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URBAN SEARCH AND RESCUE WIRELESS ROBOT

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ABSTRACT

In the aftermath of disasters such as the 9/11 terrorist attacks and other natural disasters such as earthquake and floods taking place were human life is endangered along with the destruction of the property , it becomes clear that immediate rescue efforts must take place to rescue the trapped victims, of the disaster in a way that doesn't put the lives of the rescue workers themselves at risk in rescuing. In situations like these urban search and rescue robots (USARs) can save lives and inform about the surrounding environmental conditions to the rescuer while keeping rescue workers safe. Protecting the lives of rescue workers is always an important issue, means trapped victims can't get needed help if the rescuer himself is not safe. Today robotics is evolved in many fields such that now new branch of robotics promises to save lives in dangerous situations by placing the risk of rescue work in the hands of machines instead of rescue personal. These machines, called Urban Search and Rescue Robots (USARs) operated by rescue personals, may soon be standard tools used by rescue teams in many challenging rescue operations. Designing robots for urban search and rescue (USAR) is an extremely challenging task which may take into account many conditions related to rescue field, environment, the intensity of disaster, the number of victims trapped because it violates many of the assumptions made in the average robotics lab. These robotic vehicles must be specially equipped with the machinery, sensors to inform rescuer about the condition of victim and its surrounding environmental condition and to take corrective actions. These machines can accompany human rescuer in many challenging rescue tasks for example small openings, difficult terrains, tough weather conditions, without giving a false response, which is a source of error in human factor.

Index Terms: *All terrain vehicle, PIR sensor, Wire IP camera, Gas sensor, Temperature sensor and Wi-Fi.*

1. INTRODUCTION

In light of recent disasters and catastrophes, which are either environmental such as , hurricane, earthquake, flood, and fire, or manmade such as bombing, wars, and terrorist attacks, the need for creating new ways to rescue the survivors who get trapped under the debris and rubble, in the fastest possible way, is a must. According to the study of Urban Search and Rescue (USAR), the first 48 hours of the rescue operation are crucial as the probability of saving a victim is high, after that the probability becomes nearly nil.

During the rescue operation, many human factors are involved such as policemen, fire fighters, and doctors. All of them are exposed to very dangerous situations which are caused by the destructed surrounding they work in, such as landslides, collapsed buildings, and fire. Hence, the probability of rescuer of becoming a victim is high. Therefore, the rescue operation imposes a significant risk on rescuer's life. From this point of view, looking for alternatives to human rescuers has been an important issue. Trained dogs have also been used in this field for assisting rescuer because of their high sensitivity to any slight motion and human presence. However, in such situations, it is not a clever idea to depend totally on them because even if they can detect the presence of a living victim, they still cannot judge the situation and relay the information of victim quickly and systematically for proper rescue. For that reason, dogs cannot work independently only kept as assistants to human rescuer.

Figure 1: URBAN SEARCH AND RESCUE WIRELESS ROBOT

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Therefore, the need is for a totally or partially independent alternative to the human factor in this field. Meanwhile, robotics as a separate branch is achieving relatively good progress. Robots are used in fields such as industry, education, medicine, and military and have proven their robustness and efficiency and hence they can be effectively used in rescue operations with little modifications.

Therefore, robots are expected to play an important role in replacing entirely or even assisting the human factor in many of these fields. Even though the USAR field seems to be very challenging for robots and automation, robots have already invaded this field like many other fields.

The first real attempt to use robots as a rescuer was during the 9/11 attack in New York City. Since then, a worldwide interest in this field is been evolving rapidly

2. LITERATURE SURVEY

The existing systems are based on wired as well as wireless search operations. We have some systems, based on a new approach for detecting surviving humans in destructed environments using a simulated autonomous robot.

The system proposes, a new approach for detecting surviving humans in destructed environments using a simulated autonomous robot. The proposed system uses a low-cost camera in order to acquire a snapshot of the scene and a passive infrared sensor (PIR) in order to detect the existence of live humans. Having detected a sign of a live victim, the PIR sensor triggers the camera to capture an image of the scene. The image is fed into a controller based system, trained to detect the existence of a human body or parts within an predefined range. This approach requires a relatively small number of images to be captured and processed during the rescue operation. This way, the cost of real time image processing and transmission of data is considerably lowered. The results of the performed experiments showed that this system has the ability to achieve high performance in detecting living victims on scene with quick response and is less costly. The live body detection accuracy of the system is ranged between 78% and 90% which depend on a number of factors such as the position of victim body, the intensity of light of the scene, and the color matching between the body and the surrounding environment.[1]

In another system technology for multi robotic systems has advanced to the point where we can consider their use in a variety of important areas, including search and rescue. A essence of multi robot systems is the ability to have a large number of robots effectively controlled by small numbers of operators or rescuers. In this paper, two ways for controlling a team of 24 robots in a task of an urban search and rescue environment are compared. In both ways, multiple operators must observe video streams from the robots to detect and mark live victims on a map as well as monitor robots that cannot get themselves out of challenging situations. In the first way, the operators must also provide path points for the robots to navigate, using both video and a partially completed map to choose appropriate trajectory points. In the second way, the robots automatically plan their trajectory, allowing rescuers to focus on monitoring the video of scene, but without being able to interpret live video to guide navigation.[2]

In another proposed robotic system, a new microwave sensitive life-detection system which can be carried by special rescuing robotic vehicle has been developed. The system can be used for rescue work, anti-terrorist actions and law-enforcement works purposes. microwave transmitting/receiving (T/R) system with automatic cancellation subsystem and signal processing system are presented. Experiments have been conducted to verify the effectiveness of this system. The recorded frequency of signal spectrums for respiration and heartbeat of a victim behind an obstacle.[3]

In a team led by Dr. Murphy, an IEEE Fellow has taken rescue robots to disaster sites like the World Trade Center after 9/11 attack and New Orleans after hurricane Katrina, says that robots have been used in at least one previous earthquake.

The U.S. Army Corps of Engineers, used a ocean robot, underwater remotely operated vehicle, or ROV, in a Haitian government project to investigate bridge and seawall damage. In the earthquake hit of Japan in 2011, Japan's leading experts in rescue robotics had deployed wheeled and snake-like robots to assist emergency rescuers in the search for survivors of the devastating earthquake and tsunami that struck the country. For a disaster like the disaster in Japan several types of robots could be useful, including:

a) Small unguided aerial vehicles like robotic quad rotors for inspection of upper levels of buildings and lower altitude checks snake robots capable of entering collapsed buildings and pass through rubble.

b) Small underwater ROVs are preferred for bridge inspection and underwater recovery and surveillance.

Like most search and rescue robots, currently the Japanese industries are designing USAR to go where humans can't easily reach. According to a paper in 2007, the a snake-like robot whose body is covered by "cilia," small filaments that vibrate and enable the robot to crawl at a speed of 4.7 centimeters per second, tackle obstacles, make turns at sharp corners and follow walls .

Quince is mobile robots equipped with four sets of wheels, some of which can make movement up and down that allow the robot to tackle obstacles. It is equipped with cameras as well as with an infrared sensor and carbon-dioxide sensor for detecting the presence of survivors or victims trapped under rubble.

Projects of NASA such as human-robotic systems (NASA 2004), Fong and Nourbakhsh (Fong and Nourbakhsh 2005) point out that to reduce human efforts, costs, fatigue driven error and risk. Intelligent robotic systems will have to be part of rescue mission. They also observed that serious attention has been paid to joint human-robot interactions, and making the human-robot collaboration natural and efficient is crucial to future space exploration. Companies such as Honda (Honda 2007), Toyota (Toyota 2007) and Sony (Sony 2007) are also interested in developing consumer robots that interact with humans in the home and workplace, so use of robots is increasing in daily needs and some high risk missions such as rescue .

3. SYSTEM ARCHITECTURE

The current paper focuses on finding humans those who are trapped under debris and rubbles during man made or natural catastrophe. The proposed system uses Wi-Fi technology for data transmission and vehicle control. The system is mounted with camera for live video transmission and some sensors to detect surrounding conditions. System architecture is divided into two different parts. One is located at the rescuer station (computer) and another on the vehicle.

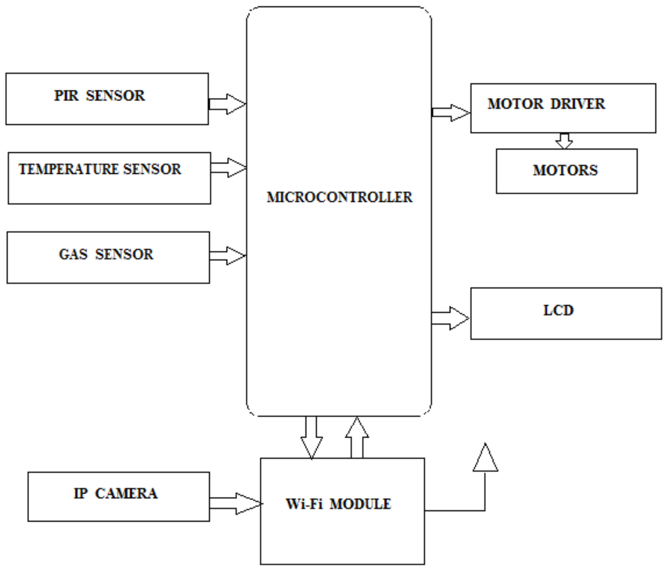

Figure 2: Vehicle Circuitry Block Diagram

The fig 2 consists of vehicle circuitry block diagram in which the prime components of the project is shown. Here the heart of circuitry is microcontroller. Various sensors such as PIR sensor, MQ-6 gas sensor, and LM-35 temperature sensor are interfaced as input to the microcontroller. These sensors provide useful data regarding the surrounding environmental conditions and the status of the victim.

Motor drivers are interfaced as output device to the microcontroller, which further provide sufficient controlled current to the motors for vehicle movement. The communication to the vehicle regarding its navigation control is established using Wi-Fi. For this a Wi-Fi module is interfaced to the microcontroller.

Wi-Fi module:

HLK-RM04 is a new low-cost embedded UART-ETH-WIFI module (serial port - Ethernet -Wireless network) developed by Shenzhen Hi-Link Electronic co. Ltd.

This product is an embedded module based on the universal serial interface network standard, built-in TCP / IP protocol stack, enabling the user serial port, Ethernet, wireless network (Wi-Fi) interface. Through the HLK-RM04 module, the traditional serial devices do not need to change any configuration; data can be transmitted through the Internet network. Provide a quick solution for the user's serial devices to transfer data via Ethernet.

For video transmission IP camera is used. LCD is provided for displaying the status of established connection of vehicle and rescuer system.

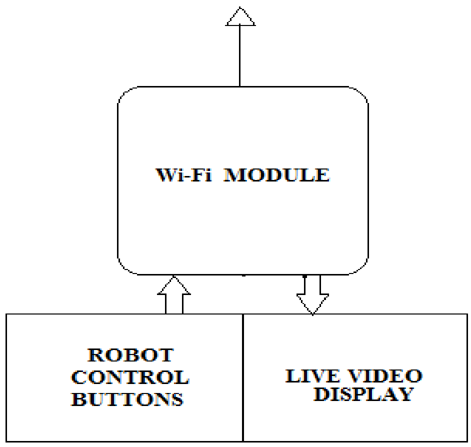

Figure 3: Display and control unit block diagram

The fig 3 consists of display and control unit which is placed on rescuer's or operator's side. On this side three components are most important:

- A controller device having Wi-Fi support such as laptop. The rescuer will monitor the surrounding conditions and control the robotic vehicle navigation with the help of controller device having Wi-Fi support.
- Robot control buttons panel on Visual basic window and live video and sensor output display window on visual basics.

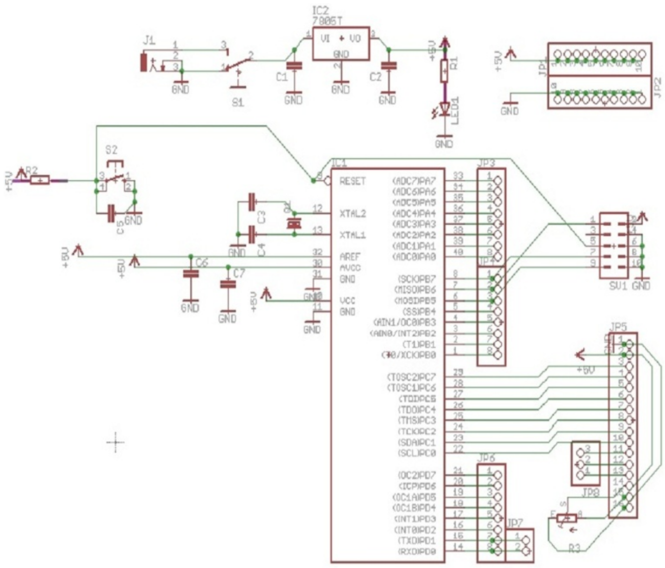

Figure 4: Circuit diagram of the proposed system.

The hardware consist of microcontroller ATMEGA 32 which is used to monitor and control the system, and

Various sensors such as:

PIR sensor (HC-SR-501):

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are

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commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

- Gas sensor:

The LPG Gas Sensor(MQ-6) is designed to enable LPG detection interface to Microcontroller without ADC Channels. It allows determining when a preset LPG gas level has been reached or exceeded. Interfacing with the sensor module is done through a 4-pin SIP header and requires One I/O pin from the host microcontroller. The onboard microcontroller provide initial heating interval after power up and then starts to measure LPG sensor output. If it is found that LPG contents are above stated value, it will inform the host controller by pulling the output pin to high and start to blink an onboard status LED. The sensor module is mainly intended to provide a means of comparing LPG sources and being able to set an alarm limit when the source becomes excessive.

- Temperature sensor(LM-35):

The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. Thus the LM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling.

TheLM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The low output impedance, linear output, and precise inherent calibration of the LM35 make interfacing to readout or control circuitry especially easy

These sensors are combined to detect the presence of LIVE humans and the surrounding environmental conditions. Here Wi-Fi module is used to return the acquired data of sensors. The robotic vehicle is navigated and controlled with the help of Wi-Fi and software developed on Visual basics. The vehicle also has facility for live video transmission of the rescue scene. D-Link Camera is preferred for the same.

3. RESULT ANALYSIS

Figure 5: snapshot taken from live video of mobile camera mounted on robotic vehicle.

The above image shows the snapshot of a scene taken from the live video transmission during the rescue operation of robotic vehicle. It is observed that the transmission of the data from the sensors and the video takes place effectively and efficiently up to a distance of 22 meters in open area without lag after this range for lossless data transmission repeater can be incorporated. The video starts to lag after a distance of 22 meters and completely stops transmission at 25 meters without a repeater.

The robotic vehicle consists of specialized tracked wheels to travel on uneven surfaces. The vehicle can also climb staircase of medium step size, this facility proves advantageous while the rescue is to be done inside wreck of building. The robotic vehicle power source is a battery, which is of heavy duty and rechargeable specially chosen in concern to the rescue work. The battery can provide power to the vehicle up to 3 hours in continuation.

4. CONCLUSION

Implementation of this robotic system will reduce the risk of rescuer’s life in many rescue operations and will increase the efficiency of rescue operation.

We are developing a Robotic vehicle which will have an easy interfacing with the Wi-Fi. It will be very user friendly search and rescue robot with good reliability. The proposed robotic system will reduce rescuer's efforts. This system also alerts rescuer about the surrounding conditions so that the rescue operation will be safe for rescuer also. The system also reduces faults by using more number of sensors and comparing their data. This method increases the efficiency of the system.

5. FUTURE SCOPE

Many modifications can be performed on the robotic vehicle, taking in concern the required rescue applications. By using various technologies such as GPS module to locate the accurate position of victim the rescue operation can be made more efficient. Transmission and reception of data can be possible with the help of GSM module. Bomb detection and diffusion can be made possible by using appropriate circuitry and specialized algorithms. It is also possible to mount Ammunition and on the vehicle for military applications.

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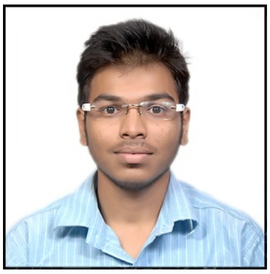

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