A Systematic Review on the Technique for object detection hidden behind the wall

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Abstract

In today's world, security is the main concern whether it is national security or international security. Research is going on since many decades on the security of the individual in various emergency conditions. Detection of the object or human being behind the wall is one of the major security issues for police and military. In such situation antenna play an important role i.e. enhancing the bandwidth, gain of the antenna, High resolution and good penetration are the main interest for research purpose. By using Microstrip antenna in through-the-wall detection we can easily identify the number of object/Human are behind the wall.

Keywords

Through-wall detection, Micro strip antenna, band of frequency.

1. Introduction

Through divider, identification is probably the best test confronting the Security today time. For through wall detection through wall radars are used[28]. In various operations such as military operations, rescue operations, the hidden path behind the wall is of interest since it enables the path for better planning and assessment of any kind of threat [27]. Different types of radar are used for through wall detection monostatic radar,bistatic radar, Super wideband radar, Microwave doppler radar, and so forth Some radar gadgets work inside a particular reach in chosen recurrence bands[28]. Through divider identification Radio Frequency (RF) electromagnetic wave radar innovation has shown superb outcomes due to better recurrence entrance through dividers comprised of various materials. Radars i.e., Microwave Doppler radar have had the option to distinguish the slight movement related to the breath of living beings[26].In some research Radio Frequency Identification System (RFID) technology is used to track or rescue the victims in earthquake situations. For heterogeneous wall compressive sensing techniques are used for better results because front wall reflections are there which make sensing difficult through walls using radar[29]. Algorithms such as Linear inverse scattering algorithm are used for through wall detection. Truncated singular value decomposition based on Born approximation is used for analyzing the performance and for obtaining reconstruction of reflected signal[30]. Along with different techniques different methods are there to get approximate result such as autofocusing method are used. In through wall detection parameters of the wall, type of wall plays an important role to identify the target behind the wall. Different algorithms are there to remove or minimize the clutter such as Single value decomposition method(SDV),Factor analysis, Independent component analysis etc. For TW detection EM waves are used because of better penetration, so antenna is used as a metallic device for transmitting and receiving the signals or we can say that transmitting and receiving of Electromagnetic waves plays an important role. Antenna can be used as a temperature sensor device. Antenna which also acts as an impedance matching device has extensive application in Bio-Medical Systems. Through-the-wall imaging (TWI) Systems is one of the applications of Antennas which are used in bio-medical[1]. In TWI, the signal is transmitted in the free space which results in significant attenuation of the

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transmitted signal various types of losses and impedance mismatch occurs. Application like through wall detection of human/object needs higher resolution of radar and maximum penetration of the transmitted signal is desirable [2].Microstrip antennas have several advantages. Microstrip antennas are light weight, have a low-profile planar configuration and have a small volume. Microstrip antennas support circular polarization and linear polarization. Easily integrated with other MICs on the same substrate. Microstrip antenna can be used for personal commutation [3]. Alongside such countless benefits, Microstrip radio wires have not many drawbacks like lower acquire, Narrow Bandwidth, and low force taking care of Capability. To expand the addition of the Microstrip Antenna we need to make a variety of the fixed antenna (on a similar substrate). Expansion of the variety of the fix receiving wire might expand the general component of the fix radio wire exhibit, so scaling down the space between the fix should be pretty much as little as could really be expected. On the other hand, scaling down outcomes in numerous undesirable results like solid coupling if there should be an occurrence of exhibit components, increase consequently misfortune, we can see the impact in radiation execution and info impedance of the cluster. In this way to limit these undesirable results cluster scaling down with diminished shared coupling in microstrip fix exhibits are there which gives us various examination openings [4], Narrow Bandwidth is the second burden of the Microstrip Antenna which can be increment by expanding the substrate thickness and force taking care of limit of the Microstrip Antenna can be upgraded by applying covering on a superficial level over the emanating component with a layer of dielectric material [5].

2. Characteristics of Microstrip Patch Antenna

Microstrip antenna posse's attractive features: Different shapes of microstrip patch antennas are available according to the shape their Characteristics varies:

1. In patch antennas, an infinite number of resonant modes are there having specific resonant frequency governed by the shape and size of the patch and substrate relative permittivity[6].
2. On the basis of the shape of the radiating patch, microstrip patch antennas have different types. Different shapes have different characteristics such as dual frequency, dual polarization and circular polarization.
3. Fringing fields are present in the edges of the patch. In this affect the behavior of patch changes i.e. The patch behaves as if it has a slightly larger dimension so the effective dimensions can be achieved by introducing Semi-empirical factors. We can see the variation of these factors from patch to patch.
4. Two modes which are generally used are (1,0) or (0,1) modes. Every mode has their own characteristic pattern. Modes (1,0) or (0,1) are strongest in the broadside direction
5. Impedance bandwidth of the antenna is directly proportional to the substrate thickness and indirectly proportional to the relative permittivity of the substrate. In both cases, the use of low permittivity substrates and high permittivity substrate is prohibited. So, to microstrip patch antenna geometry the impedance bandwidth is limited to the 5% of free space wavelength[7].

3. Literature Review

Sandeep Kaushal[8] In this researcher main focus is on through wall detection of metals plates of various shapes In this researcher give us practical examples of how slight variation in the parameters leads to the blurriness of the image. If not exact the approximate value must be taken so that if there is any blurriness in the image that can be reduced by using the Autofocusing approach i.e., a peak signal to noise ratio technique developed by using the algorithm that is curve fitting and genetic algorithm. Here stepped frequency continuous wave -based radar at the frequency of 1–3 Ghzhaving transmitted power and gain of antenna 3dBm and 20dB respectively.

Carlos R. P. Dionisio[9] In this research took parameters i.e., frequency range 1-5.5Ghz, Gain 7dBi-11dBi, Frequency steps is 1Mhz, Vivaldi Antennas having power 10dBm. to see the variation in the performance of the antenna two types of walls are taken into consideration that are Drywall and Concrete wall. To get the complete information of the target behind the wall here researchers collected data that is A-scan, B-scan, C-scan. Clutter which is also called a high intensity signal which make difficulty for research for the imaging of the target. So, there are many methods to reduce the clutter such as Subtraction of reference clutter from the collected that in the presence of the target. ICA,SVD and there are many other methods to reduce the clutter or make it negligible even if reference clutter is not able to be obtained. Data is collected by considering two types of walls. Signal speed is decreasing as going from antenna and the wall which leads to the displacement in the target position. Signal attenuates as there is a variation in the distance between target and radar because distance is quite a sensitive parameter between radar and the target.

Jawad Ali [10] In this frequency range is 2.8Ghz-15.6Ghz,Antenna type-UVW Monostatic antenna
with a gain 6.05dB, Substrate used in this is Rogers RT-5880 Duroid. In this research is designed monostatic antenna for the detection of human skin through the wall. In this concrete wall is being used. From analysis we can see that the proposed monostatic UWB antenna has the potential to detect the buried targets.

Dr. B Levitas[11] In this UWB Radar for the Detection and the Positing of Human beings present behind the wall or any non-metallic obstacle.
In this Frequency range is 0.675Ghz-12.25Ghz, Antenna Type UWB having Bandwidth is 11.7Ghz, Distance between person and antenna is 2.6m.In this we get to know about the nature of market. Research took the system bandwidth in such a way that it results in the resolution of 1.3cm in a free space which is quite helpful in finding the motion of the human chest due to breathing. Through Spectrum Stability we analysis that in case of breathing, three peaks of resonance are there due to the movement of the body parts of human being and in case of non-breathing only one peak is seen in the stability spectrum. The cause of one peak in the spectrum is the heart beating movement. Spectrum stability of Breathing person and the non-breathing person is shown below.

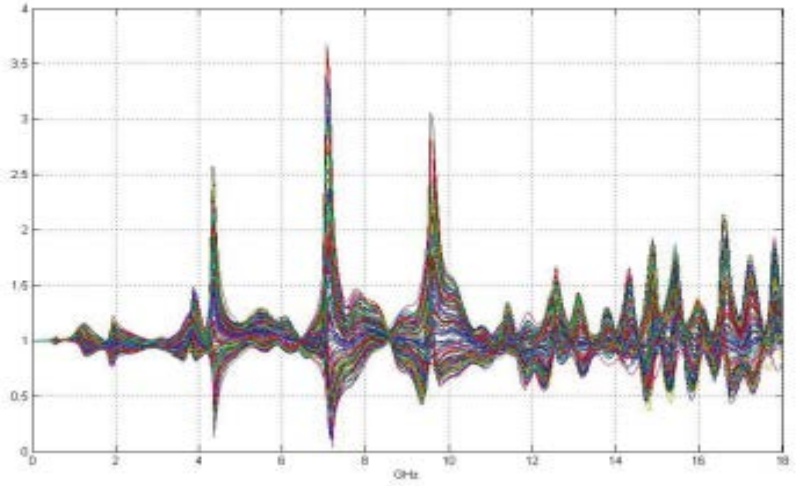

Figure 1:Spectrum stability of pulses reflected breathing person

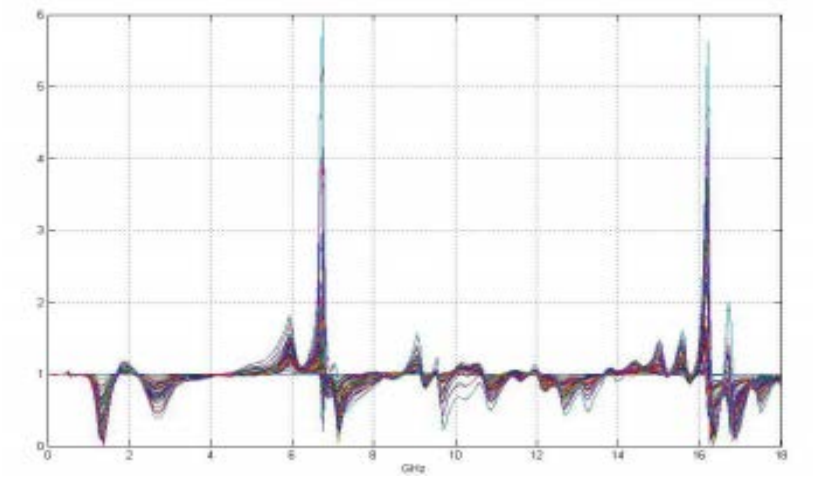

Figure 2: Spectrum stability of Pulse Reflected from Non-breathing Person.

Sukhvinder Singh [12] This researcher is mainly concerned about the detection of the human target behind the wall on the basis of breathing movements.

This frequency is 4.3Ghz, Antenna type is UWB Radar with bandwidth 2.3Ghz, Antenna Gain is 10dB.Various set of measurements are taken for the different types of walls for the detection of humans using UWB radar. Different types of techniques are used for different types of walls. In we can see that from wooden doors, gypsum and brick wall heart beat detection using doppler approach is possible but it gives reverse result in case of thick concrete wall i.e., through thick concrete wall it is difficult to detection heartbeat using doppler approach. Unwanted high intensity signal i.e., clutter is reduced by SVD method.

Zhao Xingwen[13] and his fellow researcher took frequency range 2Ghz-4Ghz and have done Detection using a new type of magneto-electric dipole antenna used in Ultra-wideband Through-the-wall radar.

Analysts proposed a strategy to acknowledge wide shaft one-way radiation for this butterfly gap radio wire design to be added. Then, at that point, plan and create radio wire as needs be. Here butterfly space UWB wide pillar radio wire which is added with a reflection plate and reflection cavity. Here to add a metal reflection load up on the back for unidirectional radiation for through divider location analyst planned the plane of two rectangular winding receiving wire. Type of antenna array used by the researcher is two-input one-output antenna array which helps in the detection of multiple target behind the wall.

Buying Lu [14] In this researcher is detecting the motion of the human being inside the building by using the stepped-frequency continuous-wave synthetic aperture radar interferometry technique. In this radar system, antennas having frequency range of 1-2Ghz are Archimedean spirals. This type of antenna is very helpful in maintaining gain and the input impedance. Archimedean spirals antenna has shown outstanding performance in circular polarization.

The proposed way to deal with moving-target sign comprises of radar picture arrangement, noncoherent energy change identification, and interferometric stage discovery. This is the thought process to diminish the bogus cautions when contrasted with non-intelligible recognition draws near.

QiangAn[15] In this scientist utilizes all out variation(TV) compelled reproduction approach. By utilizing UWB radar having various info numerous yield (MIMO) exhibit with few components utilized for identification and imaging of target. There are various methods that are utilized to upgrade the imaging. Her research utilized an edge-protecting regularization approach dependent on TV to get form upgraded picture. For confirmation of the methodology, a limited contrast time-space (FDTD) based reenactment is done.

Chi-Wei Wu [16] In this researcher want to detect human target behind the barrier by phase change of reflected Microwave so for this pulse radar system is used for the detection of the movement of the human being which also include the movement of chest i.e., heart beat and breathing. Here researcher show the efficient use of pulse radar over Conventional continuous-wave approach.

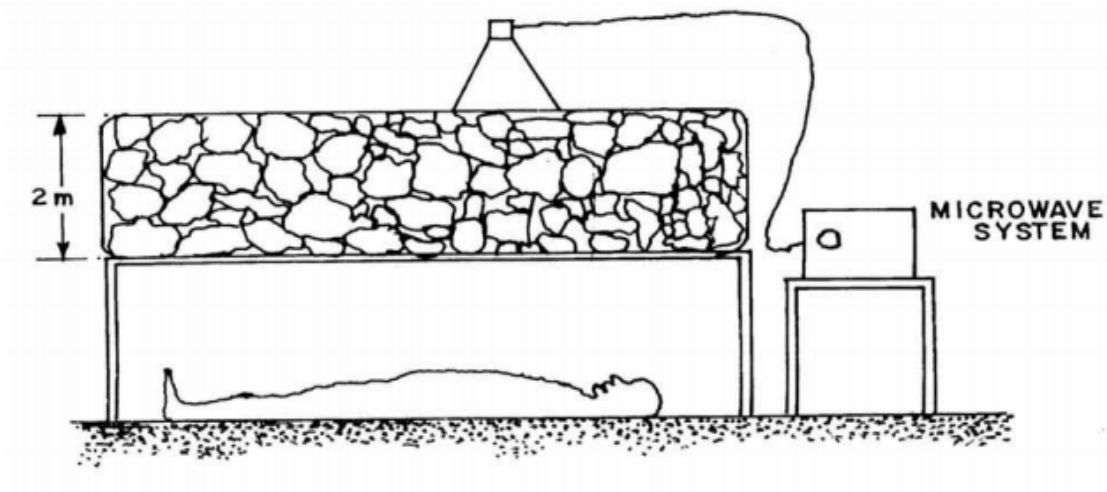

Figure 3: Experimental setup of rescue system

Othman[17] In this paper researchers want to detect heartbeat of the patients by using non-contact method. By using principle i.e., Doppler effect and for filtering of the signal filtering technique i.e., Butterworth filtering technique applied by using MATLAB. In this several measurements is taken by varying distance(feet) and transmitted power level in dBm. Horn antenna with a gain of 7 to 14dBi & nominal impedance 50 ohm is taken and for generation the transmitted signal Vector spectrum analyzer is using with a sweep time of 50 second & frequency range of 1 Ghz to 18Ghz is used. In this experiment by using 5.8Ghz for the detection of respiration magnitude and heart beat by using doppler radar we analysis that if there is the less distance between subject and antenna large phase variation is identified. Intsinon-contact detection we can see that if the distance between target(Human) and horn antenna is less we can easily detect the heartbeat respiration as compared to the large distance between the target and antenna. If there is a variation in power level it affects the respiration intervals.

Banerjee[18] In this researcher is using the doppler technique for the identification of the victims buried under the debris due to earthquake or any other natural hazards. Here they design and develop the victim locator which works on the microwave frequency and doppler effect. Electronic remote victim locator can penetrate dry concrete debris with a depth of 2m. Air void play an important role to increase the detection depth. The experimental setup of remote sensing system shown below with system block diagram.

Such technique is also used for the purpose of security without alternating the target person. Improvement of detection depth can be varied by varying the debris material at the different frequencies. This type of electronic setup is useful for the rescue system(post-earthquake).

Mabrouk[19] and his research fellow mates used algorithms i.e., data cleaning algorithms and detection algorithms for the target behind the wall. In this they are using P410 radar having center frequency 4.3Ghz and bandwidth is 2Ghz.Here single value decomposition is used for clutter suppression and for detection of human breathing skewness variations are used. In this, two targets are behind the wall, one at 3.5 m and another at 3.8m and to improve return signal by removing the dominant singular values iterations. Here infinite impulse response butterworth band pass filter used for SVD. In this wall parameter, gypsum type wall with 20cm is used and this is an efficient method for the detection of more than two targets behind the wall and able to remove the unwanted signal

which is reflecting from a human target. SVD and Skewness emergers to one of the efficient methods for clear output signal from target.

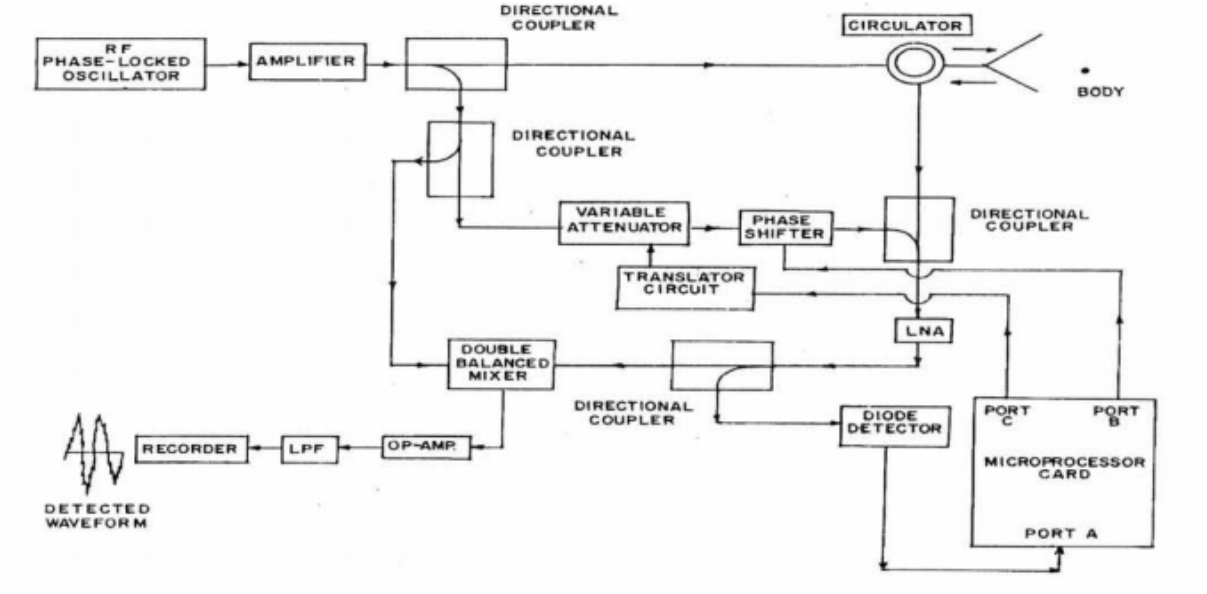

Figure 4: System block diagram

Akbari[20] In this paper we analysis the use of RFID technology for the detection of the human during natural disaster like earthquake. In RFID digital data is encoded in smart labels are captured via radio signals. In this there are two of Victims that is Victims with RFID Tags and without RFID tags. For victims without RFID Tags use RFID with a computer sensor(smart phone).Even though there are multiple disadvantages of this RFID Tags i.e., low security, impossible to read wet tags[21,22] hardware problem etc. In case of advantages, rescuing of victims. Decrement in rescue time[23], ability to detect several targets simultaneously [24].

Semeykin[25] In this research paper,we get to know that researchers used a very low central frequency that is 400MHz because of the climatic condition.RO-400 radar detector is used there to detect moving targets behind the wall. Efficiency of the detector to detect moving targets behind the wall is less in case of concrete wall as compared to the wall made up of plywood. Two operating modes are used here 1.5D and 2D accordingly the result appears on respective windows. Here we get to know that, radar detectors with 400MHz central frequency help us to achieve detection range up to greater extent i.e., 14m range for 30cm thick wall. Algorithms used by RO-400 radar is- Background removal, Hilbert transform and Thresholding.

After going through literature surveys, we can conclude that there are many ways through which we can detect the living and non-living objects behind the wall. There are different methods for human detection like autofocusing method for Through wall imaging where low frequency band are used, Ultra-wide band radar are also there for detection in this by resonance peaks we are able to detect the target, Human breathing rate using SFCW radar by using Compressive sensing technique are there for through wall detection. For better results the penetration depth must be good enough to get the clear view of the target and the size of the antenna required to be as small as possible i.e., for portability of the system.

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