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System to Detect Human Being Buried Under the Rubble during Disaster

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Abstract: ***Death of lots of people occurs as a cause of the earthquake. Such news comes in the newspaper after the unavoidable casualty. Because of this, unlimited numbers of people die. It occurs as a result of disasters such as tunnel dropping, snowfall, and fall of landslides. The effect of fall of landslides occurs in June 2013, due to heavy rain came in Uttarakhand. Such worst incident happened in 2013, because of this, lost precious lives. When many people are buried under rubble during a disaster, at that situation the most important question come in mind that how to enter the area using rescue teams.The microwave life detection system is developed to detect subject or object buried under the rubble of collapsed building during the earthquake or other disasters. The object or subject includes human being/ victims. The proposed motion detection system uses microwave frequency electromagnetic signal which is able to detect motion of moving object. This system decides whether the object is in motion or not. The Doppler frequency shift of the wave is the operational principle of motion detection system. The motion detection system uses microwave Doppler radar sensor sense these waves reflected back from the object if the object is in motion and present below the ground level. Once the motion is detected, then able to decide whether the object is a human being or not. Then system using microwave test bench is used to decide whether the object is a human being or not. Also, the system operates using microwave test bench used to detect the breathing and heartbeat signals of the subject. The Matlab Simulink model show heartbeat and breathing signal. By using all these systems, able to decrease world death rate to a greater extent.***

Keywords: Life under Rubble, Doppler Shift, Dual Antenna System, Modulation Due To Body Oscillations, Microwave Life Detection System.

I. INTRODUCTION

When we read a newspaper or watch the news on TV, many times we read or heard the news of earthquake or other disasters like landslides happened. Such disasters cause losses of many human lives every year as a human being are buried under rubble. There are some existing methods used for detecting human being are the utilization of dogs, some optical devices, acoustic life detector and rescue robot. Such existing devices or method are ineffective in recovering victims lying much below few feet and also for cases where victims are trapped completely or very weak to respond to the signal sent by rescue to rescuers. Then in such cases, life detection system used for detecting human being trapped under rubble.So, save more lives due to detection of victims. Depending upon this fact "A Revolutionary System to Detect Human Being Buried under the Rubble" [1] used to trap the buried victims under earthquake rubble or collapsed buildings.

The system has been designed by the utilization of microwave frequency electromagnetic signal and microcontroller. The basic block diagram of motion detection system as shown below:

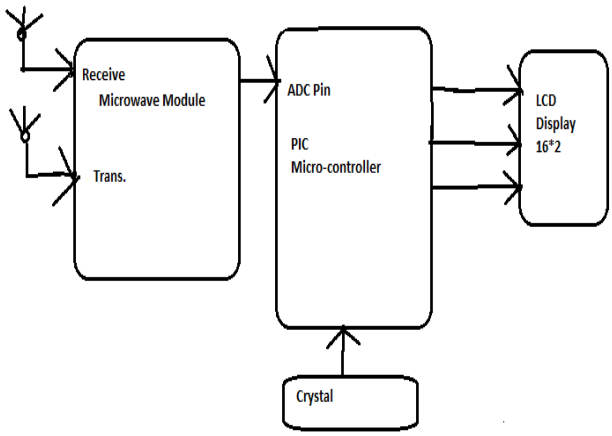

Fig.1: Basic block diagram of motion detection system [14]

In fig. [1], microwave module connects with microcontroller and microcontroller connects with LCD display. In Additional, we provide buzzer along with programming counter. When the system detects motion of moving objects, LCD display 'Alive 'instruction and buzzer become on. Otherwise, buzzer become off when LCD display 'No Response' instruction.

II. LITERATURE SURVEY

Sometimes unavoidable casualty occurs where we live or where we work. Images of such accidents serve as constant reminders of the vulnerability of these places. Emergency forces required correct information about the exact position of a human trapped or buried under rubble.It also needs information about collapse building as well as standardized intervention procedures along with information on the state of victim's health. When an earthquake or other disasters occur across the world then man-made structure like building, houses or bridges become collapse with different magnitude. In such situation, people try to survive as much as possible. There are two principle research directions including moving human tracking and life-sign detection [8-9]. Life-sign detection is applied to determine the condition of the stationary human with the life sign such as breathing [9-10].The concept of microwave life detection system emerged with the development of the systems for the rescue operation. In the initial phase, dogs were used to detect the presence of human then acoustic detectors and robot radar comes into existence for detection of buried victims. But these systems are having some major drawbacks. K. M. Chen who brings out the concept of detection of buried victims using microwave beam in 1986[1].A rescue radar system is proposed by M. Donelli in 2011[2]. A microwave life detection system operated on radio frequency was proposed in 1991 [3]. The phase change of a reflected microwave signal will provide the precious information about the buried victims [4]. An X-band experimental set up for life signs detection introduced using simple strategy [11]. W. S. Haddad gave the idea of Rubble Rescue Radar (RRR) [12] for the detection system of trapped human personnel. M. Bimpas gave the concept of three band radar system [13].

PROPOSED SYSTEM

The microwave frequency electromagnetic signal is sent from the oscillator and used to detect human being become alive or not. This signal having the characteristic to pass through barriers and would reflect back from some objects (human being).The system utilizes 10GHz microwave frequency electromagnetic signal. When system operates using microwave test bench used to detect the breathing and heartbeat signals of living subjects. But microwave detection system can work on a different range of frequency from 2GH (L-band) to 10GHz(X-band) [3]. ***A*** microprocessor-controlled automatic clutter cancellation subsystem, consisting of a programmable microwave attenuator and a programmable microwave phase shifter controlled by a microprocessor-based control unit, has been developed for a microwave life-detection system (L-band 2 GHz or X-band 10 GHz) which can remotely sense breathing and heartbeat movements of living subjects [6]. The proposed system made up of 3 parts:1)Motion detection system 2)Whether object or subject is a human being or not, detect using microwave test bench system. 3) Simulink model show waveform for heartbeat or breathing signals.

1) Motion detection system

- **System Architecture**

  The following figure shows system architecture for motion detection system:

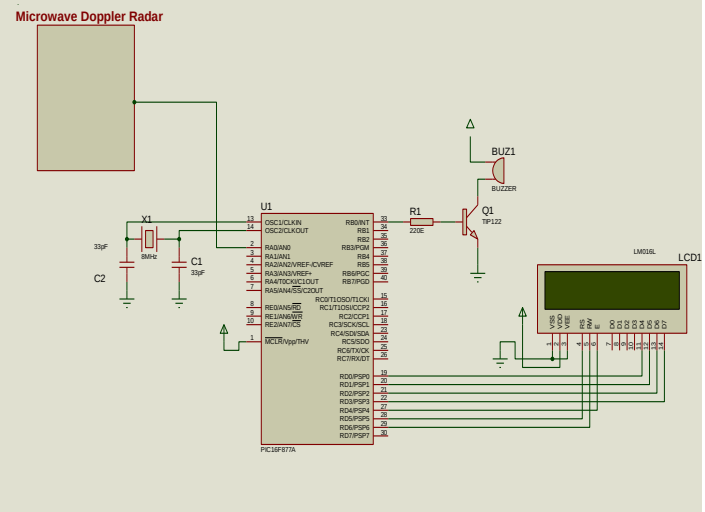

Fig.2: System Architecture of life detection system

The microwave life detection system has two important parts. These two parts are as given below:

- Microwave circuit which generates, amplifies and distributes microwave signals to different microwave components.
- A dual antenna system, which consists of two separate antennas energized sequentially.

1. Microwave Doppler Radar Sensor for Motion:

This sensor can detect motion or speed of moving objects through Doppler principle. It transmits a 10 GHz microwave frequency electromagnetic signal and waits for the signal to receive back and monitors the shift in frequency signal [16]. The block diagram of Doppler radar as shown below:

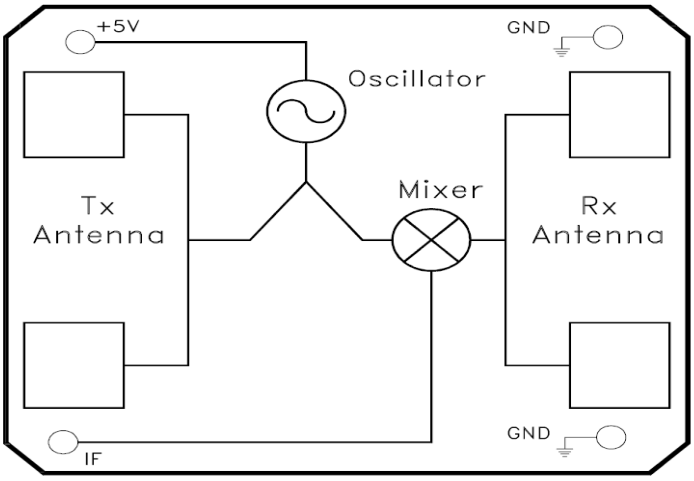

Fig.3: Block diagram of Doppler radar [15-16]

2. DOPPLER EFFECT

The Doppler Effect is a shift in frequency perceived by a receiver from a signal source due to relative movement of the source and/or receiver. Doppler radar system, a known frequency signal is transmitted from an antenna which is pointed at a reference object. A separate antenna is used to receive the signal that is reflected back from the reference to measure the Doppler shift of the signal.

3. PIC16F877A DEVICE

Here a microcontroller used is 'Peripheral Interface Controller'PIC16F877A devices are available in 40 packages. It has 5 input output ports and 3 timers/counters. It has 15 interrupts and 8 A/D input channels. The Parallel Slave Port is implemented only on the 40 pin devices. Its operating speed is DC – 20 MHz clock input DC – 200 ns instruction cycle. It has 8K x 14 words of Flash Program Memory and 368 x 8 bytes of Data Memory (RAM).Its pinout compatible to other 28-pin or 40/44-pin.

- **Hardware set up**

The fig. 4 shows hardware model for motion detection of moving object:

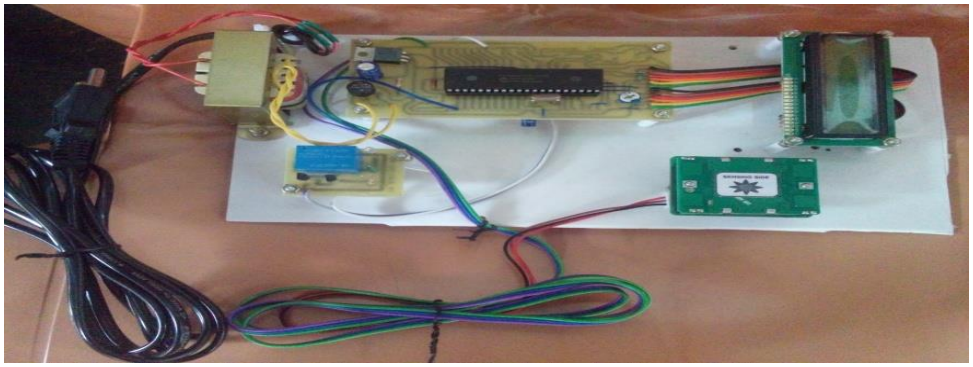

Fig.4: Hardware model for motion detection system

A. Working Principles of motion detection system

The principle of detection is first, 10 GHz microwave frequency electromagnetic signal is sent from the oscillator and pass through rubble to detect vital signs of life. The microwave is having the property to penetrate through barriers and would reflect back from some objects. These objects include humans. So, the reception of signals shows the presence of a live human under the rubble. When sensor sense motion, buzzer become on, counter become start. Programming counter time period is from 0 to 6.If the sensor detects motion during the counter time period, it increments and again starts from 1 up to 6 along with LCD display 'Alive' instruction. During this counter time period, once the motion is not detected then buzzer become off and LCD display 'No Response' instruction, counter become stop to 0. Thus in order to maintain a high sensitivity for this application, the wave reflected from the rubble or the surface of the ground has to be canceled as thoroughly as possible.

2) System using microwave test bench

- **Hardware set up**

The fig.5 show hardware model for system using microwave test bench

Fig.5: Hardware model for system using microwave test bench (pyramidal horn antenna)

B. Working Principles for system used to detect whether object or subject is human being or not, using microwave test bench

When microwave life detection system operates using microwave test bench then it is used to detect the breathing and heartbeat signals of living subjects. The phase shift between transmitted and received signals is the operational principle of heartbeat or breathing signal detection system. When microwave beam detects any vibration or oscillation as it penetrates up to it. Then the beam was reflected back from that oscillating surface with phase shift after detection of oscillation. On the basis of amplitude, decide whether the subject is human or not. In this part, various antennas are used such as pyramidal horn, E-plane section horn, H-plane section horn and parabolic dish antennas to see the pattern on CRO. The microwave life detection system using microwave test bench as shown below in fig.6:

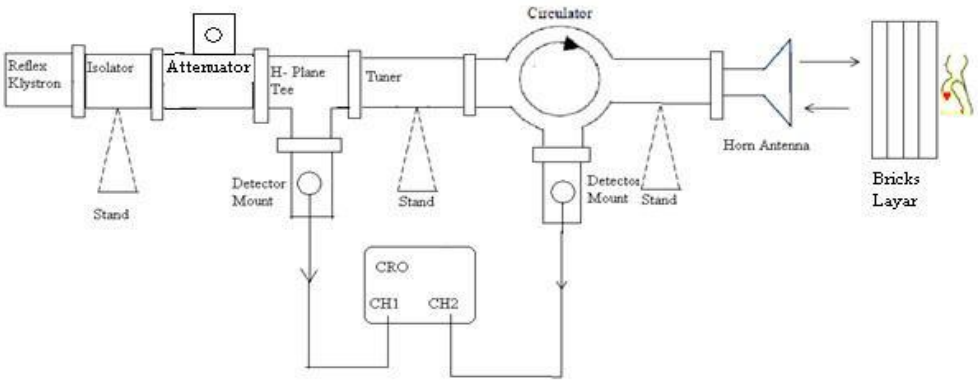

Fig.6: Microwave life detection system using microwave test bench [7]

3) INTRODUCTION TO SIMULINK

Simulink is model-based design for dynamic and embedded systems. It provides an interactive graphical environment and customizable set of block libraries that design, simulate and implement. It tests a variety of time systems, including communications, controls, signal processing, video processing, and image processing. Simulink software provides huge library functions used for developing the Simulink model. Simulink model shows a simulation of life detection system based on detection of the heartbeat using Doppler frequency [5].

The Simulink model is shown in figure 7:

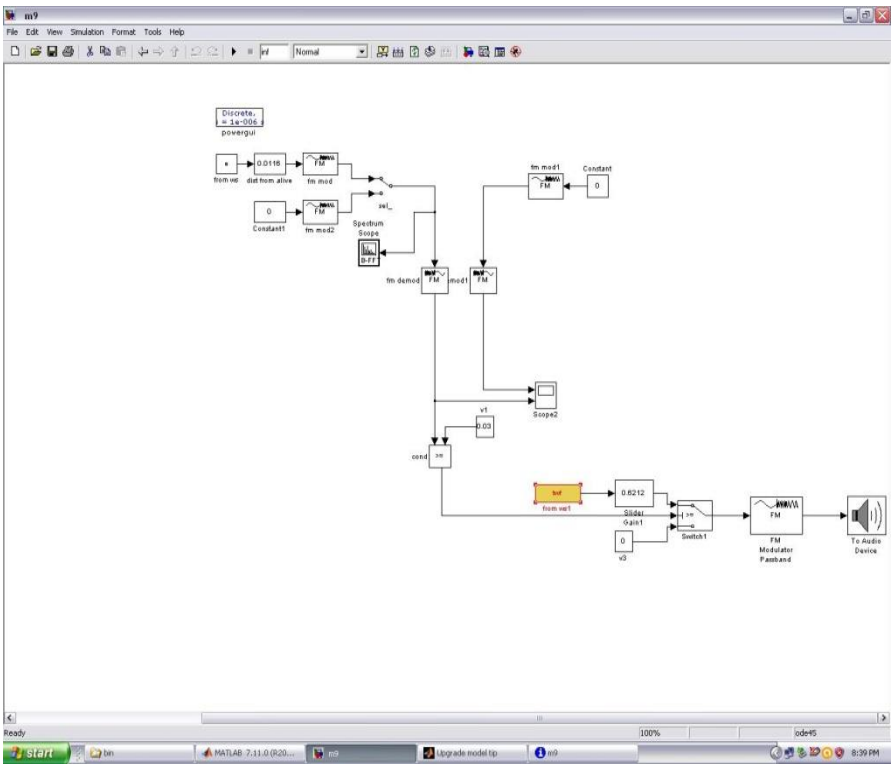

Fig.7: Simulink Model [14]

The Flow Chart for motion detection system as shown below

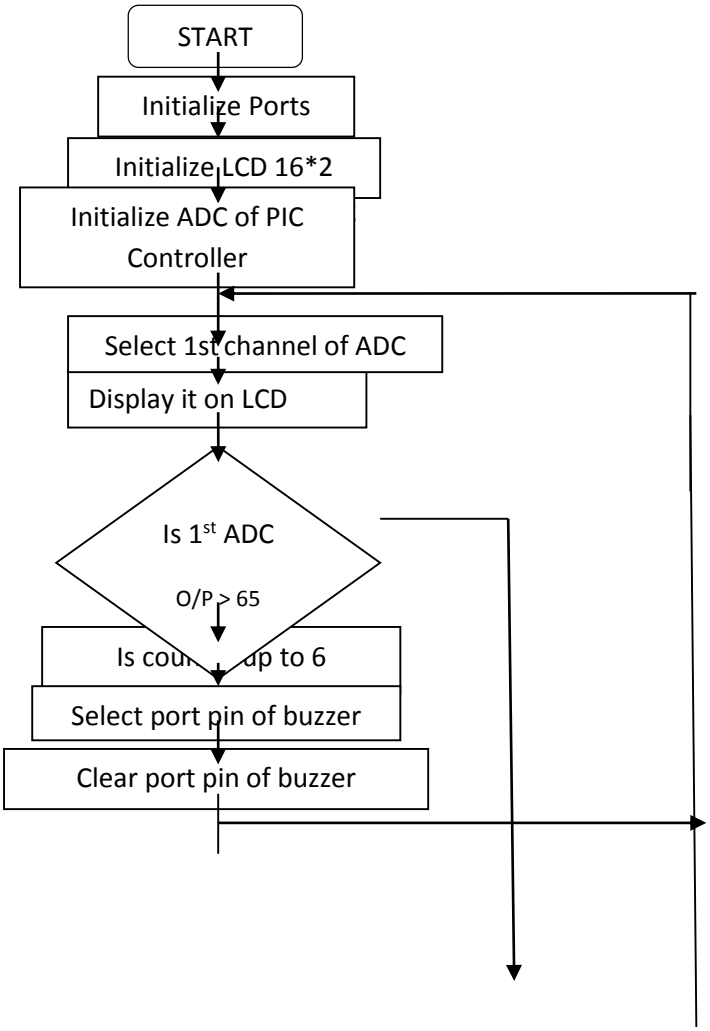

Fig.8: Flow Chart for motion detection system

III. EXPERIMENTAL RESULT

- **Analysis of Result**

1) The waveform for the output of motion detection sensor display on CRO, shown in fig. a fig. b and fig this microwave Doppler radar sensor (motion detection sensor) detect whether the human being or any non-living object having motion or not. Also, it senses the speed of moving object. The speed of moving object given by more number of oscillations. If speed is more than a number of oscillations is more, shown in fig. a and fig. c. If there is no object and having no speed then it displays straight horizontal line, shown in fig. b.

2) Pattern using the microwave test bench system display on CRO, shown in fig. d and fig. e. It detects whether the object is a human being or non-human being. Detection of a human being or non-human being depend on amplitude while the object moves in a horizontal and vertical direction. If the amplitude is more then it detects this object is a human being, shown in fig. d. If the amplitude is less then it detects this object is not- a human being and shown in fig. e.

3) The waveform obtained from simulink model display in scope block on the laptop screen, shown in fig. f and fig. g. The waveform for breathing or heartbeat signals for alive, shown in fig. f. Both transmitting and reflected waves are present and shown in fig. f. When an object is not alive then fig. g shows only transmitting wave and reflected wave become absent.

For all these 3 parts, the waveform for the output of each model for analysis of result as shown below:

1) Waveform for output of motion detection sensor on CRO

Fig. a: Waveform for Human having motion

Fig. b: Waveform for human being absent

Fig. c: Waveform for non-living object having motion

Fig. a, b and c show waveform for an object having motion or not. Fig. a shows a number of oscillations and having some amplitude.It means the object is present, has some speed and object has motion. So, the sensor senses it and display 'Alive' instruction on LCD and buzzer become ON. Fig. b shows no amplitude and no oscillations. It means the object is absent and having no speed and no motion. It displays 'No Response' instruction on LCD and buzzer become OFF only when programming counter become off. Fig. c shows waveform for a non-living object having some oscillations and some amplitude. It means the object is in motion and has some speed. From all these waveforms of fig. a, b and c, it is observed that when waveform possess some amplitude and oscillations then it means that object having some motion as well as speed. When the distance between object and sensor become increases then the amplitude of waveform decreases and vice-versa. It means distance and amplitude of wave having an inversely proportional relation. When the speed of object increases then a number of oscillations also increases and when the speed of object decreases then the number of oscillations also decreases. It means oscillations and speed having proportionate.

2) Waveform pattern for various antenna using microwave test bench system on CRO

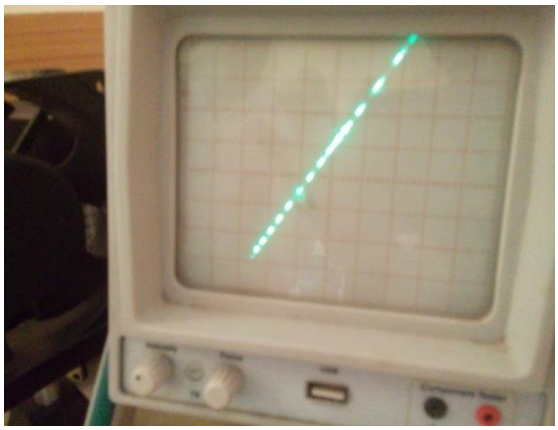

Fig. D: Waveform for pyramidal horn antenna for human being being

Fig. e: Waveform for pyramidal horn antenna for non-human

Fig. d and fig. e shows waveform for pyramidal horn antenna for the subject (living, non-living). Fig. d shows waveform for human being and fig. e shows waveform for non-living object/subject when object either move in a horizontal or vertical direction. From all these waveforms of fig. d and fig. e, it is observed that amplitude become increases for human being and amplitude become decreases for non-human being. It means that amplitude depends on the object (living/non-living). The object is used as a reference while either move in a horizontal or vertical direction. The amplitude varies according to the object (either object is a human being or non-human being).

3) Waveform obtained from simulink model

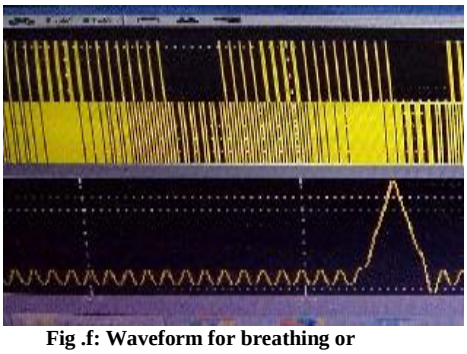

Fig .f: Waveform for breathing or heartbeat signal

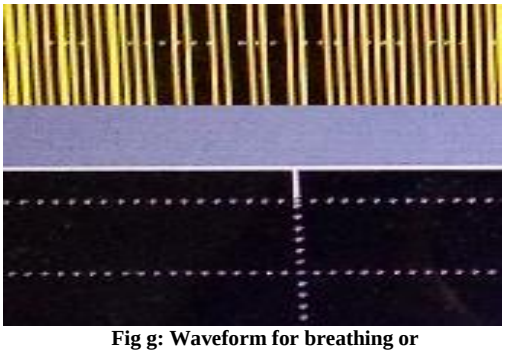

Fig g: Waveform for breathing or heartbeat signal absent

Fig. f shows waveform for breathing or heartbeat signal of alive person in the scope2 block. At some distance, using dist. from alive block and fm modulator block are used to display these waveforms mention in fig. f. Both block (dist. from alive and fm modulator) shown in fig. 7 of simulink model. Fig. f shows both transmitting and reflected waves. Upper row show transmitting waves and below scale (row) show reflected waves for breathing or heartbeat signal. Fig. g show waveform for breathing or heartbeat signal in scope block when the object is not present. Fm mod2 (2nd modulator) block is used to display this waveform mention in fig. g. Fm mod2 block shown in fig. 7 of simulink model. Fig. g display only transmitting wave in an upper row and reflected wave is absent in below row when a person is not alive. From this waveform of fig. f and fig. g, it is observed that simulink model waveform output depends on reflected waves.

CONCLUSION

Microwave life detection system able to detect a human being buried under rubble most efficiently and as possible in short time. When system operates using microwave doppler radar sensor, then it is used to detect whether the object is in motion or not. For motion detection system is conclude that distance between the sensor, object, and amplitude of wave having an inversely proportional relation. When system operates using microwave test bench, used to detect the breathing and heartbeat signals of living or non-living subjects. It means this system conclude that amplitude depends on the object. The amplitude varies according to the object (either object is a human being or non-human being). Matlab simulink model shows heartbeat or breathing signals in scope block on laptop or computer. It is conlude that simulink model waveform output depends on reflected waves. So, all these systems used to detect victims easily and successfully. Therefore, save precious lives and reduce world death rate to a greater extent.

In future, develop such system which is used to detect more number of victims at a time. Also, give a graphical representation of victims in what position victims which are buried under rubble during disasters.

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