Implementation of Smart Rescue Operations and Adversity Managing System using the Internet of Things and Sensors

J L Mazher Iqbal, Y Aparna

Abstract— Certain situations are very tough for human beings to approach immediately such as storms, floods, earthquakes, jungle fires, and explosions etc. These circumstances cause excessive destruction and human misery. The rescue of victims is a very challenging task and to be addressed as early as possible. In the area of rescue and adversity managing embedded system, very few contributions by the scientific community compared to other embedded systems. The disasters and rescue operations are not effective irrespective of advances in technology all over the world. In this article, we propose a sophisticated embedded system with essential sensors such as PIR Sensor, Ultrasonic Sensor, Accelerometer and Sound sensor. The proposed system collects data from the intended location and sends this data to a distant location using ZigBee S2C module wireless technology and then through the Internet of Things (IoT). This system can be integrated with Unmanned Aerial Vehicle (UAV) and capture the essential information in the hard to reach areas during adversities. This gathered information will assist rescue operation team post-disaster.

Key Words: Sensors, Internet of Things (IoT), Unmanned Aerial Vehicle (UAV)

1. INTRODUCTION

Adversities can be either natural or man-made which occur all over the world irrespective of their technology innovations. There are many preliminary cautionary for various forms of adversities already existing, but still, the number of disasters is increasing globally day by day [1]. Disaster not only causes great damage to human society but also to animals, birds and other living beings. When adversity occurs, the primary aim of the rescue team or volunteers is to save the lives of as many as possible in a short span of time. Humans cannot immediately attend such events as such as locations are not accessible due to the destruction of transport or poor environmental conditions [2] [3]. The time taken to establish assistance depends on the type of disaster, the severity of the disaster, its location etc. The entire rescue operations are to be done in a controlled manner for better action [4]. The paper [5] reviews existing methodologies to encounter the appropriate problems with adversities, such as initial cautioning, statistical analysis, monitoring, and victim localization. The paper [6] deals with an unmanned aerial vehicle to the monitoring connected with an onboard camera. The captured video signal from a surveillance camera is transmitted using available mobile communication networks. In [7] intelligent street light supervision system with enhanced managing is discussed. Sensors in [7] decrease power consumption. Wirelessly monitored and control is performed with the help of the ZigBee transceiver. In [8] [9] embedded systems for various automatic Vehicle applications such as Accident Detection, Air Pollution Detection are discussed. The paper [10] discuss a smart medicine box embedded system. This paper discusses the design, realization and testing of the embedded system for data acquisition and data transmission using Raspberry Pi 3 which is identified as Section-A (Embedded System at intended location). It also discusses the design, realization and testing of Arduino based embedded system whose primary function is data reception from Section-A and it also discusses the system which is identified as Section-B (Embedded system at a distant location). This system can be integrated with Unmanned Aerial Vehicle (UAV) and capture the essential information in the hard to reach areas during adversities. This gathered information will assist rescue operation team post-disaster. This article is organized as follows. In Section. 2, the proposed smart rescue operations and adversity managing system is presented. Section 3 presents the results and discussion. Finally, conclusions are drawn in Section. 4.

2. PROPOSED METHOD

Fig.1 and Fig.2 show the Embedded System at the intended location as Section-A. The main processor in Section-A is Raspberry Pi which works on raspbian OS loaded on a memory card. The Pi camera is the major sensor of the proposed system whose image is stored in the memory card for every one second in ".png" format. The Raspberry Pi 3 also collects outputs from PIR Sensor, Ultrasonic Sensor, Accelerometer, and Sound sensor through its GPIO pins. All these sensors are provided with digital outputs except accelerometer. Hence the analogue output from the accelerometer (ADXL335) is fed to Raspberry Pi through the MCP3008 ADC Module. The Raspberry Pi processes and sends the sensor data (other than the camera) to the Xbee S2C module through its UART port. This module operates at a

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J L Mazher Iqbal, Professor, Departmnet of ECE, Embedded Systems & Technology, Vel Tech Rangarajan Dr. Sagunthala R and D Institute of Science and Technology, Avadi, Chennai, Tamil Nadu, India

Y Aparna, M. Tech, Embedded Systems & Technology, Vel Tech Rangarajan Dr.Sagunthala R and D Institute of Science and Technology, Avadi, Chennai, Tamil Nadu India

frequency of 2.4GHz and transmits the data on to the air. The Section-A can be placed on suitable UAV for reaching the intended location. Also, the images captured by Pi camera can be copied from memory card to a commercial pen drive through one of the USB ports of raspberry Pi 3 after the flight duration of the UAV. In case of lack of proper view in the images, the data from other sensors can be considered for knowing about any moving object and distance from UAV. The presence of any sound at the location is picked by the sound sensor. The XBEE S2C module of section-B receives the data transmitted from Section-A and is fed to RX pin of Arduino through UART. The received data is processed by Arduino which is displayed on 16x2 LCD on a rotational basis and also put on the cloud through the ESP8266 module.

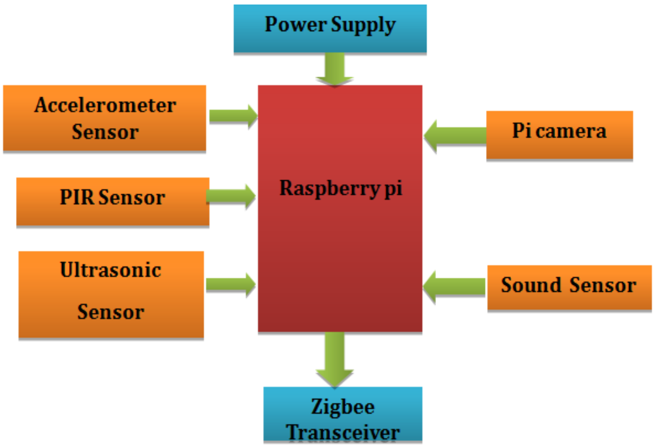

Fig.1.Block diagram of the Embedded System at intended location-Section-A

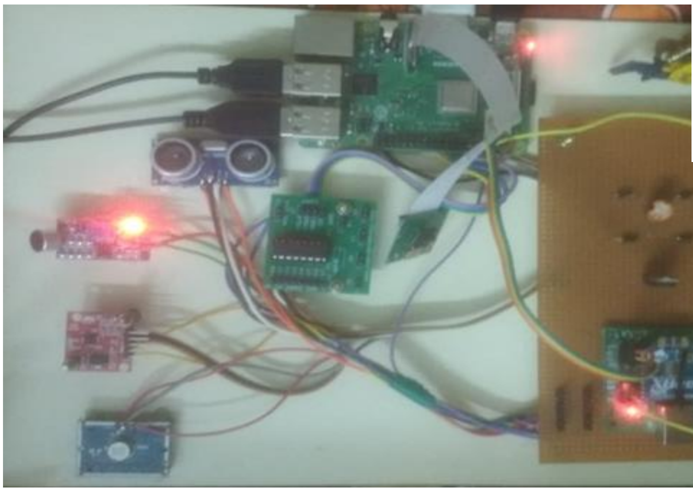

Fig. 2. Experimental set up of the Embedded System at intended location-Section-A

The Section-B can be used by the rescue team for gathering information about the presence and condition of victims from the required location. Also, the Section-B posts the data onto the cloud enabling the quick and widespread of information upon access. The main processors used in this project are Raspberry Pi 3 and Arduino UNO which are best suitable for this system because of their simplicity, availability, compactness, cost-effectiveness and less weight. Especially, the weight of Section-A needs to be limited since this will have an impact on the selection of UAV. As the weight increases, the UAV needs to have more payload carrying capacity, which increases the cost and complexity of the system. The Raspberry Pi 3 is faster and more capable than its earlier version. It has Broadcom BCM2837 64bit Quad Core Processor and operates on the 1.2GHz clock. It has four USB ports to which the keyboard and mouse can be easily connected. The Pi camera is interfaced to raspberry Pi through Camera Serial Interface (CSI). The Software for the Raspberry Pi is developed in PYTHON programming language using idle python 2.7. The Arduino UNO is based on ATmega328P 8bit AVR family microcontroller with analogue and digital input pins. It operates at a clock frequency of 16MHz. Arduino IDE (Integrated Development Environment) is required to program the Arduino Uno board. The major tasks carried out by the software in Raspberry Pi is the collection of information from the sensor outputs using respective GPIO Pins and the processing of that information for the rescue operation, sending those processed data to the Section-B module through Xbee module UART interface and storage of the Pi camera pictures in.PNG format onto the memory card. The Arduino software takes care of data reception from the ZigBee S2C module, display of data on LCD and placing data to the ESP module. These software development platforms are readily available.

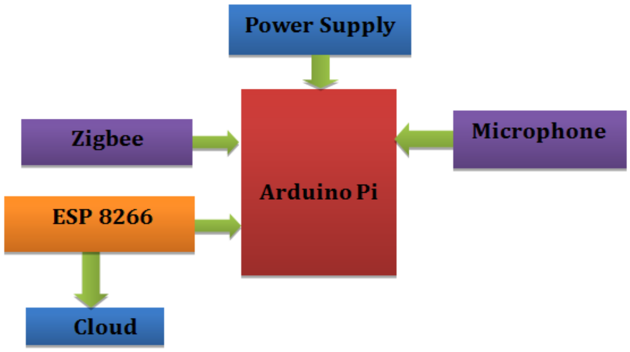

Fig.3 Block diagram of the developed system Section-B

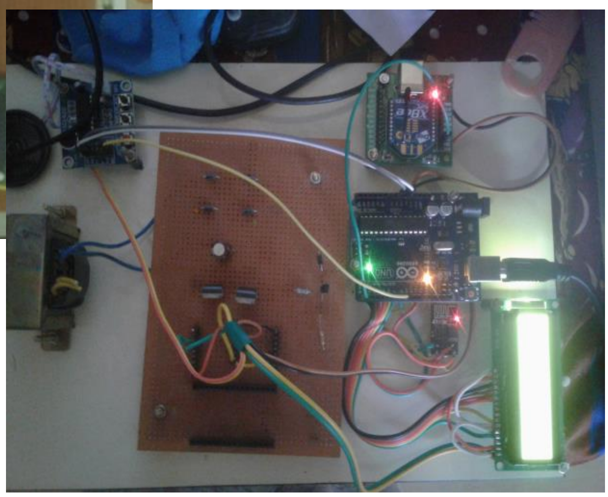

Fig.4. Section-B of developed system

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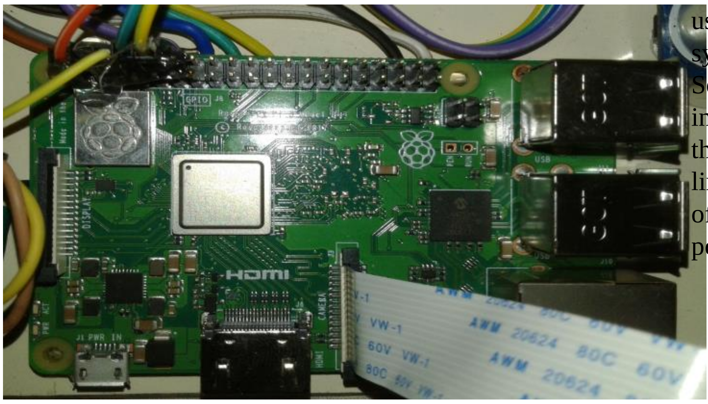


Figure 5.The Raspberry Pi 3 Board

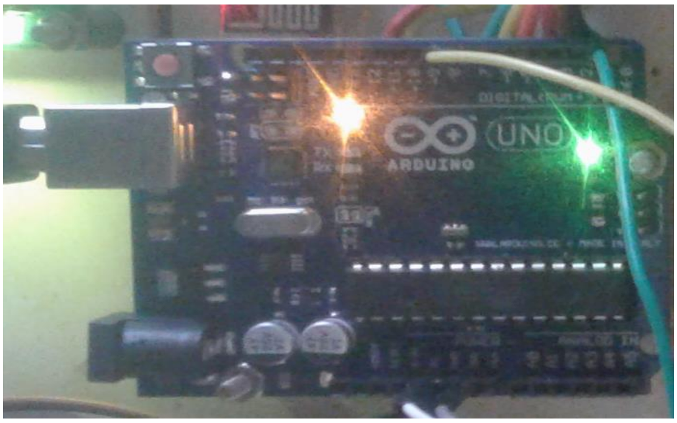
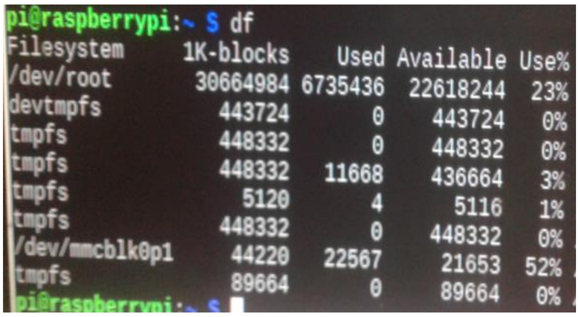


Fig. 6. Arduino UNO Board

3. RESULTS AND DISCUSSION

In this section the results of the proposed Smart Rescue operations and adversity managing System is presented. The Raspberry Pi Camera is the key sensor of this system. The Pi Camera board is interfaced to the Raspberry Pi through CSI connector. The camera delivers a clear image of 5MP resolution. It uses Omni vision OV5647 CMOS sensor in a fixed focus module and is capable of 2592 x 1944 pixel static images. The usage of the memory card is shown in Fig.7 and it is clear that around 20GB of memory is left unused. Each picture taken from Pi camera requires 1MB of storage on an average. Since free space available in the memory card is 20GB, the number of photos that can be stored are 20,000 photos corresponding to time duration of more than 5 hours where the picture is captured at one photo per second rate. Therefore the camera can be used with a UAV of flight duration up to 5 hours. But such UAVs are very high-end and require high power backups. There are UAVs commercially available with a flight duration of 30 min, the control range of less than 5Km, the battery capacity of less than 3500mAh and camera of less than 10MP resolution. The indigenous study, research and development of such products are highly essential especially in adversity management field where assistance is significantly less. In addition to Pi camera, there are other sensors whose output is displayed through the Raspberry Pi program as shown in Fig. 8. The storage of the captured image, distance, position information, movement detection and sound detection are displayed on the screen. However, this is only for the local display used for initial testing. It is to be noted that 230V supply and adapters are used for powering ON section-A and section-B. For the final system, battery options can be explored. The Final output at Section-B can be verified at 16X2 LCD where the received information is displayed one after the other. The snapshot of the same is shown in Fig.9. The Xbee module has an outdoor line of sight range of 1.2Km with very low transmitter power of 3mW. Increase in range will need boost of transmitter power which can also be explored.

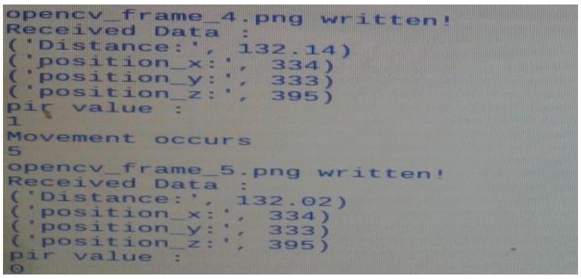


pi@raspberrypi:~ $ df

Filesystem	1K-blocks	Used	Available	Use%
/dev/root	30664984	6735436	22618244	23%
devtmpfs	443724	0	443724	0%
tmpfs	448332	0	448332	0%
tmpfs	448332	11668	436664	3%
tmpfs	5120	4	5116	1%
tmpfs	448332	0	448332	0%
/dev/mmcblk0p1	44220	22567	21653	52%
tmpfs	89664	0	89664	0%

pi@raspberrypi:~ $

Fig. 7. Details of memory usage



```
opencv_frame_4.png written!
Received Data :
('Distance:', 132.14)
('position_x:', 334)
('position_y:', 333)
('position_z:', 395)
pir value :
1
Movement occurs
5
opencv_frame_5.png written!
Received Data :
('Distance:', 132.02)
('position_x:', 334)
('position_y:', 333)
('position_z:', 395)
pir value :
0
```

Figure 8. Screen shot of display at Section-A

Fig. 9. Screen shot of LCD at Section-B

4. CONCLUSIONS

The embedded system for victim and rescue team assistance is designed, realized and tested. The proposed smart rescue operations and adversity managing system enhances the accessibility of adversity effected areas and provide fast rescue for victims. The embedded system accommodate all the necessary sensors, ZigBee S2C module. It collect the information, process and send through a wireless medium. Suitable UAVs can be adopted with sufficient battery backup and control range which may be

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customized. This reduces overall cost of the system as well as gives a free hand to developer to modify or upgrade the system. The camera selected in this article operates in visible spectrum, in place of which a night Vision camera can also be used to increase the scope of the system.

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