Real-Time Fire Navigation System Using Computer Vision and AI

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Abstract- Fire hazard is a physical hazard in industries that are taking lives more than ever because of the lack of Fire Alert and Rescue Navigation systems (FARNS). Fire disasters are becoming more and more troublesome day by day in industries. People are dying in high-storied buildings and industry sectors due to fire hazards. IoT and OpenCV can bring new aspects to Fire Alert and Rescue Navigation systems. The OpenCV-Based Fire Rescue Navigator System can be used to locate the location of the fire hazard and deliver emergency fire alerts via online and offline channels. Contrary to expectations, firefighters can quickly and easily reach the affected area and save lives. A reliable fire rescue navigation system and monitoring solution are essential to our industry. Our system presented an insurmountable way to rescue fire occupants utilizing an OpenCV-based Fire rescue navigation system which can also overcome internet and power outages in devastating fire hazard situations.

Index Terms- IoT, Raspberry Pi, Fire Rescue Navigator System, OpenCV, Computer Vision.

INTRODUCTION

The recent emergence of IoT and OpenCV luminaries is huge. Big companies are also pushing to include IoT in their products. The main goal of this work is to use the best technology to do the best, which can save lives. It is possible to save lives during major disasters such as fire, because fire is the most deleterious disaster more than all other disasters. There are technologies available to indicate an exit to the public trapped inside a burning building, but they cannot tell the exact location of a fire therefore that location can lead to more casualties. Fire drills are also organized in society and schools to educate the masses in responding to emergency situations. But this is not a complete solution as it contains more human interaction as time goes on to notice the fire and then notify the fire station about the fire. In the present case, it is also possible to install cameras anywhere in the building, but is not effective in the event of a power outage. The proposed work includes GPS, GSM, GPRS Sim 808 module and a camera sensor to perform algorithms and Open Computer Vision, then send fire alarms, locate occupants in the room for fire brigade via e-mail and in the event of a power failure, an alert offline message with the location is also sent by the SIM card. The system is not only detecting fire but also informing rescuers to protect the fire occupants through Google map location URL.

RELATED WORKS

One of the most obvious technologies for LBS is GPS, which is used in many different industries. LBS typically rely on wireless LDTs that are either spatial or terrestrial (with a constrained operational region) Global navigation system. Although mobile networks (GSM, GPRS, and UTMS) are widely available, location accuracy is not particularly good (100m and more). Different approaches are used to depict terrestrial LDTs in order to pinpoint a mobile device's location within the networks of a wireless communication provider. It is based on calculations made by the network's LMC or in the portable device. With several LBS techniques, the position may be ascertained. These techniques' levels of accuracy vary, nevertheless. One of the two fields used in LDTs is network based-hybrid. The position of the mobile device is determined by this technology using the operator's network. In use and constructed in the same manner are all mobile phone networks. As the BTS antennas link the user terminal to the international telephone network, the network is set up in cells around these antennas [1][2]. One of the dependable uses is a wireless sensor such as Zigbee, is a connection that combines the driver's display unit with a signal emitter. The tiny sensor nodes that make up this network can do computations. These nodes have the ability to feel and analyze various areas of the coach and gather data. In contrast to certain other wireless systems, ZigBee methodologies have provided considerable and distinctive benefits, including secure and dependable data transfer, simple and adaptable system construction, affordable apparatus expenses, and lengthy batteries. The ZigBee Alliance does not promote any particular technology; instead, it offers a specified foundational set of options for sensor and control systems. The ZigBee Network Node is built to be battery-operated or to use little energy. In the area of industrial control, it thus offers considerable potential development and an attractive market application. Parameters such as the relative humidity and temperature at any location on the train encompassed by the channel may simply be gathered, handled, and evaluated at any time by integrating a wireless sensor system that relies on ZigBee into a railway fire surveillance system [3]. The thermocouple sensor module is used to automatically operate the alarm system within an organization while also keeping an eye out for exterior and internal fire alarms. The alarm is set off when the temperature is detected, alerting and waking up everyone inside the building. In order to maintain fire prevention, the carriage Control systems are connected to the LED batteries. This enables the security manager to display the color lights. The alert also was put in the structure as a backup [4]. It is suggested to use a micro - controller chip to operate and integrate a self-contained smart system that gathers data from several detectors (the severity, the location and the effects). Through telephone calls and text messages, it alerts the emergency services and other users of the fire. The flame was also extinguished by spraying dampening gasses precisely where the fire was [5]. No user navigation is available. In order to function well in a critical environment, an IPS system has to contain the following crucial components: The solution must operate on such an ad hoc approach without the requirement for a stable setup platform including cables, an electrical source, and permanent equipment. The solution has to be adaptable and movable without requiring deployment at a specific site. The technology must include real-time communication and position tracking capabilities. Faraway the system's control is required [8]. By combining the data collected again from numerous servers, Wi-Fi integrated cloud solutions may identify fire, gas leakage, or smoke and notify the home's tenant to any potential threats [7]. Internal mobile and pedometer recommending the fastest route to leave the facility in emergency circumstances, augmented reality may be utilized to evacuate the facility. A positioning system based on Wi-Fi and GPS is utilized to improve network comprehension and interaction [9]. Additionally, an OpenCV-based fire escape system has been proposed. Although different systems chose different microcontroller, there is a significant increase in efficiency and longevity using Raspberry Pi. Which made our proposed system more reliable and efficient for a longer time span.

Design and Imeplemtation

A. Interfacing with Sim808 GPS GSM GPRS Module

The GSM modem requires a separate power source (5V 1A) to operate properly. Activate a 2G SIM card to monitor the data connection, then turn on the modules. The SIM will need to register with the network, which will take a few seconds. We must examine how well the Raspberry Pi and the modem are speaking to one another. For which, we make use of a python code that transmits an AT command and verifies whether an acknowledgement is received or not.

B. Raspberry Pi Camera V2 interfacing

The camera will be connected while the Raspberry Pi is still powered off. Note that the shiny contacts on the ribbon cable should face away from the USB ports.

C. Backup Power Bank

A backup power bank is needed in case of any interruption in power supply. 10000mAh power bank can power the raspberry pi for about 6 hours without any power connection which is more than enough for backup power.

D. Connecting all components with Raspberry Pi:

Camera is needed to connect while the device is off. Antennas should be connected properly with Sim 808. VCC, Ground, Serial pins are used to connect Sim 808 with Raspberry Pi.

E. Fire Detecting Using OpenCV

Python is used for implementing these fire detectors using OpenCV and masking. The program is worked by taken a video and processed the video frame by frame with high volume fire. It is switched the color space to HSV. HSV is more similar to the way humans perceive color than the default RGB color space. Next, upper and lower color values are defined. A mask is applied to the frame and only the colors in the range we defined are visible. When the program starts, the system monitors the frames for fire detection. The system runs until there is a fire incident. When the system identifies fire then the process of the system starts for Fire Rescue Navigation.

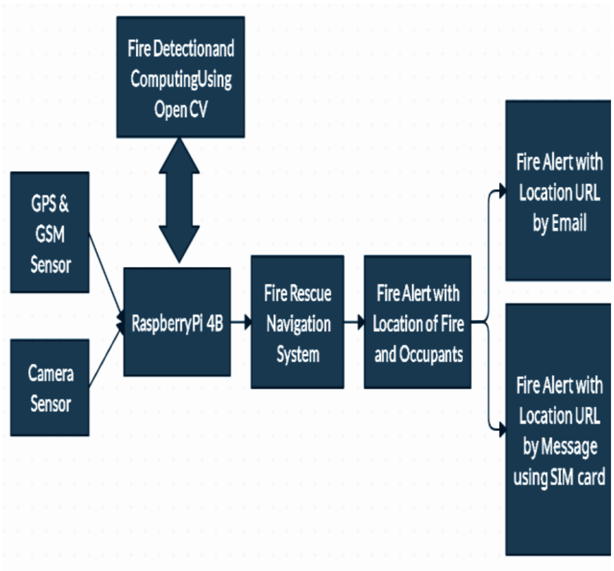

Figure 1: Block Diagram of the system

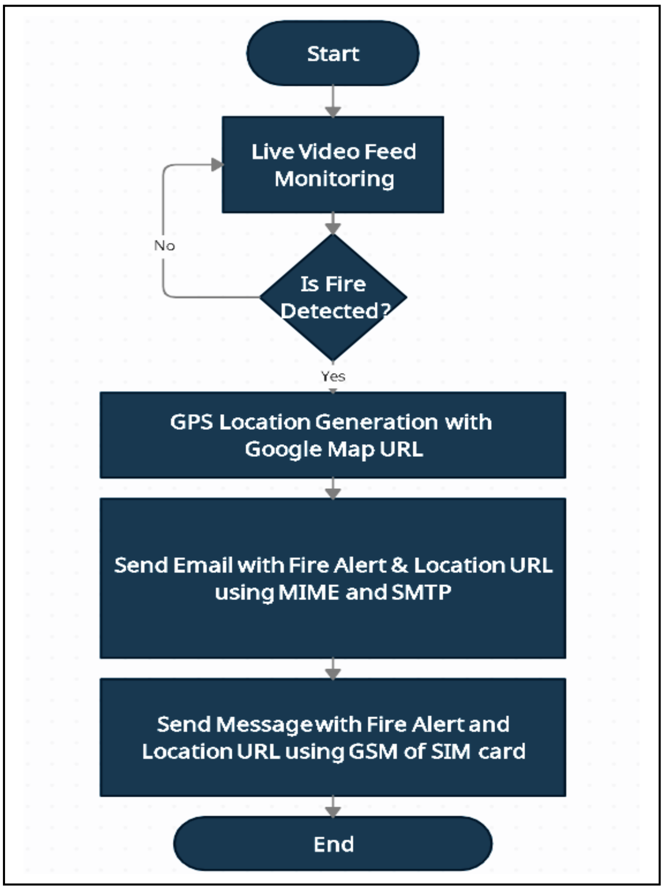

Figure 2: Flow Chart of the system

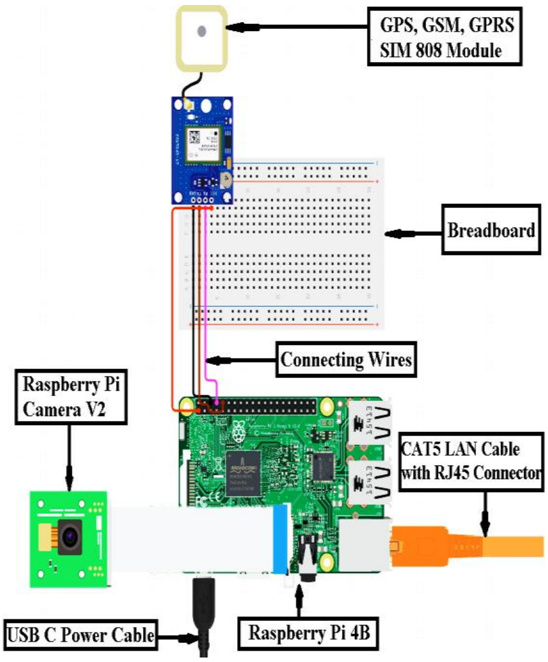

Figure 3: Circuit Diagram of the system

- Raspberry Pi 4B
- Cat5 LAN Cable with RJ45 Connector
- Raspberry Pi Camera V2
- GPS, GSM, GPRS Sim 808 Module
- Breadboard

Testing and Result

F. Fire Detection using OpenCV

Using the Raspberry Pi camera v2, fire is detected. In this instance, a camera is watching the live video feed. Using OpenCV algorithm and masking, fire can be detected. Video monitoring stops when fire is detected using OpenCV with Raspberry Pi.

G. Location tracing and Google map URL generation

In the event of a fire, a GPS, GSM, and GPRS SIM 808 sensor will identify the exact location of the fire hazard and any occupants. The generated coordinates will be transformed into a Google map URL that may be used to find fire hazard from an android, iOS, macOS, Linux and Windows platform via the internet.

H. Preparing Email

In this phase, email that will send a fire alert with the location URL of Google map of the fire hazard and the occupants is prepared using the MIME and SMTP protocols. This solution covers the internet available mediums such as android, iOS, windows, macOS and Linux platforms.

I. Preparing Offline Message

In order to overcome the issue of Internet unavailability, a message with the location URL of the fire hazard is being generated to be sent to an emergency telephone number. If firefighters have access to a phone, they can use it to identify the location of a fire hazard. The navigation for the rescue operation can be provided using a mobile network.

J. Navigation to Fire Rescuers via online and offline method

Our System will send fire rescuers the whereabouts of the fire hazard by email and text message so they can save lives without wasting time looking for occupants. Latitude and longitude will be included in the coordinates in the text message's Google Map URL. So, in the event that the internet and electricity are unavailable, the position can also be mapped on a physical map.

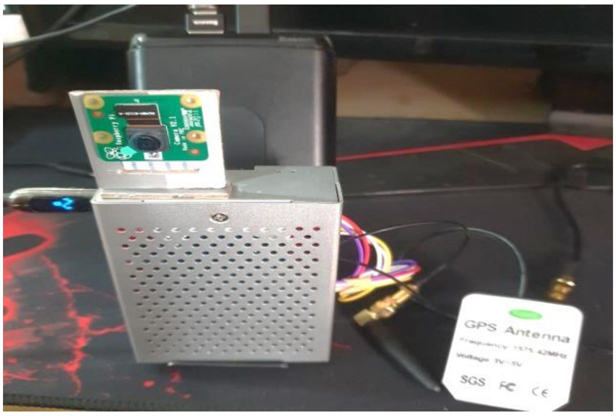

Figure 4: Implementation of the System.

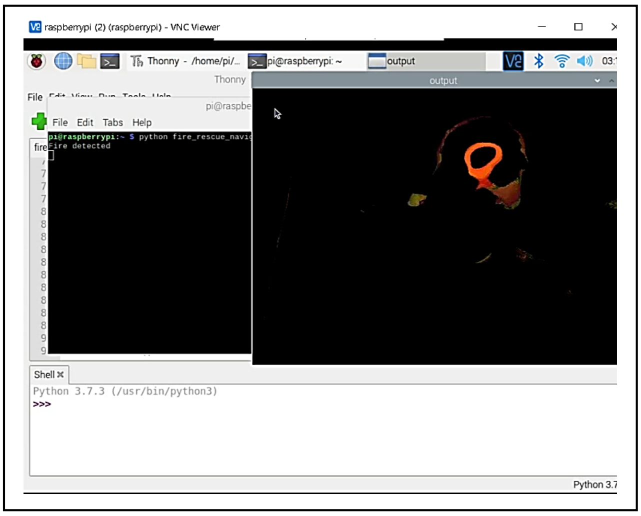

Figure 5: Fire Detection Using OpenCV with Raspberry Pi CameraV2

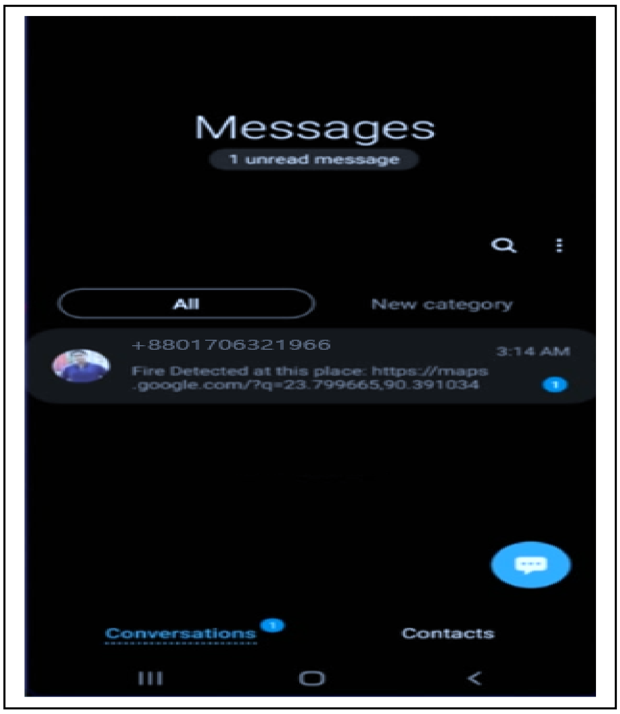

Figure 6: Receiving Offline Message to a dedicated Emergency Contact Number with Fire Alert and GPS Location URL of Google Map

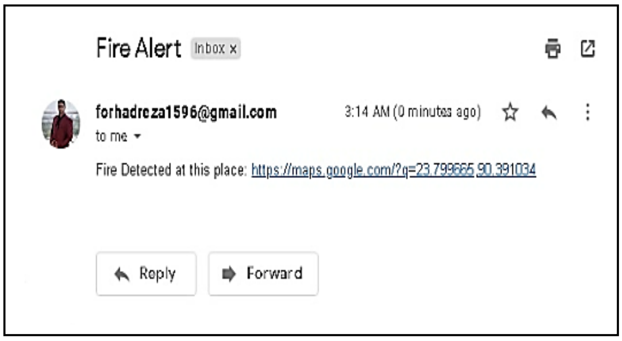

Figure 7: Receiving Email of Fire Alert and GPS Location URL via Internet

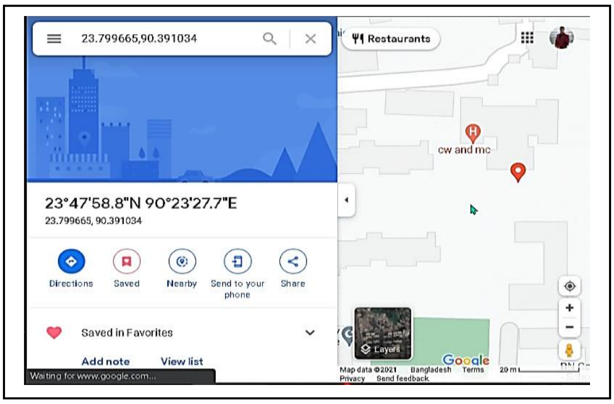

Figure 8: GPS Location obtained of Fire Hazard is shown in the Google Map using received URL

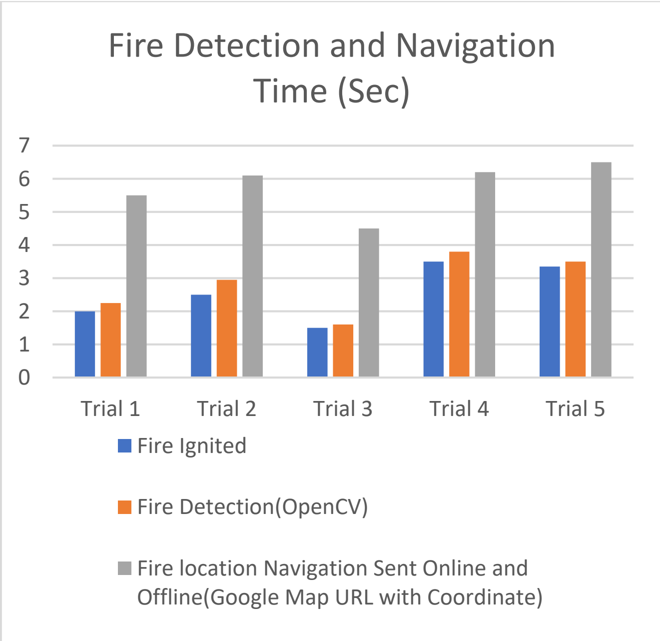

Figure 9: Fire Detection and Location of Fire Hazard Navigation Time Response

K. Fire Detection and Navigation Time Response

The OpenCV-based Fire detection process finished on average 0.25 seconds after the various trials were started. Within an average of 2.94 seconds, location of fire hazard navigation can be sent. Raspberry Pi is better in terms of performance and reliability in comparison with other microcontrollers and microprocessors. Correspondingly, time response and accuracy of the system is sustainably efficient.

CONCLUSION

This research is focusing exclusively on one objective: saving lives. Many lives could be saved in a fire hazard if this technique could be adopted in all corporate enterprises, schools, hospitals, and multistory structures. Both internet availability and unavailability are compatible with the suggested approach. In the event of a power outage, the additional power bank can keep the device running for a full day. So, in dangerous scenarios where there won't be much access to energy or the internet, this device may still detect fire, give navigational directions, and save victims lives. Our suggested method detects fire using OpenCV in an average of 0.25 seconds. This

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system can convey the position of a fire hazard, along with a Google Map URL, via online (email) and offline (text message) mediums, in an average of 2.94 seconds.

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