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LIFE DETECTING ROBOT FOR RESCUE OPERATIONS

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In this paper, a new approach for finding human beings trapped under debris of earthquake, landslides or in some hazardous conditions viz nuclear radiation leak region, using a robot is proposed. The proposed robot monitors the area via CO2 (Carbon dioxide) sensor as CO2 increases there because of exhaled breath. The sensor triggers a buzzer as the CO2 level in its vicinity reaches a set threshold value to indicate the presence of a human being nearby. The robot also has an audio/video monitoring ability with the aid of a camera with an adjacent torch. Motion of robot is controlled with the help of a remote and the real time audio, video transmitted from robot to LCD/TV via radio frequency is processed by person controlling its motion thereby an appropriate conclusion is reached regarding the presence of victim. Hence, processing and transmission cost of real-time data is reduced. This robot can provide a more simpler, reliable and cheaper way to track alive victims of disasters and help rescue them.

Keywords: Rescue Robots; Sensors; Camera; Transmitter Receiver; Motors.

1. INTRODUCTION

Earthquakes, landslides, cyclones, floods are some of the natural disasters that time and again make us realize that there is no power bigger than that of the Nature around us. With the evolution of science and technology at an uncontrolled pace, and the creation of sky scraper buildings and dwellings and encroachments everywhere, the risks of losing life due to such calamities has all the more increased and added to the chaos. Moreover, with the advancement in nuclear technology, the risks of manmade calamities like nuclear explosions and nuclear radiation leaks have also reached an all time high. Many people get killed instantly due to these natural and manmade disasters when they hit a region. Many others get trapped under debris for hours and days because their presence there cannot be detected by the rescue teams easily. Hence, they die a painful death as help could not reach them on time. For many years dogs have been used for the rescue purposes. But the rescue dogs need to be trained heavily before they can be used for these purposes. Moreover, a fully trained dog costs anything between $300 to $400 and can be used for not more than 5 years. Being sensitive these dogs don't tend to work properly during an earthquake relief as there are aftershocks after an earthquake hits a region. On the other hand, the rescue team workers cannot enter certain parts in such calamity hit zones. And if they do, a rescue worker may end up being a victim himself. For these reasons and others, for past some years mobile robots are being introduced for such rescue purposes. The systems used before faced a few problems [1]:

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1. High communication costs due to enormous transfer of images to the operator.
2. Noisy communication between system and the control unit ultimately breaking the communication link in wireless robots.
3. Microwave frequency based systems are sensitive but very expensive.
4. High processing cost due to continuous capturing, storing and transfer of images and hence slow.
5. Continuous need for illumination or use of IR camera to work independent of light but may give ambiguous results in presence of other heat sources nearby.
6. Most motion sensors algorithms assume that camera is stationary hence give unreliable results.

The system used just two motors, LED torch, a simple VGA camera and CO2 sensor is highly compact and also save on the need of expensive and powerful hardware and complex algorithms thereby reducing its cost and energy consumption. Many other such robots highly equipped with sensors, actuators etc, are autonomous and efficient but lack cost and power efficiency. Also they are less compact thereby less capable of slithing through the debris and are complex. Such robots not only have high initial costs but also incur high rear and tear costs with most parts needing replacement soon. Since a disaster afflicted area is generally large and requires quick rescue using a no. of rescue teams simultaneously, a large no. of such economic robots can help speed up the rescue work and incur minimal cost due to wear and tear.

While this system simplifies all these and many other limitations by using real time audio monitoring through LCD/television sets. As humans are very good at sound

processing this system transmitting real time audio to TV set is more reliable to distinguish a human sound timely and also help recognize unusual sounds like regular banging by victim. Also this robot moves very smoothly thereby making least noise which could otherwise interfere with the victim's shouts. Thirdly since co2 sensors are highly directional therefore the various levels help the remote operator to direct robot in direction of increasing co2 content thereby locating the source of the emissions i.e. the trapped survivor.

The proposed robot uses CO2 sensor to detect any signs of human life in its vicinity. The sensor triggers the buzzer on reaching a region with higher level of CO2 than the set threshold value of alive human region. It also has a low-cost camera fitted in its front to capture the audio, video of the region and transmit both audio/video signals on a LCD/ TV screen using cost-effective RF (radio frequency) transmitter and receiver. The robot also has an LED made torch to light the areas where robot enters and give a clear footage to the camera thereby working even in improperly lit regions. LEDs are economical and consume less power as well.

2. PROPOSED TECHNIQUE

The various steps used in the proposed technique are discussed below.

2.1 Hardware Used

Robot is fitted with the following things:

1. A low-cost camera to monitor audio/video signals from the region and transmit them to TV screen.
2. A CO2 sensor which triggers a buzzer when level of CO2 in the region is above a set threshold value.
3. DC motors to provide torque to wheels of robot to move even in rugged surfaces.

A. Design Specification

A legged robot design is very capable of moving on various terrains but involves a no. of control methods, actuators and sensors. A track flipper robot like Plasma-RX [2] can travel uneven track with less actuators etc but still very heavy, power consuming and results in high wear and tear. However this design involves only two wheels driven by two motors respectively at one end and the other end is supported by caster wheel. This design helps to maintain the overall balance of robot and prevents it from skidding. Figure 1(a) and 1(b) represent the internal and external components of robot. Figure 2 represent the receiver side display of camera. Figure 3 represent the remote side circuit.

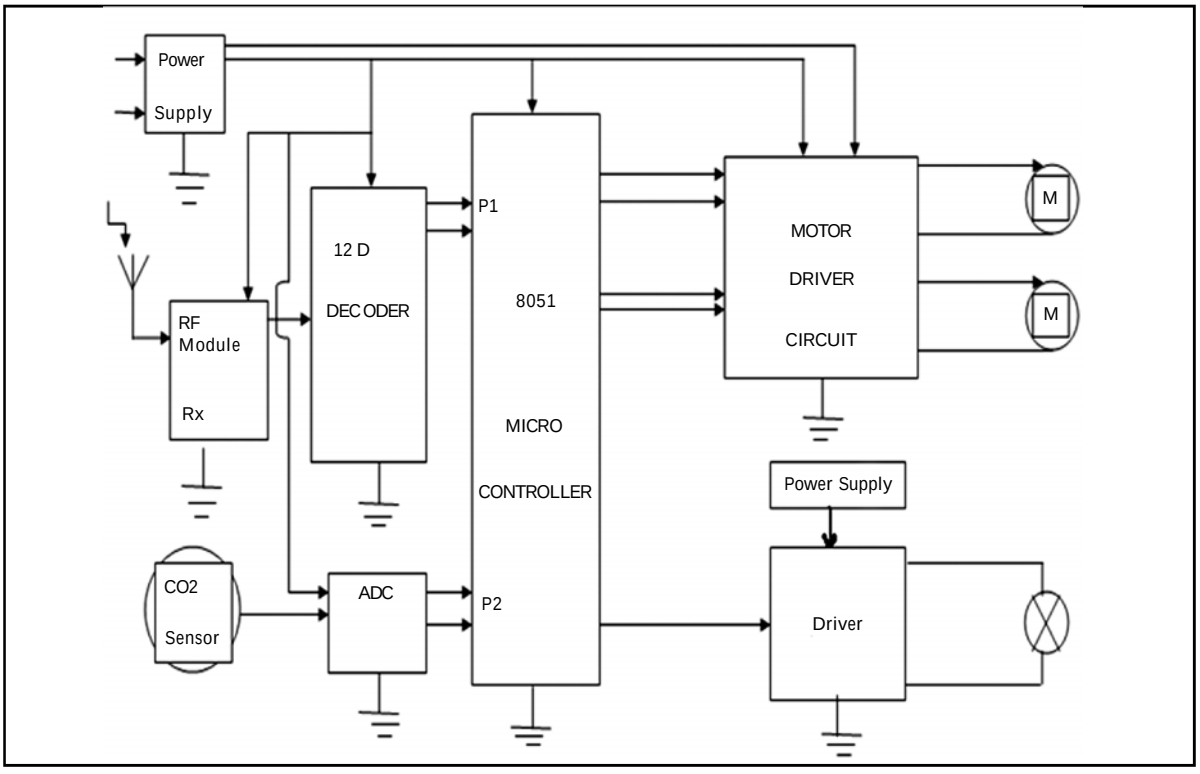

Fig. 1

Fig. 1: (a) Internal Component of Robot Side Circuit Diagrams

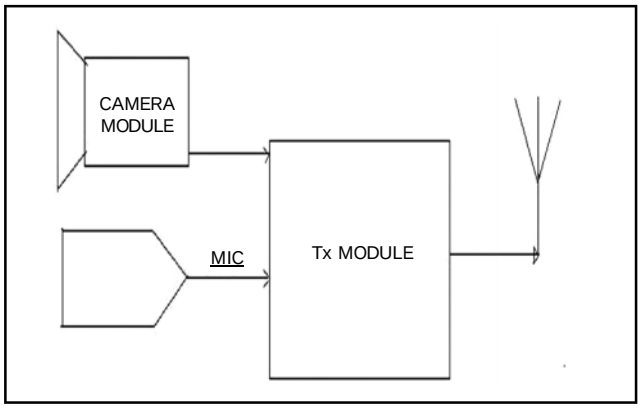

Fig. 1: (b) External Component of Robot Side Circuit Diagrams

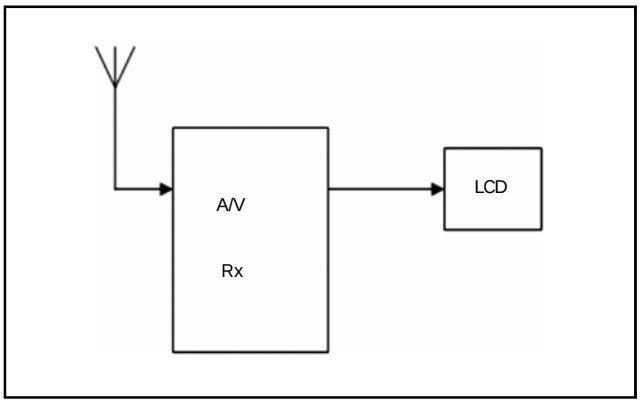

Fig. 2: Receiver Side Display

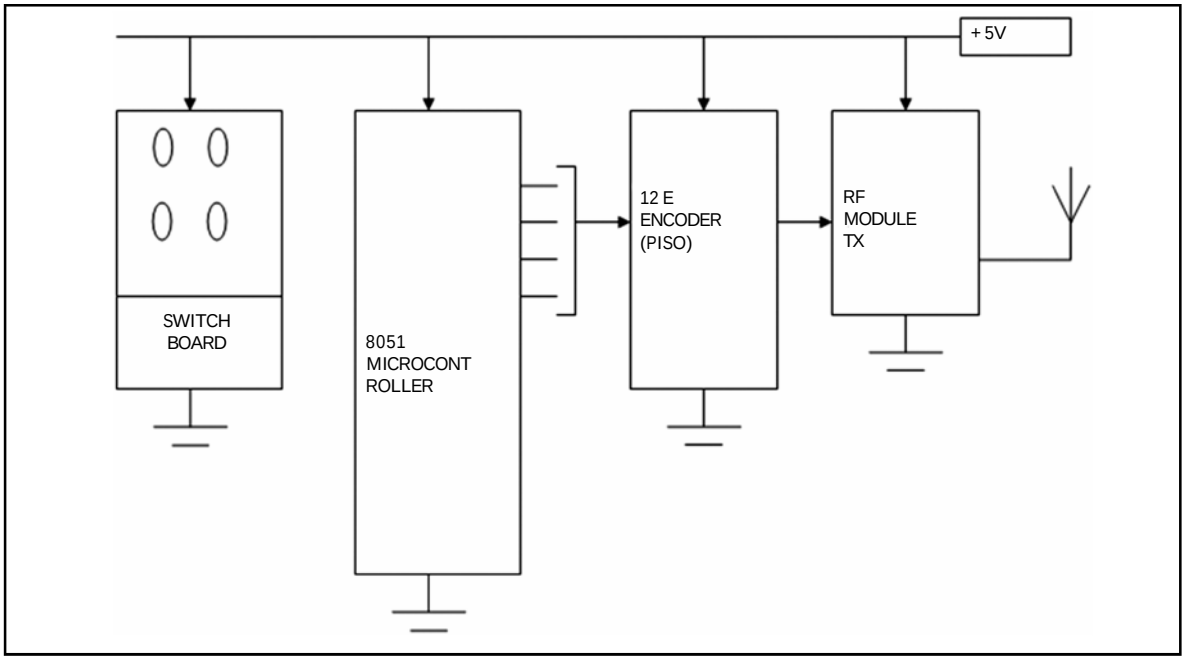

Fig. 3: Remote Side Circuit Diagram

B. Motor Used

Since the robot is very light around just 1.5 kg and has to move on rough surfaces so not very powerful motors are required. Here two 12V DC geared motors providing a torque of 1.2 kgcm were used as the power requirement of the design is quite less.

C. Sensor Calibration

Indoor CO2 levels usually vary between 400 and 1200 ppm (parts per million). Outdoor CO2 levels are usually 350–450 ppm [3]. Therefore CO2 sensor is calibrated to trigger the buzzer through ADC (analog to digital converter) when CO2 level in its vicinity gets above 1000 ppm or .10% which is the amount in a crowded or industrial area and resembles this situation of an improperly ventilated enclosed space.

D. Robot Interfacing and Control

The robot is remote controlled to enable broader control of the human operator viewing the footage in LCD in rescue. As human brain is better at real time audio, video processing and understanding alien situations rather than an autonomous robot and since there are few parameters to be observed and controlled by the operator this manual control provides reliable conclusions about presence of a survivor.

2.2 SOFTWARE IMPLEMENTATION

When the CO2 sensor detects some life signs, i.e. when CO2 level is above threshold value, the control program triggers the buzzer for a set period of time indicating presence of a human being in that region. Figure 4 shows the process flow diagram of the robot developed.

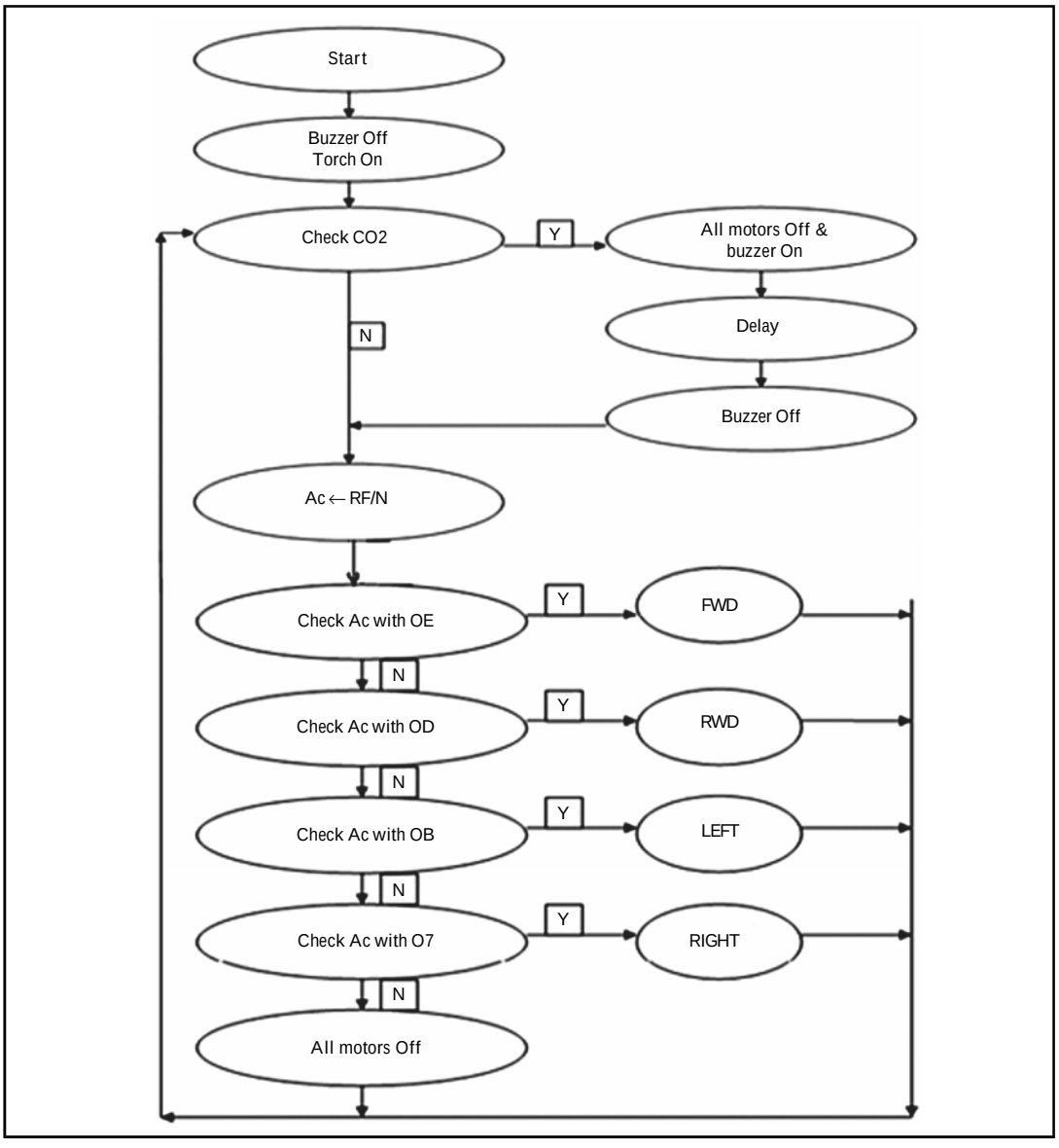

Fig. 4: Flowchart Implemented in C.

Movement of robot is controlled by a remote through radio frequency (RF) transmitter and receiver pair.

3. DISCUSSION

Aim of this research was to provide a cost-effective life detecting robot for rescue operations. Though many other systems are available like the Urban Search and Rescue Robots (USAR) with more number of sensors [4], but the problem with them is the cost efficiency and the power consumption and considerable size.

The robot uses three levels of scrutinizing criteria – CO2 sensor, audio and video capturing of the area by the camera and being economical at the same time. It is power efficient, equipments are available easily in the market, cost effective and outputs generated are reliable as well.

As CO2 sensor is highly directional, hence various levels of CO2 indicated through different LEDs of ADC guide the operator to direct robot towards the target. Real time audio, video is best processed by human operator and help to understand the environment effectively, hence resulting in appropriate actions. The robot is designed to have minimal wear and tear, therefore incur minimum cost on maintenance. Light weight and compact size are added advantages. With the implementation of this design, it sure will be a great help to the society to fight such mishaps in the future.

4. SCOPE IN FUTURE

Since this robot is developed on a small scale and is still cost and energy efficient, its future is bright and wide. Robot can further be equipped with a speaker or recorder to interact

with survivors and assure them of nearby help.Also it can be facilitated with two way communication and to transfer analog data of CO2 directly to operator thereby giving broader two way communication to transfer analog data of CO2 sensor directly to operator thereby giving flexible interpretation of the same.

The robot can also be equipped with a rotating robotic arm with camera and sensors fitted on its free end providing closer reach to target and enabling wider view.

This robot can also be used in military applications as it can hint the presence of hidden people in any region, let they be either terrorists or the hijacked people by them and indicate whether they are still alive or dead.

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