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Alive Human Detection Robot using PIR sensor

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Abstract:

Modern technology has paved the way for the construction of tall buildings and houses, which increases the risk of life loss during both natural and human-made disasters. To address this issue, we propose a recommended approach involves using a robot equipped with sensor technology to locate and determine the status of humans. The proposed solution is a robot based on passive infrared sensors (PIR). The robot is equipped with a set of sensors, including the micro controller using ultrasonic and PIR sensors, to detect signs of life from humans. If the person is found to be alive, a buzzer is activated. The robot then shares the person's location through a global positioning system(GPS) module, sending this information to the receiver via message. This way, timely assistance can be provided to individuals in need, potentially saving lives in critical situations. However, in harsh weather conditions, people may be stranded at various locations, making it challenging to find and assist them. The robot is operated via a Bluetooth module and utilizes an ultrasonic sensor to navigate autonomously.

Keywords: PIR sensor, GPS system, GSM technology, Rescue robot, Natural disasters.

1. Introduction

One of the most destructive occurrences in nature is the onset of natural disasters such as floods, earthquakes, volcanic eruptions, tsunamis, and other geological processes. These events have a profound impact on countless individuals. With the proliferation of high-rise buildings and man-made infrastructure in urban and industrial areas, the loss of life during such disasters can be significant. On average, each year, these calamities result in the loss of nearly 60,000 lives, accounting for 0.1% of all global deaths [1]. The toll taken by natural disasters is staggering, and they claim a substantial number of lives annually. Hence, saving human life during these disasters a crucial task.

In [2], the authors introduced an efficient architecture with the aim of mitigating risks for humans in unplanned and hazardous tasks, particularly in industries and nuclear settings. The human-robot interface (HRI) establishes a secure connection to the leader robot through a virtual private network (VPN), employing point-to-point tunneling protocol (PPTP) to ensure safe communication. This HRI is utilized to control and allocate various tasks to different robots, analyzing the assigned tasks based on their functionalities. The system effectively utilizes the HRI to manage and coordinate tasks for the robots, enhancing safety and efficiency in industrial and nuclear environments.

On the other hand, [3] presents a methodology focused on search and rescue operations, particularly in disaster scenarios, with a primary application in the military. The authors have equipped the robots with sensors capable of serving multiple purposes. The robots' sensor-based capabilities aid in detecting and locating humans in distress during disasters, contributing to life-saving efforts. The multi-purpose functionality of the sensors makes the proposed methodology versatile and valuable in various critical situations.

For saving the alive human within time in a destructed environment authors in [4] suggested an efficient technique. Identification of alive humans can be done by using temperature and radiation sensors. A methodology is proposed in [5] to reduce the human deaths in situation of natural hazards using radar sensors and using these sensors radio energy gets transmitted. Authors in [6] proposed a robot to save human life for Urban Search And Rescue (USAR). The article discusses the usage of a remarkable Passive Infrared (PIR) sensor, which emits infrared rays to detect the presence of humans. The sensor is designed to capture the thermal radiation emitted by a living human body, allowing it to effectively identify human presence. Once individuals are detected, the PIR sensor promptly triggers both audio and visual alerts to notify the authorities, ensuring that help reaches those in need swiftly. Camera modules are inserted to robot for capturing images [7-9].

The authors in [10] proposed a human detection robot for detecting alive human in rescue area using sensor suit. The sensor suit includes several sensors such polyelectric sensor, micro phone, USB camera, and IR camera. The poly electric sensor is used to detect human body radiation, but it's drawback is producing binary output. The emission of CO_2 (carbon dioxide) and breathing cycle of human is detected by using the system proposed in using CO_2. Using the proposed the alive human can be detected, but the problem is the CO_2 sensor response time is high.

In [11], authors presents an overview of the search and rescue environment, delving into the various applications of robots in urban search and rescue operations. Additionally, it outlines the robotic competitions designed to simulate real rescue scenarios. The authors in [12] discuss the emergence of Urban Search and Rescue Robotics as a response to the social impact of urban devastations. This article aims to present their firsthand experience and experimental findings concerning the development and implementation of various sensors.

The authors in [13] proposed a Remote Operated and Controlled Hexapod (ROACH) and it is a six-legged design that offers substantial advantages in mobility compared to wheeled and tracked designs. It comes equipped with predefined walking gaits and cameras that provide live audio and video feeds of disaster sites. The robot also supplies crucial information about object locations relative to its position to the laptop interface. Another notable robot is Kohga from the University of Tokyo, designed specifically for tackling rough terrains. Kohga is a snake-like robot composed of multiple crawler vehicles connected in a serial manner. This configuration results in a long and slender structure, enabling the robot to access narrow spaces effectively.

In the study by Bahadori [14], various techniques for human body detection (HBD) using visual information are analyzed. The primary objective of this research is to develop image processing routines tailored for autonomous robots engaged in detecting victims within rescue environments. In [15] authors introduced a human detection robot using IoT and Raspbeerry pi.

To enhance its mobility and versatility, this PIR sensor is integrated into a robot capable of moving in all directions. This makes it particularly well-suited for maneuvering in areas prone to earthquakes. The robot's propulsion system employs a geared DC motor to provide increased torque and low speed, and a stepper motor for improved turning accuracy, enabling precise control over its position.

The robot features a three-wheel geared drive, with DC motors attached to facilitate seamless forward and reverse movements. This combination of technologies equips the robot to efficiently navigate challenging terrains and respond promptly to human presence in disaster-prone regions.

According to the Urban Search and Rescue group, saving a victim's life is most likely within the first 48 hours of a rescue operation. The camera module captures video, which is then processed using machine learning with the HARR cascade algorithm. When the robot detects a person, the PIR sensor is triggered to verify whether the person is alive or not.

2. Existing system and proposed system

Earthquakes unleash a devastating impact, showing no discrimination between humans and material possessions. Often, people end up buried amidst the debris, making it incredibly challenging to locate them. The search and detection process by rescue workers becomes time-consuming, especially considering the extensive areas that get affected by the earthquake, further complicating the task.

Hence, in this article we proposes an autonomous robotic vehicle designed to navigate through earthquake-prone areas and assist in identifying live individuals during rescue operations. This innovative solution aims to save precious lives by enabling timely detection in natural calamities, even without the reliance on large rescue teams. The robotic vehicle's capabilities offer a promising means to enhance rescue efforts and potentially save lives during critical situations.

3. Circuit and working

The block diagram of the proposed alive human detection robot is shown in Fig. 1 and it's circuit diagram is shown in Fig. 2. To detect the alive human presence in a certain specified area which is affected by any disaster is too difficult. By using PIR sensor it is possible to detect the presence of Human body along with position. PIR sensor will detect the infrared rays emitted by the human body and infrared transistor detects the infrared rays emitted by the human body. The output of comparator connected to the micro controller. The micro controller detect signal from designed passive infrared sensor & gives an alarm for a specified time period. The GPS unit detects the position of person and it transmits to our mobile using global system for mobile communication (GSM) module. The micro controller gives an alarm after complete evaluations. To save human life from earthquakes etc, it is essential that a Robot attached by PIR sensor moves forward and detects human beings, if any obstacles occur Robot changes direction automatically. If any human body is present in that particular direction it immediately detects that position using GPS and sends that position to our mobile using GSM.

When an individual enters the monitored area, their presence is detected through a process where the infrared energy emitted from the intruder's body is concentrated using a Fresnel lens or a mirror segment. This focused energy overlaps a section on the chip that had previously been observing a significantly cooler part of the protected area. In this manner, the system can identify and register the presence of the intruder by detecting the contrast in infrared emissions between the person and the surrounding environment.

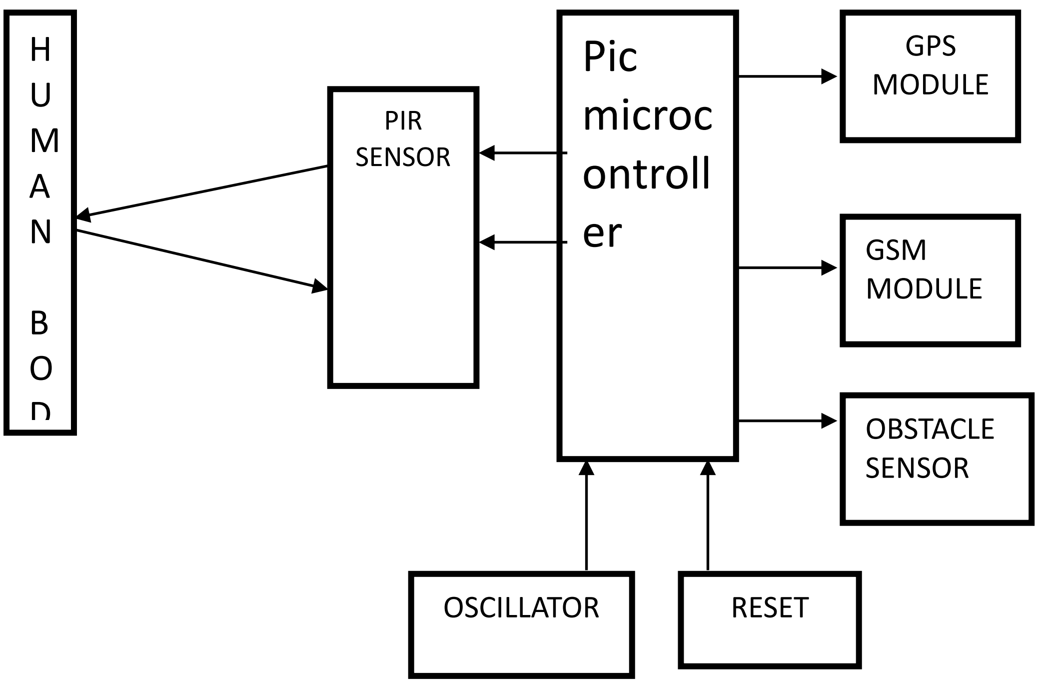

Fig. 1. Block diagram of proposed system

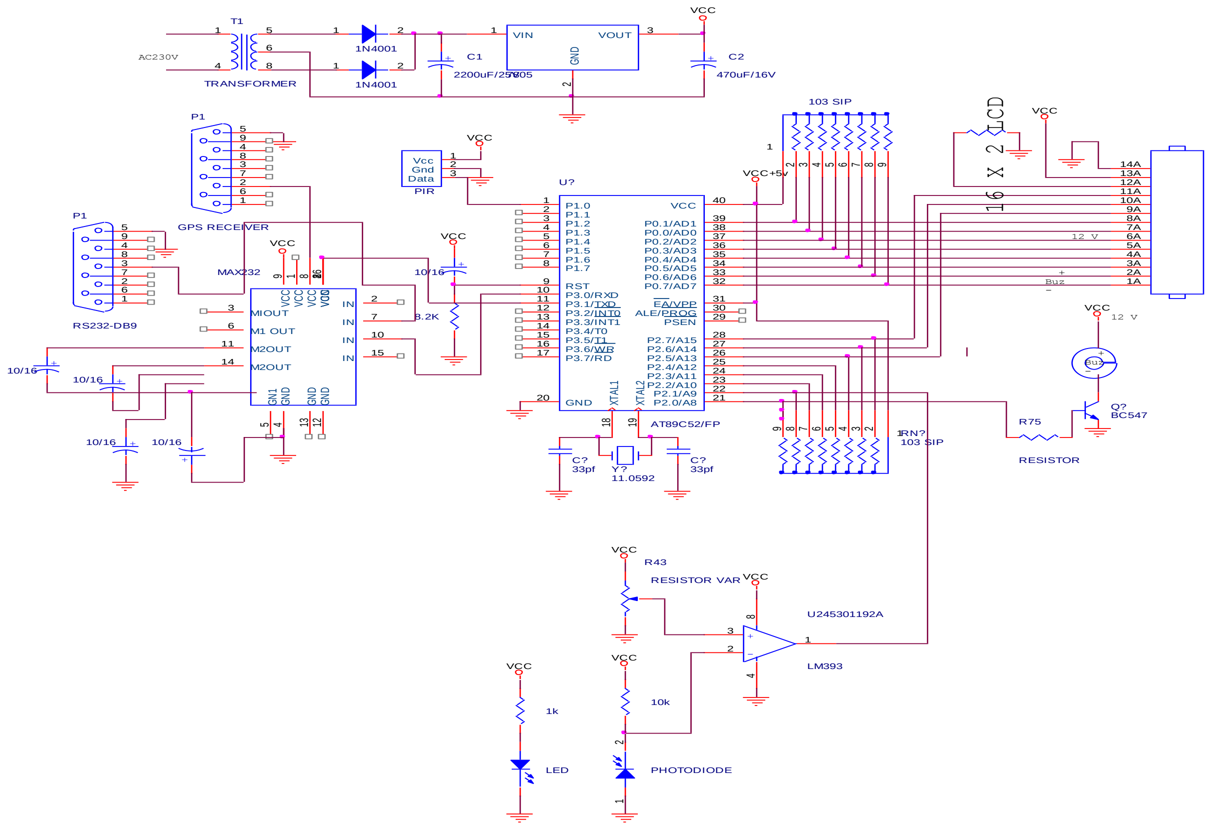

Fig. 2. Circuit diagram of human detection robot

The fundamental idea behind IR (infrared) obstacle detection is to transmit an IR signal (radiation) in a specific direction. When this signal encounters an object, it reflects back, and the IR receiver detects the returning signal. In this way, the system can determine the presence of obstacles based on the reflection of IR radiation from surfaces of objects within its detection range.

A GPS receiver determines its position by accurately measuring the timing of signals transmitted by GPS satellites located high above the Earth's surface. These satellites continuously send messages to a GSM module.
Whenever GSM module is activated it sends the longitude and latitude values to particular mobile number. After receiving these values we have to find out the exact position of person by using google map.

The MAX232c is used to provides high speed communication between GSM and GPS module. The microcontroller operates logic 0 and 1 at 0 and 5v respectively. But GSM and GPS modules operates at -3v and 15v respectively so we have to provides communication between modules and controller MAX232c is used.The Receiver pin of MAX232c is connected to GPS module which receives the longitude and latitude values and the transmitted pin of MAX232c is connect to the GSM module ,which is used to display the message in the mobile.The 16x2 LCD display is used to display which sensor and module is actived. If any obstacle is occurs the robot takes right or left directions to avoid the obstacles.

4. Hardware description

4.1 PIC micro controller

PIC microcontrollers produced by Microchip Technology are a collection of Harvard architecture microcontrollers. These microcontrollers are based on the PIC-1650, initially developed by General Instrument's Microelectronics Division.

4.2 Passive Infrared (PIR) Sensor

A PIR sensor is an electronic device that has been created to sense infrared light emitted by objects present within its field of view. These sensors are widely used in the construction of motion detectors based on PIR technology, as explained later.

4.3 Obstacle sensor

The obstacle sensor is shown in Fig. 3 and the object under consideration could be anything with a particular shape and size. An IR LED emits an IR signal onto the surface of the object, and this signal is then reflected back. The reflected signals are captured by an IR receiver, which can be either a photodiode, a phototransistor, or a readymade module capable of decoding the signal.

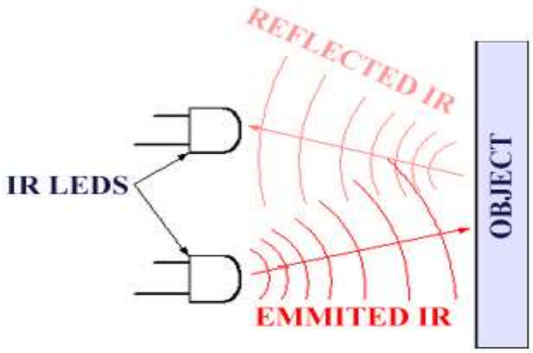

Fig. 3. Obstacle Sensor

4.4 Global system for mobile communication (GSM)

In this setup, we are utilizing a microcontroller from the 8051 series. The microcontroller is equipped with an antenna, which takes the form of a wire, and an external slot for SIM card allocation. We can insert any GSM model network SIM into this slot. The microcontroller requires an external power supply, which is provided through an adaptor supporting 9V and 2A.

To indicate its status, the microcontroller has two LEDs. The power LED emits a continuous light to signify that the system is powered on. The network signalling LED behaves differently. Initially, it blinks rapidly, and after some time, it switches to a slower blinking pattern, with only one blink per minute. This change in blinking rate indicates that the SIM has successfully acquired a signal from the network. Once the network signal is obtained, the microcontroller is capable of sending messages to any compatible network.

4.5 16x2 LCD Display

Liquid crystal displays (LCDs) are built using materials that exhibit properties of both liquids and crystals. Instead of possessing a distinct melting point, LCDs have a temperature range wherein their molecules become highly mobile, akin to a liquid state, while simultaneously forming an orderly structure, similar to that of a crystal.

Fig. 4. Interfacing LCD to the Micro Controller

5. Practical Implementation

The prototype of the proposed alive human detection is shown in Fig. 5. The proposed system is developed on a pilot scale. Here, the micro controller reads data from designed passive infrared sensor & gives an alarm for a period of specified time. The infrared transistor detects the infrared rays emitted by the human body subsequently amplified by the op-amp converts into bit 0 or 1 by the comparator. The output of comparator connected to the micro controller. The micro controller gives an alarm after complete evaluations. So, the micro controller avoids the wrong alarm by taking two or three readings from the PIR sensor. Fig. 6 shows the human detection robot waiting sensor. When an obstacle is detected by robot, it changes its direction and is shown in shown in Fig. 7 and Fig. 8 shows the robot when detected alive human and it inform the managing authority through SMS. A buzzer is also activated to inform authorities that an alive human is detected.

After switching on the power supply, the code written in the controller starts working and robot starts moving in the forward direction. PIR sensor detects the alive human present in the monitoring area. GPS module is uses to identify the location of alive human, which consists of antenna and tiny micro processor. GPS module receives the data sent by the satellite using dedicated RF bands. The GSM module send the location of alive human along with longitude, latitude to the registered mobile. Whenever the robot detects the human present in the monitored area, the PIR sensor gets activated and it shows the human detected message on LCD display and also sends the location of alive human along with the coordinates of human to the registered mobile unit. Moreover, buzzer also gets activated and it makes sound.

In the similar manner whenever an obstacle is detected in the robot monitored area the obstacle sensor gets activated again based on the code written in the controller the robot changes the direction and shows the message on the LCD display that the obstacle is detected. Sensors plays a key role in the proposed architecture. The obstacle sensor sense continuously whether any obstacle is identified in the monitored area using the sending of RF signal. PIR sensor detects alive human present in the area, where disaster is happened. It detects the alive human by receiving special radiation, which is released by only the alive human. Whenever, these waves are received by the PIR sensor from alive human, it detects the signal and convert the received signal into voltage form and sends the positive voltage to the controller. The process upon receiving the signal from PIR sensor, activates the buzzer, GPS module and GSM module and these are controlled by using code written in the controller.

Consequently, this autonomous vehicle can save numerous lives within a short period, a task that would be time-consuming and challenging if performed manually. Enhancing the vehicle with high-range sensors and high-capacity motors can further improve its capabilities. Additional sensors such as mobile phone detectors and metal detectors can be implemented to enhance the vehicle's effectiveness in rescue operations.
While urban search and rescue robots already utilize a range of sensors, their main limitation lies in their cost. However, in this paper, we have utilized sensors that are both cost-effective and readily available, making the proposed autonomous vehicle a more practical and viable solution for life-saving missions.

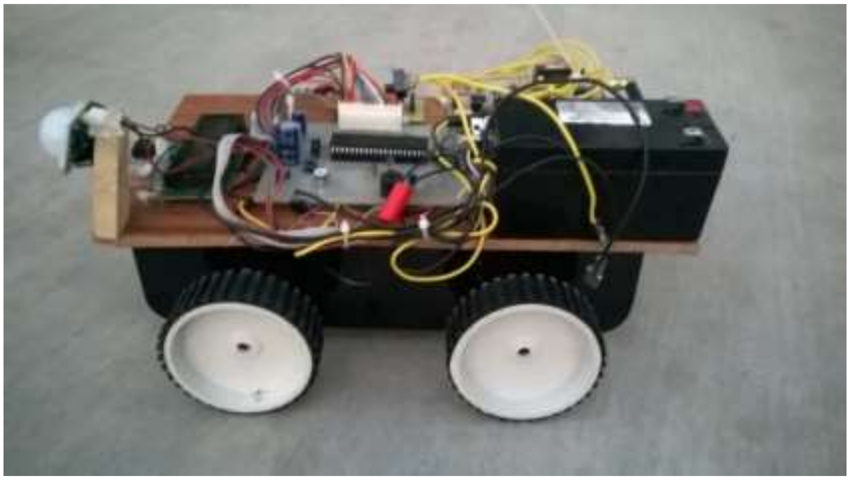

Fig. 5. Prototype of human detection ROBOT

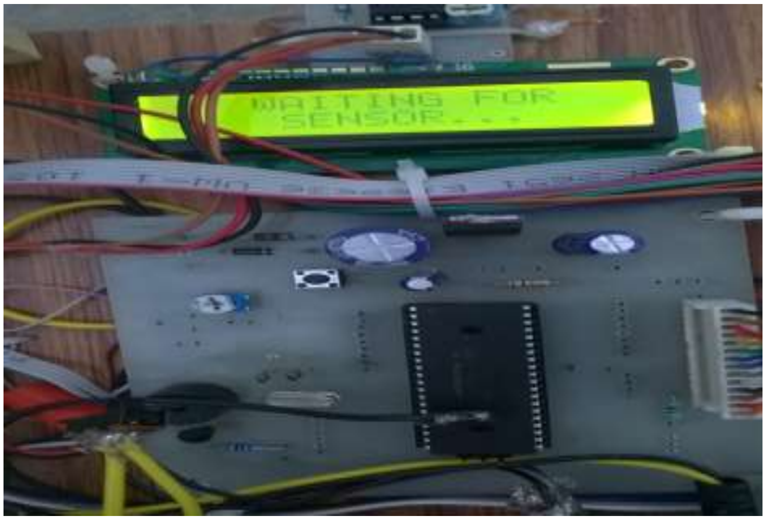

Fig. 6. Human Detector Robot waiting for sensors

Fig. 7. Human Detector Robot when Obstacle is detected

Fig. 8. Human Detector Robot detecting Human with PIR sensor

6. Conclusion

This article presents a novel methodology for detecting surviving humans in devastated environments, employing a simulated autonomous robot. The proposed hardware technique save the victim persons life during natural disasters using PIR sensor, GPS and GSM modules. The robot's circuit incorporates two levels of sensing, aiming to create a cost-effective system. The first level sensor combines a PIR sensor with a temperature sensor to effectively detect the presence of living humans in a given scene. The proposed system demonstrates superior performance compared to existing methods, showcasing advantages in terms of reduced processing cost, communication cost, storage cost, and power consumption. By implementing this innovative approach, the detection and rescue process becomes more efficient and economical, enhancing the chances of locating and aiding survivors in critical situations.

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