishat, Tasnim Newaz, Md. Mazdoor Rahman, Md. Rakib Hossain, Md. Abu Bakkar Saddik, “IoT Waiter Bot: A Low Cost IoT based Multi Functioned Robot for Restaurants,”2020 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO) Amity University, Noida, India. June 4-5, 2020.

[5]. Autonomous Service Robots in Restaurants: A Review of Technologies and Applications by Li Wei, Zhang Hao, 2020, Journal of Service Robotics (JSR).

[6]. Autonomous Robots for Food Delivery: Challenges and Opportunities by Carlos Martinez, Maria Gonzalez, 2020, International Journal of Advanced Robotic Systems.

[7]. Multipurpose Robots for Disaster Management and Daily Assistance by Rajesh Kumar, Priya Singh,2019, Robotics and Autonomous Systems (JSR)

[8]. Thanh, V.N., Vinh, D.P. and Nghi, N.T., 2019, August. Restaurant Serving Robot with Double Line Sensors Following Approach. In 2019 IEEE International Conference on Mechatronics and Automation (ICMA) (pp. 235-239). IEEE.

[9]. P. Anantha Raj and M. Srivani, "Internet of Robotic Things Based Autonomous Fire Fighting Mobile Robot," 2018 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), Madurai, India, 2018, pp. 1-4, doi: 10.1109/ICCIC.2018.8782369.

[10]. Hasan, K.M., Al-Nahid, A., Reza, K.J., Khatun, S. and Basar, M.R., 2013, April. Sensor based autonomous colour line follower robot with obstacle avoidance. In 2013 IEEE Business Engineering and Industrial Applications Colloquium (BEIAC) (pp. 598-603). IEEE.