A Review on Wi-Vi Technology

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Abstract: Technology is making rapid progress and is making many things easier. As the innovative thinking of persons is increasing day-by-day, new methods for wireless networking have evolved of which our present topic Wi-Fi is the most accepted technology. Wi-Fi is popular wireless networking technology which provides a facility allowing computers, Smartphone’s or other devices to connect to the Internet or communicate with one another wirelessly within a particular area. Wi-Fi networks have no physical wired connection between sender and receiver. Wi-Fi uses radio waves to provide network connectivity. Wireless Vision (Wi-Vi) is a new technology similar to the same concept of Wi-Fi which enables seeing through walls with the help of Wi-Fi signals. Wi-Fi can also extend our senses, enabling us to see moving objects through walls and behind closed doors. In particular, we can use such signals to identify the number of people in a closed room and their relative locations. We can also identify simple gestures made behind a wall, and combine a sequence of gestures to communicate messages to a wireless receiver without carrying any transmitting device. By the use of Wi-Fi signals and MIMO communication, a wireless vision device has been made that captures the human motion behind the wall or closed room. Use MIMO interference nulling to eliminate reflections off static objects and focus the receiver on a moving target

Keywords: Gesture-Based User Interface, MIMO, Seeing Through Walls, Wireless.

I. INTRODUCTION

The use of WI-FI signal is not only as an information carrier; these WIFI signals can be used to track the moving object behind the wall or can say in a close room. This idea can be used to minimize the causalities in standoff and hostage condition, emergency responder can be used to see through wall, rubber or collapsed structure.

The fantasies narrated to X-perception perception; comic books and sci-fi movies are completely being prospect. This paper is chiefly investigation throughout the Wi-Fi token with the sophisticated MIMO communications by capturing the guide of humans behind the defense. In this technology, the most demanding part is the reflections for the wall itself rather than reflections system the object. Due to censure off wall, minute variations coming through the object are prevented from being tracked. This conduct of the object is known as “Flash Effect”. Multi-GHz transmission systems are required to separate. The objective of this journal is to enable a see-through-partition technology that is moderate-bandwidth, moderate-divinity, pithy, and open to no-military entities. To this limit, the Notes introduce Wi-Vi, a see-through-counterscarp device that engrosses Wi-Fi sign in the 2.4 GHz ISM tie. Wi-Vi Hindrance itself to a 20 MHz-wide Wi-Fi channels, and avoids ultra-wideband solutions employment now to Artroitness the glitter effect. It also distributes the large antenna array, exemplary in exceeding systems, and uses instead a smaller 3-antenna MIMO radio. Wi-Vi works by sending Wi-Fi radio waves through a barrier and to recognize moving object through wall the WIFI signal transmitted in the direction of wall, this results in two problem (I) Flash effects, (II) magnitude of signal reduced by three to five times after traversing the wall.

There are recent advances in MIMO communications to build a device or a system that can capture the motion of humans behind a wall or door and in closed room. Law enforcement personnel can use this device to avoid walking into a scupper and minimize casualties in hostage situations.

The objective of this paper is to enable a see-through-wall technology that is low-bandwidth, low-power, compact, and accessible to non-military entities. To this end, the paper introduces Wi-Vi, to a see-through-wall device that employs Wi-Fi signals in the 2.4 GHz ISM band. Wi-Vi limits itself to a 20 MHz-wide Wi-Fi channel, and avoids ultra-wideband solutions used today to address the flash effect. It also disposes of the large antenna array, typical in past systems, and uses instead a smaller 3-antenna MIMO radio’s, how does Wi-Vi eliminate the flash effect without using GHz of bandwidth? We observe that we can adapt recent advances in MIMO communication to through-wall imaging. In MIMO, multiple Antenna systems can encode their transmissions so that the signal is nulled (i.e., sums up to zero) at a particular receive antenna. MIMO systems use this capability to eliminate interference to unwanted Receivers. In contrast, we use nulling to eliminate reflections from static objects, including the wall. Specifically, a Wi-Vi device has two transmit antennas and a single receive antenna. Wi-Vi operates in two stages. In the first stage, it measures the channels from each of its two transmit antennas to its receive antenna. In stage 2, the two transmit antennas use the channel measurements from stage 1 to null the signal at the receive antenna. Since wireless signals (including Reflections) combine linearly over the medium, Wi-Vi based on capturing the reflections of its own transmitted signals off moving objects behind a wall or door in order to track them. Wi-Vi operation does not require any access to any device on the other side of the wall. Specifically, when it is interact with a non-metallic wall, some form of the RF signal would traverse the wall; reflect off objects and humans. It comes back with a signature of what is inside a closed room. By capturing these reflections, it is possible to image objects behind a wall or door. Building a Device or system that can capture such reflections is difficult because the signal power after penetrating the wall twice (in and out of the wall) is reduced by three to five times of magnitude. Even the difficult challenge is the reflections from the wall itself, which is stronger than the reflections from objects inside the room.

WHAT WI-VI CAN DO:

Detect the Number of Moving Humans in a Closed Room : Wi-Vi allows us to detect presence of a moving human in a closed room. It can also can determine with high accuracy up to 3 moving objects. Determine the Relative Locations of Moving Humans: The technology can also determine the motion of different persons in a closed room. It can answer questions such as: Is the person moving towards the device or
away from it? What is the angle of motion of a person inside a closed room relative to the location of Wi-Vi Enable Communication through a Wall without Carrying a Wireless Device: Wi-Vi is both a transmitter and a receiver. A human can communicate with it using simple gestures without carrying or wearing any wireless device. Identify Simple Gestures from Behind a Wall: Wi-Vi can detect very simple gestures made through a wall, making it the first through-wall gesture-based interface.

II. RELATED WORK

Wi-Vi is related to past work in three major areas

A. Through Wall Radar:

Interest in through-wall imaging has been surging for about a decade. Earlier work in this domain focused on simulations and modeling. Recently, there have been some implementations tested with moving humans these past systems eliminate the flash effect by isolating the signal reflected off the wall from signals reflected off objects behind the wall. Recently few implementations have been developed with discrimination with humans in moving assertions. This isolation can be achieved in the time domain, by using very short pulses (less than 1ns) whereby the pulse reflected off the wall arrives earlier in time than that reflected off moving objects behind it. Alternatively, it may be achieved in the Frequency domain by using a linear frequency chirp in this case; reflections off objects at different distances arrive with different times. By analog filtering the tone that corresponds to the wall, one may remove the flash effect. Wi-Vi system has different characteristics as it requires equity bandwidth, and act in the same range as Wi-Fi. Wi-Vi overcomes the requirement for the UWB by worn MIMO nulling to remove flash effect. These systems unheeded the flash result and tried to work in high interference caused by the reflections off the wall. They generally think about propagation caused by moving objects behind the wall. However, the flash result limits their detection capabilities. Hence, most of those systems square measure incontestable either in simulation or in free area with no obstruction. those incontestable with associate obstruction use a low-attenuation standing wall, and don’t work across higher attenuation materials like solid wood or concrete Wi-Vi shares the objectives of those devices; but, it introduces a replacement approach for eliminating the flash result while not broadband transmission. This allows it to figure with concrete walls and solid wood doors, as also absolutely closed rooms. The sole try that we have a tendency to square measure alert to that uses Wi-Fi signals so as to check through walls was created in 2012. This method needed each the transmitter and a reference receiver to be within the imaged space what is more, the reference receiver within the space has got to be connected to constant clock because the receiver outside the area. In distinction, Wi-Vi will perform through-wall imaging while not access to any device on the opposite facet of the wall. To address the limitation of the ultra wide-band system, in 2012 an attempt was made to use WI-FI signal to see through wall. The objective of this attempt was to enable the technology of see through wall at low-bandwidth, low-power, compact size, and accessible to non-military entities. With these objectives WI-VI system was developed that employs WI-FI signals in the 2.4GHz ISM band. This system limits its operating frequency to a 20MHz wide WI-FI channel, instead of wide spectrum in Ultra Wide-Band system to remove the flash effect. As a through-wall imaging technology, Wi-Vi differs from all the above systems in that it requires only few MHz of bandwidth and operates in the same range as Wi-Fi. It

overcomes the need for UWB by leveraging MIMO nulling to remove the flash effect. They typically rely on detecting the Doppler shift caused by moving objects behind the wall. However, the flash effect limits their detection capabilities. Hence, most of these systems are demonstrated either in simulation or in free space with no obstruction. The ones demonstrated with an obstruction use a low-attenuation standing wall, and do not work across higher attenuation materials such as solid wood or concrete Wi-Vi shares the objectives of these devices; however, it introduces a new approach for eliminating the flash effect without wideband transmission. This enables it to work with concrete walls and solid wood doors, as well as fully closed rooms. Researchers have recognized the limitations of UWB systems and explored the potential of using narrowband radars for through wall technologies. These systems ignore the flash effect and try to operate in presence of high interference caused by reflections off the wall.

B. Gesture Based Interfaces:

Today, commercial gesture-recognition Systems – such as the Xbox Kinect, NintendoWii, etc. – can identify a wide variety of gestures. The academic community has also developed systems capable of identifying human gestures either by employing cameras or by placing sensors on the human body. Recent work has also leveraged narrowband signals in the 2.4 GHz range to identify human activities in line-of-sight using micro-Doppler signatures. Wi-Vi, however, presents the first gesture-based interface that works in non-line-of-sight scenarios, and even through a wall, yet does not require the human to carry a wireless device or wear a set of sensors. Recent work has also leveraged narrowband signals in the 2.4 GHz range to identify human activities in line-of-sight using micro-Doppler signatures. Wi-Vi, however, presents the first gesture-based interface that works in non-line-of-sight scenarios, and even through a wall, yet does not require the human to carry a wireless device or wear a set of sensors.

C. Infrared and thermal imaging:

System supported infrared and thermal imaging extend the human vision on the far side the visible Magnetism vary and permitting us to find objects in presence of smoke & darkness. This technique is operated by capturing infrared or thermal energy mirrored from the primary obstacle in the line of sight of their sensors. Similar to Wi-Vi, these technologies extend human vision beyond the visible electromagnetic range, allowing us to detect objects in the dark or in smoke. They operate by capturing infrared or thermal energy reflected off the first obstacle in line-of-sight of their sensors. However, cameras based on these technologies cannot see through walls because they have very short wavelengths (few μm to sub-mm) unlike Wi-Vi which employs signals whose wavelengths are 12.5 cm
Figure 1—A Moving Object as an Antenna Array. In (a), an antenna array is able to locate an object by steering its beam spatially. In (b), the moving object itself emulates an antenna array; hence, it acts as an inverse synthetic aperture.

III. WI-VI OVERVIEW

Wi-Vi is a wireless device that captures moving objects behind a wall. It leverages the ubiquity of Wi-Fi chipsets to make through wall imaging relatively low-power, low-cost, low-bandwidth, and accessible to average users. To this end, Wi-Vi uses Wi-Fi OFDM signals in the ISM band (at 2.4 GHz) and typical Wi-Fi hardware. Wi-Vi is essentially a 3-antenna MIMO device: two of the antennas are used for transmitting and one is used for receiving. It also employs directional antennas to focus the energy toward the wall or room of interest. For its design incorporates two main components:

1) the first component eliminates the flash reflected off the wall by performing MIMO nulling; 2) the second component tracks a moving object by treating the object itself as an antenna array using a technique called inverse SAR. Wi-Vi can be used in one of two modes, depending on the user’s choice. In mode 1, it can be used to image moving objects behind a wall and track them. In mode 2, on the other hand, Wi-Vi functions as a gesture-based interface from behind a wall that enables humans to compose messages and send them to the Wi-Vi receiver.

IV. NULLING TO REMOVE FLASH

Wi-Vi however, avoids mistreatment associate antenna array for 2 reasons: First, so as to get a slender beam and thus come through a decent resolution, one wants an oversized antenna array with several antenna components. This might end in a large and dearly-won device. Second, since Wi-Vi eliminates the flash result mistreatment MIMO nulling, adding multiple receive antennas would need nulling the signal at every of them. This might need adding additional transmit antenna. A few points square measure value noting concerning Wi-Vi” procedure to eliminate the flash effect:- To eliminate the flash result we've got to get rid of mirrored signal received from stationary objects each in front off and behind the wall and direct signals from sending antenna to receiving antenna.

Wi-Vi’s uses nulling rule that provides a 42dB mean reduction in signal power that is enough to remove the flash result. Nulling is performed within the presence of objects moving behind the wall and front of the wall.

Table 1: One-Way RF Attenuation in Common Building Materials at 2.4 GHz

<table>
<thead>
<tr>
<th>Building Materials</th>
<th>2.4 GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>3db</td>
</tr>
<tr>
<td>Solid wood Door 1.75 inches</td>
<td>6db</td>
</tr>
<tr>
<td>Interior Hollow Wall 6 inches</td>
<td>9db</td>
</tr>
<tr>
<td>Concrete Wall 18 inches</td>
<td>18db</td>
</tr>
<tr>
<td>Reinforced concrete</td>
<td>40db</td>
</tr>
</tbody>
</table>

V. ELIMINATING THE FLASH EFFECT

Flash effect term refers to “The reflection from the entire stationary object behind the wall rather than just wall”, which is much stronger than the reflection from the object inside the closed room. This is due to the attenuation which electromagnetic signals suffer when penetrating through the dense obstacles. Table 1 shows some of the examples of the one-way attenuation experienced by Wi-Fi signals in construction materials. For example- once the signal is traversed through solid wood door or interior hollow wall, the Wi-Fi signal power is reduced by 6dB and 9dB.

Electromagnetic signal produces important attenuation dense obstacles that results in stronger flash signals than the other mirrored signals off the article. Considering the tables on top of within which a method RF attenuation of signal is determined through Wi-Fi signal. As mirrored signal on each the reflection constant because the cross-sectional of object owing to that the particular mirrored signal becomes weaker. Hence, Wi-Vi increases the sensitivity to the reflection of interest by victimization the development of nulling the interference or by power boosting.

VI. IDENTIFYING AND TRACKING HUMANS

Since, we’ve eliminated the impact of static objects within the atmosphere we are able to currently target pursuit of Moving objects as humans.

A. Tracking a Single Human:

Most prior through-wall systems track human motion using an antenna array. They steer the array’s beam to determine the direction of maximum energy. and this direction corresponds to the signals abstraction angle of arrival. By following that angle in time, it is possible to infer however the thing moves in area.

However, Wi-Vi avoids using an antenna array for two reasons: First is in order to obtain a narrow beam that means achieve a good resolution, one needs a large antenna array with many antenna elements. This would result in a bulky and expensive device. Second is, since Wi-Vi eliminates the flash effect using MIMO nulling, adding multiple receive antennas would require nulling the signal at each of them. This requires adding more transmit antennas so the device will become bulkier and more expensive.

B. Tracking Multiple Humans

With multiple humans, the noise increases significantly. On one hand, each human is not just one object because of different body parts moving in a loosely coupled way and on the other hand, the signal reflected off all of these humans which are correlated in time, hence they all reflect the transmitted signal. The lack of independence between the reflected signals is important. For example, the reflections coming from two humans may combine systematically to dim each other for some period of time.

C. Through-Wall Based Gesture Communication

For a human to transmit a message to a computer wirelessly, the typically has to carry a wireless device. In contrast, Wi-Vi can enable a human who does not carry any wireless device to communicate commands or short messages to a receiver using simple gestures. Wi-Vi designates a pair of gestures as a ‘0’ bit and a ‘1’ bit. A Human can compose these gestures to create messages that have different interpretations. Additionally, Wi-Vi can evolve by borrowing other existing principles and practices from today’s communication systems, such as adding a simple code to ensure reliability, or reserving a certain pattern of ‘0’s and ‘1’s for packet preambles. At this stage, Wi-Vi’s interface is still very basic, yet we believe that future advances in through-wall technology can render this interface more expressive.

Advantages
First advantage is this system uses only one receiver still effectively measures the time it takes for the signals to reflect to calculated the exact location. Second is with low cost Wi-Fi technology system can be utilized in disaster recovery and gaming activities. And lastly Wi-Vi technology, as a gesture-based interface, does not require a line of sight between the user and the device.

**Applications**

There are some of the applications of wi-vi technology described here.

**Law enforcement:** Law enforcement personal can use the device to avoid walking into an ambush, and minimize causalities in hostage and standoffs situations.

**Emergency situations:** Emergency responders can use wi-vi to see through rubble and collapsed structures. Smart Sensing: This Wi-Vi technology can be extended to sense motion in different parts of a building and allow automated control of heating or cooling and lighting systems.

**Personal Security:** Common users can use it for intrusion detection and when stepping into dark alleys and unknown places. Entertainment: It enables a new dimension for input-output devices in gaming which does not affect on occlusion and works in non-line-of-sight.

**User Interface Design:** This technology may also be leveraged in the future to enable the controlling household appliances via gestures, and non-invasive monitoring of children and elderly.

**CONCLUSION**

We discussed Wi-Vi, a wireless technology that uses Wi-Fi signals to detect moving humans behind walls or doors and also in closed rooms. As compared to previous systems, which are targeted for the military, Wi-Vi enables the small cheap see-through-wall devices which operate in the ISM band, rendering them feasible to the general public. Wi-Vi also builds a communication channel between a human behind a wall or in a closed room and device itself, allowing person to communicate directly with Wi-Vi without carrying any of transmitting device. We believe that Wi-Vi has a set of functionality that future Wireless networks will provide. Future Wi-Fi networks will likely expand beyond communications and deliver facilities such as indoor localization, sensing as well as control. Wi-Vi gives evidence of advanced form of Wi-Fi-based sensing and localization by using Wi-Fi to track humans behind wall without carrying any wireless device.

**References**


