

MICROWAVE LIFE DETECTION SYSTEM UNDER RUBBLE

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Abstract— Many people are killed during natural disaster which includes a cause of earthquake or manmade disasters like landslides, building collapse and avalanche. There is no end to the lives lost as the result of these disasters. When victims were trapped under rubble, there was a little chance that they would found. Due to fact that rescue techniques like optical devices, robotic systems were found limited application for the detection of buried victims. The use of sniffing dogs for detection of dead victims takes precious time which can be utilized to save alive victims. If the victim was unconscious and was unable to shout for help, then the existing rescue systems found to be failed. In order to decrease the death rate of the world caused due to these disasters, A Revolutionary System was developed to detect the victims trapped under the rubble using Microwaves. The Micro Wave Life Detection System is developed for the search and rescue of victims trapped under rubble of collapsed buildings during disasters under the principle of Doppler frequency shift. The life signs can be detected as it can able to sense to heartbeat and breathing fluctuations of human being of buried victims. By advent of this system the world death rate as a cause of earth quake may decrease to the greater extent.

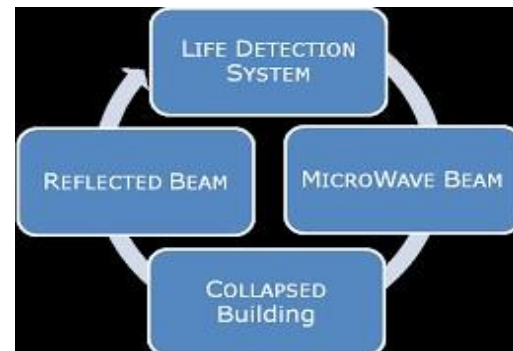
Keywords— Rubble, Micro Wave, Doppler Frequency Shift, Heartbeat, Breathing .

I. INTRODUCTION

Most of the victims of natural disasters in the different parts of the world are trapped under rubble of the collapsed buildings. a detection of victims can save his life. Some existing methods for detecting human victims buried under earthquake rubble is utilization dogs, optical devices, acoustic life detectors, rescue robot. As in the radar application, the phase of the instant wave can be changed due body vibrations. Based upon this fact a revolutionary system to detect human being buried under the rubble used to trap the buried victims under earthquake trouble or collapsed buildings. This rescue system operating at a particular band of frequency (L or S) band can detect the breathing and oscillations of heart beat signals buried under

the rubble. The reflected wave from the human subject will be modulated by their body movements. Information obtained about the location of buried victim will help to rescue them. Need for such a system [1][2][3][4][5]: Existing ways to detect the human being under the earthquake rubble and collapsed buildings are utilization of the dogs, optical devices and acoustic life detectors and the rescue robot.

II. PRINCIPLE OF MICROWAVE LIFE DETECTION SYSTEM



PRINCIPLE OF OPERATION[3][4]:

The principle of detection is firstly, microwave is sent through rubble to detect vital signs of life.

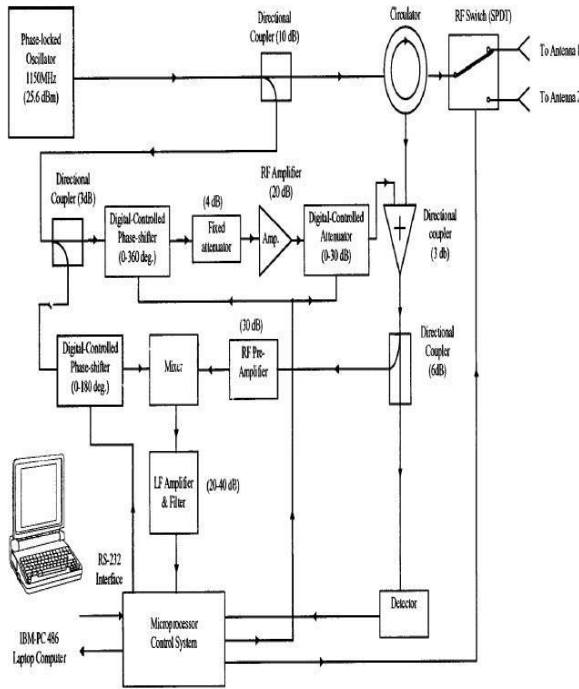
Microwave has the property to penetrate through barriers and would reflect back from some objects. These objects include humans as well as stationary objects. When the beam hits the body, the signal gets reflected with an additional modulation created by movement of heart and breath fluctuations. So, the reception of modulated signals shows the presence of alive human inside the rubble. With the modulated signal there are some signal which are reflected from the immobile object such as rubble . Thus in order to maintain a high sensitivity for this application, the clutter cancellation circuit is used.The clutter wave from rubble or surface of the ground has to be cancelled as thoroughly as possible. For this an automatic clutter cancellation system is used.

III. BLOCK DIAGRAM

The microwave life detection system has four major components. They are

- 1.Micro Wave Circuit which generates, amplifies and distributes microwave signals to the microwave components.
- 2.A Dual Antenna System, which consists of two antennas. that can act as both transmitter as well as receiver which are energized sequentially.
- 3.A Microwave Controlled Clutter Cancellation System, which creates an optimal signal that cancels the large reflected clutter from the rubble.

4.A Laptop computer which controls the microcontroller and acts as a monitor



IV. MAJOR COMPONENTS OF MICROWAVE CIRCUITS

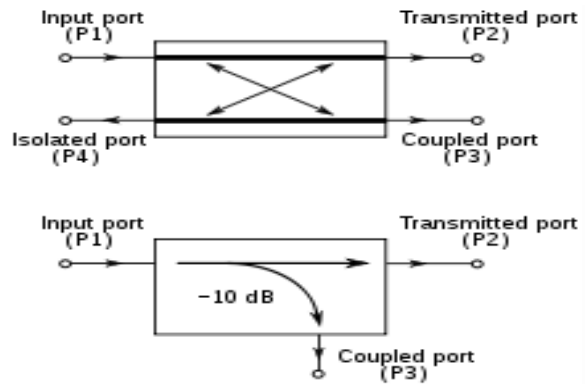
1.PHASE LOCKED OSCILLATOR: A phase-shift oscillator is an electronic oscillator which contains an inverting amplifier, and a feedback filter which 'shifts' the phase of the amplifier output by 180 degrees at a specific oscillation frequency. The filter will produce a phase shift which increases with frequency. It must have a maximum phase shift greater than 180 degrees at high frequencies, so that the phase shift at the desired oscillation frequency is 180 degrees. Here the phase locked oscillator generates a very stable electromagnetic wave of frequency 1150 MHz with output power say 400mW.

2.DIRECTION COUPLER: Directional coupler is an electronic components having four-port circuits where one port is being isolated from the input port and another port is considered to be through port. Directional couplers are passive reciprocal networks. All four ports are ideally matched, and the circuit is ideally lossless.It is used for isolating or eliminating or combining signals in microwave signal routing.The ports in this direction coupler are:

- 1.Input
- 2.Isolated

- 3.Transmitted
- 4.Coupled

A design is made through which an input power is made to split between coupled port and transmitted port in a specific ratio known as coupling ratio.If the signal is reversed so that it enter the transmitted port so that most of it passes through the input port, but the coupled port is now the port that was previously regarded as the isolated port. The coupled port is a function of the incident port. Waveguide couplers couple in the forward direction where a signal incident on port 1 will couple to port 3 and port 4 is isolated port. Micro strip or strip line coupler are backward wavecouplers where the input is given to the transmitted port which couples to port 4 and port 3 acts as an isolated port.



3.CIRCULATOR: A Circulator is a device in which microwave signals entering at any port are passed onto the next port in rotation only.These are non reciprocal devices. All ports are matched and transmission of power takes place only in cyclic order.An ideal circulator is perfect lossless.For a 3 port circulator,if a signal is applied at port 1,then the output is observed at port 2 while port 3 is isolated.Similarly,if a signal is applied at port 2 then the output is observed at port 3 while port 1 is isolated.A 3 port circulator are used to couple a transmitter to various receivers.A circulator can be made to circulate either in clockwise or anti clockwise direction.It is also called as duplexer sometimes as it duplexes two signals in to one channel i.e it can transmit and receive into an antenna.An antenna can perform two functions with the help of circulator which seperates radiating electromagnetic wave from the received electromagnetic wave.

4.ANTENNA SYSTEM: The dual antenna system has two antennas, which are energized sequentially by an electronically controlled microwave single-pole double-throw (SPDT) switch. The switch turns on and off at a frequency of 100 Hz which is much higher than the frequency range of the

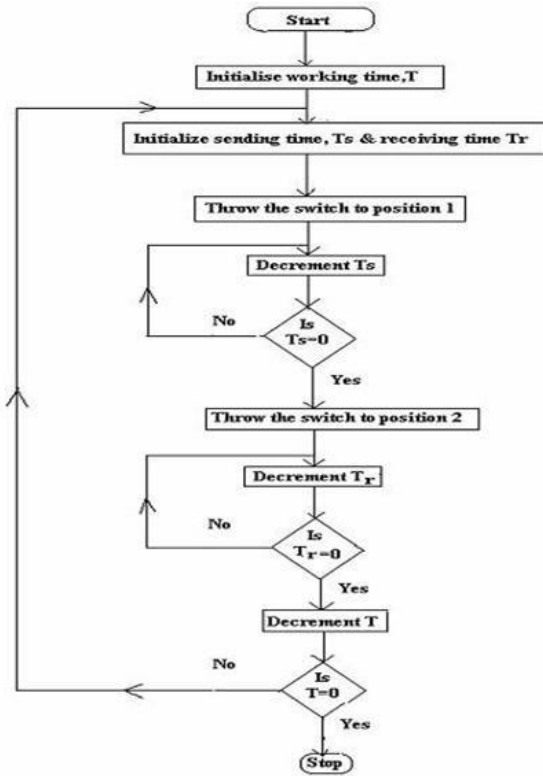
breathing and heartbeat signals between 0.2 Hz and 3 Hz. we can consider that the two antennas essentially sample their respective objects at the same time. In this dual-antenna system, the two antenna channels are completely independent of each other.

combination of attenuation and phase shifting to achieve optimum level to cancel to clutter signal.

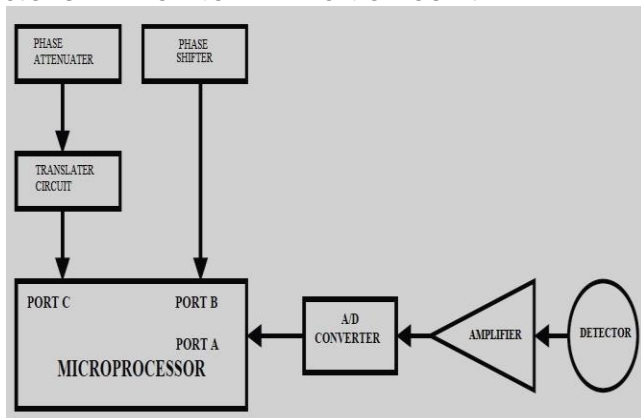
V.WORKING OF THE SYSTEM

A phase-locked oscillator generates a very stable EM wave of frequency 1150 MHz with an output power of 400mW . This wave is then fed through a 10-dB directional coupler and a circulator before passing through a radio-frequency (RF) switch.This power energizes the dual antenna system sequentially. The 10-dB directional coupler branches out one-tenth of the wave (40 mW) to the 3-dB directional coupler and the rest nine-tenth of wave is passed through the circulator (360 mW).The 3-dB directional coupler divides the input power of 40mW equally One output of the 3-dB directional coupler (20 mW) will drive the clutter cancellation circuit and the other output (20 mW) serves as a local reference signal for the double-balanced mixer.

When the wave gets radiated by an antenna will penetrate into the earthquake rubble to reach a buried human subject.The reflected wave received by the same antenna consists of a large reflected wave (clutter) from the rubble and a small reflected wave from the subject's body. The large clutter from the rubble can be cancelled by a clutter canceling signal. However, the small reflected wave from the subject's body cannot be cancelled by a pure sinusoidal, canceling signal because it is modulated by the subject's motions through Doppler effect. The dual-antenna system has two antennas, which are energized sequentially by an electronic switch. It will act as transmitter as well as receiver according to the programming.



5.CLUTTER CANCELLATION CIRCUIT:



The clutter signal is passed through a detector as which gives an output of a DC voltage of few t mV which is amplified by an operational amplifier and fed to analog to digital converter whose output is given to the Port A of microprocessor. The output port C and port B are connected to the phase attenuator and phase shifter respectively. The controller uses different

The clutter cancellation circuit used to cancel the clutter from the immobile objects consists of a digitally controlled phase-shifter (0–360⁰), a fixed attenuator (4 dB), a RF amplifier (20 dB), and a digitally controlled attenuator (0–30 dB). The principle of the clutter cancellation circuit is to automatically generate a signal that is adjusted such that it to be of equal amplitude and opposite phase as that of the clutter from the rubble. Hence, when the output of the clutter cancellation circuit is mixed with the received signal from the antenna, through the circulator, in a 3-dB directional coupler, the large clutter from the rubble is completely cancelled and finally the output of the 3-dB directional coupler consists only of the small reflected wave from the subjects body. This output of the 3-dB directional coupler is then passed through a 6-dB directional coupler which divides 1/4th of this output can be amplified through a RF preamplifier (30 dB) and then mixed with a local reference signal in a double-balanced mixer. Then the other 3/4th of the output of 3-dB direction coupler is detected by a microwave detector to provide a dc voltage, which serves as the indication for the degree of the clutter cancellation.The microwave beam incident into the rubble gets

phase modulated due to change in body vibration. The phase modulation occurs under the principle of Doppler Shift .

MODULATION :

The microwave beam incident into the rubble gets phase modulated due to body vibration. The phase modulation is occurs according to the Doppler Shift. The use of Doppler radar was demonstrated for detection of respiratory rate, and heart rate using commercially available waveguide X-band Doppler transceivers.

Doppler Shift Effect

When a source generating waves moves relative to an observer, or when an observer moves relative to a source, there is an apparent shift in frequency. If the distance between the observer and the source is increasing, the frequency apparently decreases, whereas the frequency apparently increases if the distance between the observer and the source is decreasing. This relationship is called Doppler Effect (or Doppler Shift) after Austrian Physicist Christian Johann Doppler (1803-1853). By the Doppler Effect, microwave beam reflected from a moving surface undergoes a frequency shift proportional to the surface velocity. If the surface is moving periodically, such as the chest surface of person due to breathing, this can be termed as a phase shift proportional to the surface displacement. If the movement is small compared to the wavelength, the system will mixed received signal with transmitted signal which gives output proportional to the body oscillation of human subject.

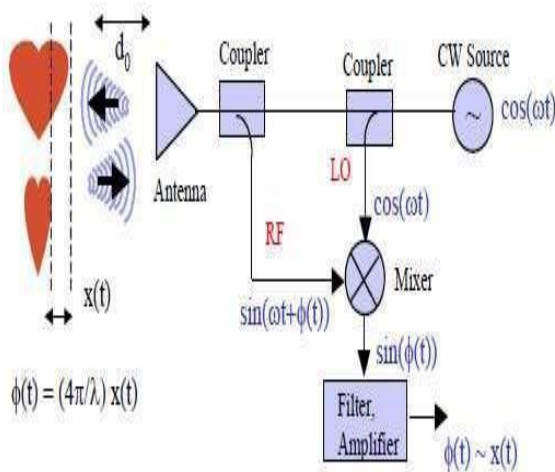


Fig. illustrates this concept. Internal body reflections are greatly attenuated and will not be considered here. We

assume that a continuous wave radar system transmits a signal of frequency f . The actual working of Doppler shift starts with reflected beam from a target at a distance d_0 , with a time-varying displacement given by $x(t)$.

VI.COMPARISON WITH OTHER SYSTEMS

- 1.The working principle of life detection system is based on penetration of microwave beam and Doppler shift effect. [1]
- 2.By using high precision, long range infrared distance sensors comprising of powerful LED, the distance from human object can be precisely and reliably measured and it can be indicated to the rescue operators. [2]
- 3.Automatic clutter cancellation system is used to maintain a high sensitivity.[3]
- 4.Matrix laboratory software is used to find the people who are buried under the rubble. [4]
- 5.Heart beat signals are measured by reflector antenna and probe antenna.[5] .

VII.CONCLUSION AND FUTURE SCOPE

A new sensitive life-detection system using microwave radiation for locating human subjects buried under earthquake rubble or hidden behind various barriers has been constructed. This system operating at 1150 or 450 MHZ can detect the breathing and heartbeat signals of human subjects through an earthquake rubble or a construction barrier of about 10-ft thickness. The location of the person under the rubble can be known by calculating the time lapse between the sending time, t_s and receiving time, t_r . Since it will not be possible to continuously watch the system under critical situations, an alarm system has been set, so that whenever the laptop computer system processes the received signal and identifies that there is a human being, the alarm sound starts. The possible shortcoming of this system is the effects of the background noise created by the environment and operators. A sophisticated signal processing scheme may further improve the system performance.

In future, depending upon the developing such technology, if we can enhance the system so that it will able to detect number of victims buried under the respective rubble. Then rescuer will prefer area with more number of victims. Eventually, our system can save more lives.

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