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# Human Detector- Unmanned Ground Vehicle

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**ABSTRACT**: A UGV is a vehicle system able to operate in robust environments where it is difficult for humans to work and is sometimes dangerous for humans. These robotic vehicles can adapt themselves to complex environments and perform specified tasks. When natural calamities like earthquake occurs, it affects structure of building badly and may result in destruction of building. This project is to design remote controlled UGV to detect human presence using Active RFID tags in Institutes, Offices and Colleges. Active RF transmitters will be provided to each user. In case of natural calamities like earthquake if humans get buried under the debris the Unmanned ground vehicle will move on the debris and detecting the signal from transmitters. System will give range of 5 to 8 meters depending upon various environmental factors in which human being will be present. The RF transmitters will work at 433 MHz. There is no need for the RF reader to transmit a large amount of power as the RF transmitter has an onboard powers source.

**KEYWORDS**: Unmanned Ground Vehicle, Search and Rescue, RF transmitter, disaster management.

## I. INTRODUCTION

An unmanned ground vehicle (UGV) is a vehicle that operates while in contact with the ground and without an on board human presence. UGVs can be used for many applications where it may be inconvenient, dangerous, or impossible to have a human operator present. Generally the vehicle will have a set of sensors to observe the environment, and either will take autonomously decisions about its behaviour or pass the information to a human operator at a different location who will control the vehicle through teleoperation.

The UGV is the land-based counterpart to unmanned aerial vehicles and remotely operated underwater vehicles. Unmanned robotics are being actively developed for both civilian and military use to perform a variety of dull, dirty, and dangerous activities. There are a wide variety of UGVs in use today. Predominantly these vehicles are used to replace humans in hazardous situations, such as handling explosives and in bomb disabling vehicles, where additional strength or smaller size is needed, or where humans cannot easily go. Military applications include surveillance, reconnaissance, and target acquisition. They are also used in industries such as agriculture, mining and construction.

UGVs are also being developed for peacekeeping operations, ground surveillance, gatekeeper/checkpoint operations, urban street presence and to enhance police and military raids in urban settings. UGVs can "draw first fire" from insurgents — reducing military and police casualties. Furthermore, UGVs are now being used in rescue and recovery mission and were first used to find survivors following 9/11 at Ground Zero.

Uses of UGV:

### *A. Space Applications*

NASA's Mars Exploration Rover project includes two UGVs, Spirit and Opportunity, that are still performing beyond original design parameters. This is attributed to redundant systems, careful handling, and long-term interface decision making. Opportunity (rover) and its twin, Spirit (rover), six-wheeled, solar powered ground vehicles, were launched in July 2003 and landed on opposite sides of Mars in January 2004. The Spirit rover operated nominally until it became

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trapped in deep sand in April 2009, lasting more than 20 times longer than expected. Opportunity, by comparison, has been operational for more than 12 years beyond its intended lifespan of three months. Curiosity (rover) landed on Mars in September of 2011, and its original two-year mission has since been extended indefinitely.

*B. Civilian and Commercial Applications*

Multiple civilian applications of UGVs are being implemented to automatic processes in manufacturing and production environments. They have also been developed as autonomous tour guides for the Carnegie Museum of Natural History and the Swiss National Exhibition Expo.

*C. Agriculture*

UGVs are one type of Agricultural robot. Unmanned harvesting tractors can be operated around the clock making it possible to handle short windows for harvesting. UGVs are also used for spraying and thinning. They can also be used to monitor the health of crops and livestock.

*D. Emergency Response*

UGVs are used in many emergency situations including Urban Search and Rescue, fire fighting, and nuclear response. Following the 2011 Fukushima Daiichi Nuclear Power Plant accident, UGVs were used in Japan for mapping and structural assessment in areas with too much radiation to warrant a human presence. Our project deals with specialized application of Unmanned Ground Vehicle (UGV) to detect humans trapped under debris in case of a disaster. The project is intended to develop a system to save time required to search for live persons stuck under debris in case of disasters. Many a times people get stuck under debris and it becomes time consuming and sometimes difficult (as humans might not be reachable) task to find them. Saving even minutes in such case could result in saving lives.

## II. LITERATURE SURVEY

### II.1 TYPES OF ROBOTS

*A. Legged Robots*

Legged robots, such as Titan VIII and Parawalker (Figure 1(a) & (b)), are developed for their ability to move in outdoor environment with obstacles, while others, like Robot III (Figure 1(c)), are developed to study gait patterns of insects or animals. Commercially, there are hobby kit robots such as Hexapod III (See Figure 1(d)) for sale.

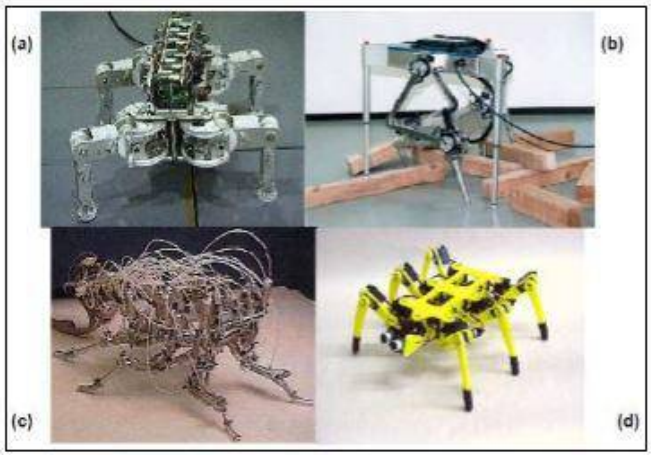


Fig. 1 Legged Robots :a) Titan VIII from Tokyo Institute of Technology; b) Parawalker from Tokyo Institute of Technology; c) Robot III from Case Western Reserve University; d)Hexapod III from LynxmotionInc

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*B. Tracked Robots*

There are not many tracked robots in the robotics research community but instead many commercial companies developed them for mostly explosive ordnance disposal purposes, for example, Brat, Cyclops and Mini-Andros II (See Figure 2(a), (b) and (e)). Urbie as shown in figure 2(c) is developed for urban reconnaissance and surveillance while MicroVGTV as shown in Figure 2(d) is developed for piping inspection as well as urban search and rescue. Lurch as shown in Figure 2(f) is the research robot developed for terrain exploration. There is one common feature among those tracked robots that can climb staircase, that is, one or two additional pairs of articulated tracks. With one or two additional degree of freedoms, these robots can overcome more type of obstacles compared to conventional tank-like tracked robots.

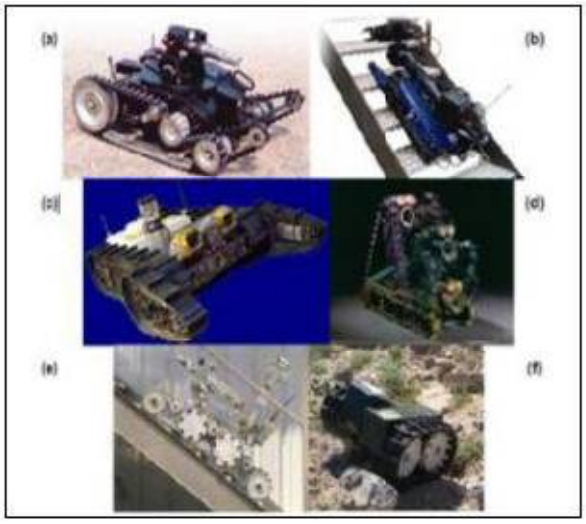

Fig. 2 Tracked robots: a) Brat from Kentree; b) Cyclops from AB poole; c) Urbie from iRobot; d) Micro VGTV from Inuktun; e) Mini-Andros II from Remotec; f) Lurch from Sandia

*C. Wheeled Robots*

Wheeled robots are the most common types of robots available. Their design can be very simple to serve as platforms to carry payload, for example, explosive ordnance disposal robots like Lynx and Hobo (See Figure 3(a) and (b)). Their design can also be very complicated, such as Ratler and Sojourner (See Figure 3(c) and (d)), to serve as platforms for planetary exploration.

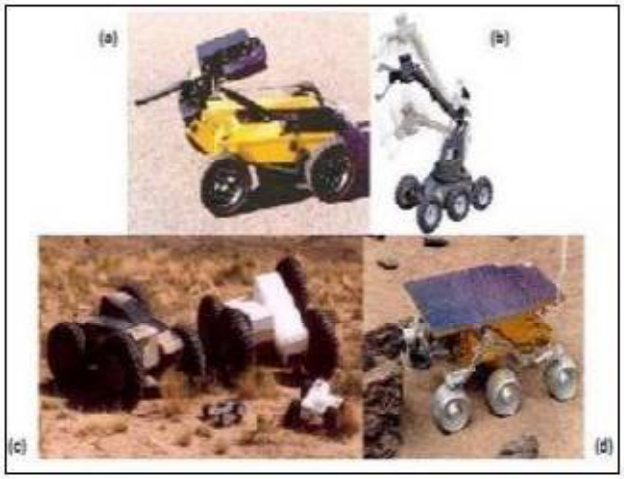

Fig. 3 Wheeled robots: a) Lynx from AB poole; b) Hobo from Kentree; c)Ratler Rovers family from NASA; d) Sojourner from NASA

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*D. Re-configurable Robots*

Polybot and Polypod are reconfigurable robots that are highly versatile, which are made of one or two type of repeated modules respectively. They can reconfigure themselves to whatever shape that best suits the current tasks.

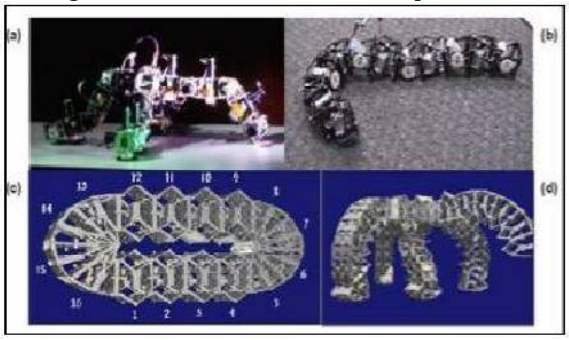

Fig. 4 Reconfigurable robots: (a&b) Polybot; (c&d) Polypod

Table 1. Comparison among Different UGV

| Factors/Types of Robot | Wheeled | Tracked | Legged | Reconfigurable |
|---|---|---|---|---|
| **Terrain Capabilities** | Limited | Moderate | Good | Good |
| **Stability** | Good | Excellent | Poor | Moderate |
| **Speed** | Excellent | Good | Moderate | Moderate |
| **Payloads** | High | High | Low | Low and Limited |
| **Complexity** | Low | Moderate | High | Very High |

## II.2 HUMAN DETECTION

Human sensing (also called human detection or human presence detection) encompasses a range of technologies for detecting the presence of a human body in an area of space, typically without the intentional participation of the detected person. Common applications include search and rescue, surveillance, and customer analytics (for example, people counters). Modern technologies proposed or deployed for human sensing include: Acoustic sensors, Image recognition of human shapes, RF sensors, Thermal sensors and Chemical sensors.

*A. Detection using Radar*

Detection of human target is based on the fact that there is always some movement due to breathing or movement of body parts (as in case of a walking person). This small movement can be used to detect a human being from other objects behind a wall or beneath rubble but it becomes challenging due to high clutter from the wall and other objects inside a room. An effective human detection method requires a model of ISM radar waveform propagation and scattering, e.g., interaction with the human body

*B. Detection using active RFID Transmitter and Receiver*

Active RFID tags are basically miniature radio flares and contain both a radio transmitter and a radio receiver circuit. The reader in their range communicates with the tags in accordance with the protocol (standard/ proprietary) that they follow. The readers can collect information from multiple tags at the same time. Active RFID tags can be provided to each user. In case of natural calamities like earthquake if humans get buried under the debris the unmanned ground vehicle will move on the debris and detecting the tag.

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## III.PROPOSED METHODOLOGY AND DISCUSSION

### A. *Block Diagram*

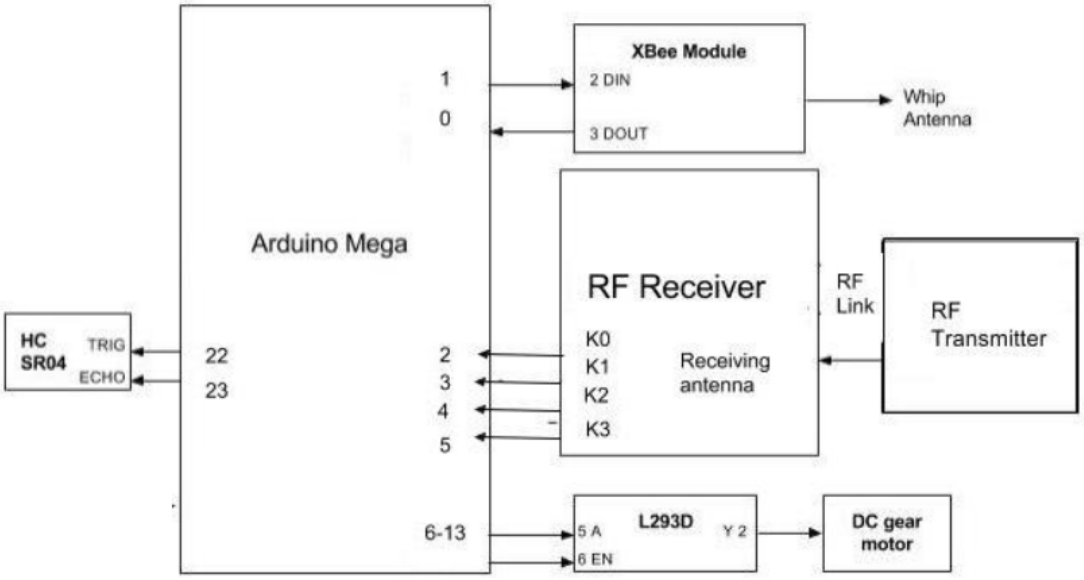


Fig. 5 Block Diagram

Above block diagram includes following circuit blocks with description.

i. *Arduino Mega:*

This unit is responsible for overall working of the UGV. It is responsible for proper functioning of all other blocks. It has control over other blocks like motion control, transreceiver unit for detection signalling and motion control, as well as it uses the data provided by radar unit and makes decisions to control other blocks.

ii. *HC SR04:*

This unit consists of transmitter and receiver transducer so that pulses are transmitted and echoes are received after reflection from the obstacle discovered in the path.

iii. *Motors:*

We are using 12V DC gear motors working at 0.65Amp current. Using four motors at the base of UGV for simple motions.

iv. *Motor driver unit:*

We use two L293D Quadruple Half-H drivers. These circuits are required for proper motion of motors.

v. *XBEE Module:*

XBee is a specification for a suite of high level communication protocols used to create personal area networks built from small, low-power digital radios. ZigBee is based on an IEEE 802.15 standard. Though low-powered, ZigBee devices often transmit data over longer distances by passing data through intermediate devices to reach more distant ones.

vi. *RF Transmitter:*

RF transmitter is used to transmit RF signals from human end using 433 MHz ASK transmitter and HT12E encoder IC.

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vii. *RF Receiver:*

RF receiver is used to detect RF signals from transmitter at human end using 433 MHz ASK receiver and HT12D decoder IC.

### *B. Flowchart*

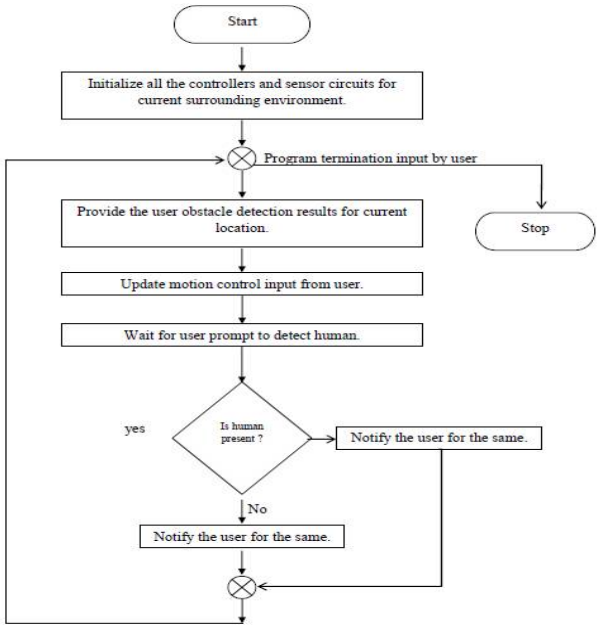


Fig. 6 Flowchart

## IV. RESULTS

Track wheeled UGV is developed using Arduino microcontroller to work on 12V 2400mAh Li-Po Battery and controlled wirelessly using XBEE. Active RF transmitter and receiver are developed using 433MHz ASK module working on two 3V Lithium cells and embedded with UGV.

### *A. Motion Control*

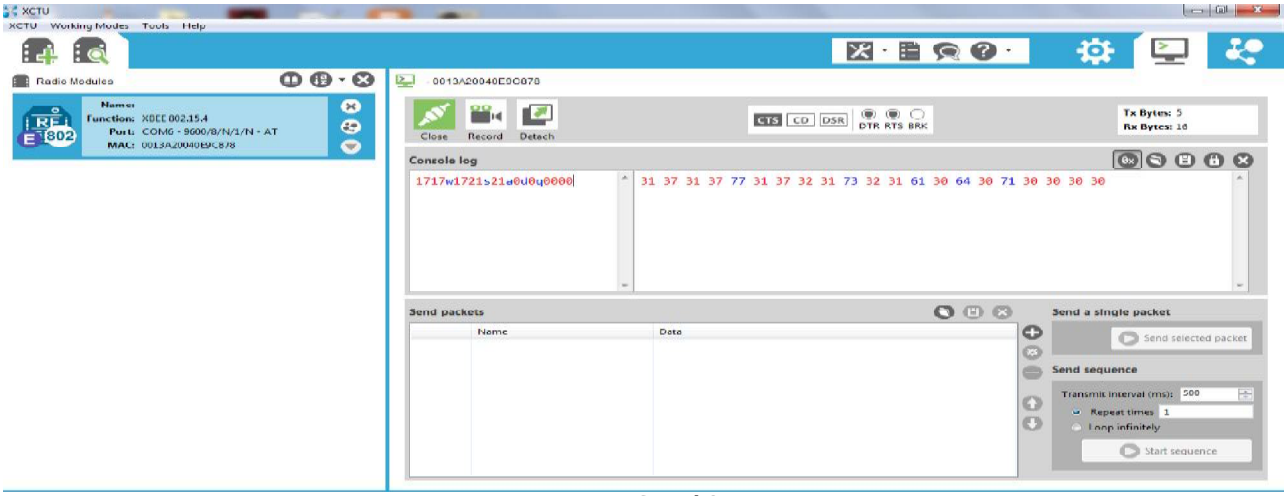


Fig. 7 Motion Control Output

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Motion control keys
w- forward

s- backward

a-left

d-right

q-stop

*B. Obstacle Detection*

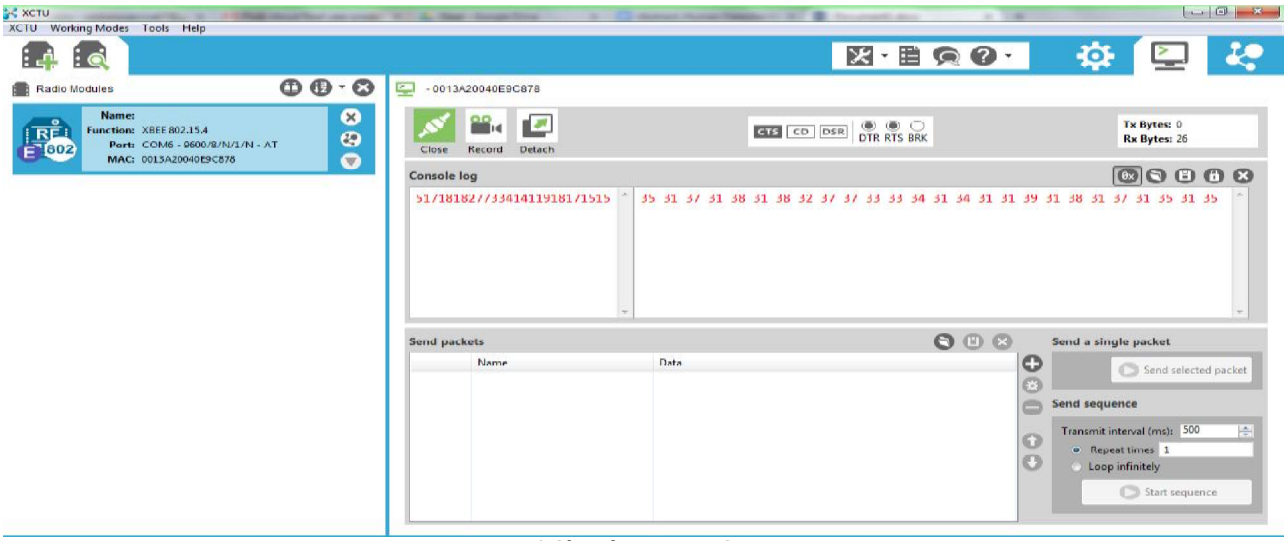


Fig. 8 Obstacle Detection Output

Output distance figures in 'cm'.

*C. Human Detection*

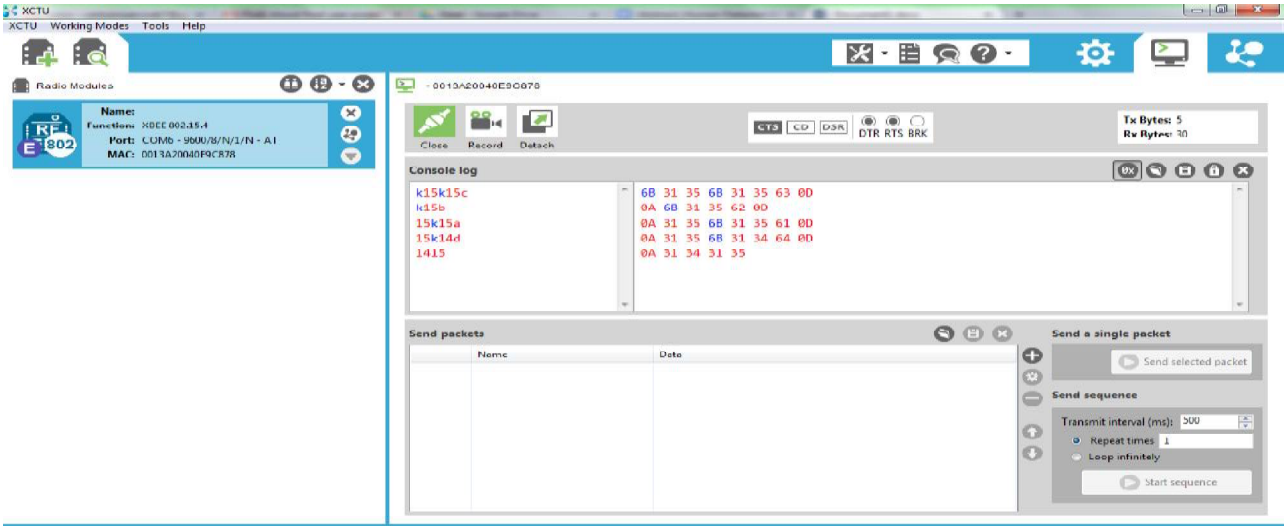


Fig. 9 Human Detection Output

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- Please note: Blue colour indicates transmitted data and red colour indicates received data in above three screenshots.

## V. CONCLUSION

The Unmanned Ground Vehicle had been designed to work in rough terrain. Our system has been developed to be able to detect humans indirectly using RF transmitters embedded in their identity cards. System is able to detect humans and provide a radial area in which human is detected. System is able to detect humans indirectly even under dense debris like concrete walls. However, a truly robust system for search and rescue operation will require UGV with better capabilities like fire and waterproof properties for worst disaster situation and better direct human detection techniques to necessity of RF transmitter for detection. There are pros and cons in methods for both direct and indirect detection of humans under debris. Direct human detection is a simple solution from end user point of view however it is found to be too much complex, costlier and difficult to achieve from developer point of view. Efficient sensors to detect humans under debris are found to have huge cost and require intense handling skills and hence indirect methods are preferred in project for prototype demonstration of such a system to conclude following points:

1. Successful implementation of human controlled robotic vehicle.
2. Robotic vehicle is controlled wirelessly using ZigBee technology.
3. Obstacle detection is available through ultrasonic sensor HC SR04.
4. Direct human detection under debris is highly complex, costlier, difficult to implement and requires intense technical skills.
5. Indirect human detection under debris is implemented using ASK RF transmitter.
6. Successful human detection through debris is like concrete is achieved.

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[14] www.researchgate.net/224097083 fig2 Figure-3–Heartbeat-signal-detected-at-24-Ghz-for-different-power-levels-2-dBm-a-7