Review On Wi-Vi Technology

**D.V. Ashok Sairam1, P. Joshna2** Student (Bachelor of Technology), Computer Science and Engineering, IIIT Trichy, Tiruchirappalli, India 1 Student (Bachelor of Technology), Electronics Communication and Engineering, IIIT Trichy, Tiruchirappalli, India 2

**Abstract:** Wi-Fi signals are typically information carriers between a transmitter and a receiver. In this paper, we show that 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. This paper explores the potential of using Wi-Fi signals and recent advances in MIMO communications to build a device that can capture the motion of humans behind a wall and in closed rooms. This paper introduces two main innovations. First, it shows how one can use MIMO interference nulling to eliminate reflections of static objects and focus the receiver on a moving target. Second, it shows how one can trace a human by treating the motion of a human body as an antenna array and tracing the resulting RF beam. We demonstrate the validity of our design by building it into USRP software radios and testing it in office buildings. This paper also says about the Applications of Wi-Vi Technology and How the technology is useful in real world.

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

**I. INTRODUCTION**

This paper gives the idea about the potential of using

Wi-Fi signals. 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. Emergency responders can be using it to see through the collapsed structures or debris. The advantages of this for ordinary users are the device for gaming, usurpation detection, privacy-enhanced monitoring of children, elderly or personal security when stepping into dark lanes and unknown places. The concept of this seeing through opaque obstacles is similar to sonar and radar imaging.

Wi-Fi signals are typically information carrier signals between a transmitter and receiver. Now it is possible with the Wi-Fi signals can also extend our senses [1]. They enable us to see moving objects through walls as well as behind the closed doors. So it is possible with the help of such signals to identify the number of people room and their relative locations in a closed room. We can also identify gestures made behind a wall and combine the sequence of gestures to communicate messages or commands to a wireless receiver without carrying any type of transmitting device. Wi-Vi means “Wi-Fi” and “Vision” which is nothing but wireless vision. It’s a new promising technology that enables seeing through walls using Wi-Fi signals. It also allows us to track moving objects or human through closed rooms and behind the wall. 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 [2]. 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 [3]. Even the difficult challenge is the reflections from the wall itself, which is stronger than the reflections from objects inside the room. A reflection off the wall on the receiver’s analog to digital converter i.e. ADC, preventing it from considering the minute variations due to reflections from objects behind the wall [4]. This behavior is called as the “Flash Effect" since it is similar to how a mirror in front of a camera reflects on the camera’s flash and prevents it from capturing objects in the scene [5].

**II. RELATED WORK**

Wireless Vision i.e. Wi-Vi is related to past work in major three areas.

A. Through Wall Radar

There is growing interest in through-wall imaging for about a decade. Earlier work in this area focused on the simulations and modeling. Recently, there are some design implementations tested with moving humans. These past design of systems or devices eliminate the flash effect by doing isolation of the signal reflected off the wall from signals reflected off objects behind the wall. This isolation can be achieved in the time domain with the help of very short pulses (less than 1ns). Where the pulse reflected off the wall arrives earlier in time than that reflected off moving objects behind it due to the distance travelled.

It can also be achieved in the frequency domain by using a linear frequency chirp signal given by L. Kempel, E. Rothwell, C. Coleman, G. Charvat and E. Mokole et al in 2010. In this scenario, reflections off objects at different distances come with different tones. By doing analog filtering the tone that corresponds to the wall, one can remove the flash effect. These techniques require ultra-wide bandwidths (UWB) of the order of 2 GHz.

Wi-Vi technology is different from the above systems. In that Wi-Vi, it requires only few MHz of bandwidth and

operates in the same range which is required for Wi-Fi. whose wavelengths are nearly 12.5 cm3. In (a), an antenna This technology removes the flash effect by leveraging array is able to locate an object by steering its beam MIMO nulling so it does not require UWB. Researchers spatially. In (b), the moving object itself emulates an have recognized the limitations of UWB systems. They antenna array; so from this fact it acts as an inverse also describe the capacity of using narrowband radars for synthetic aperture. through wall caused by moving objects behind the wall

and door. However, the flash effect affects on the **III. WI-VI OVERVIEW**

detection capabilities. Hence, most of the systems are

demonstrated either in simulation, modeling or in free Wi-Vi technology is a wireless device that captures

space with no obstruction. Wi-Vi has the objectives of moving objects behind a wall and door. Wi-Vi has the

these devices. It gives a new method for eliminating the strategic advantage of Wi-Fi to make through wall

flash effect without wideband transmission. This enables imaging relatively low cost, low power, low-bandwidth,

to work with concrete walls, solid wood doors and also and accessible to average users. Wi-Vi uses the Wi-Fi

fully closed rooms. The attempt which we are aware of OFDM signals in the ISM band i.e. at 2.4 GHz and typical

that uses Wi-Fi signals in order to see through walls was Wi-Fi hardware. Wi-Vi is basically a 3-antenna MIMO

made in 2012. This system needs both the transmitter and device in which two antennas are used for transmitting and

reference receiver to be inside the imaged room. Then, the one is for receiving. This also includes directional

reference receiver has to be connected to the same clock as antennas to focus on the energy toward the wall or room of

the receiver outside the room and Wi-Vi can operate interest. Its design includes two main components:

through-wall imaging without any access to any device on 1) The first component is used to eliminate the flash

the other side of the wall. reflected off the wall by performing MIMO nulling.

2) The second component is used to tracks the moving

B. Gesture-based interfaces object by treating the object itself as an antenna array

Today’s commercial gesture recognition systems such as using a technique called inverse SAR i.e. ISAR. Wi-Vi

the NintendoWii, Xbox Kinect, etc. can identify a wide can be used in one of above two modes. It depends on the

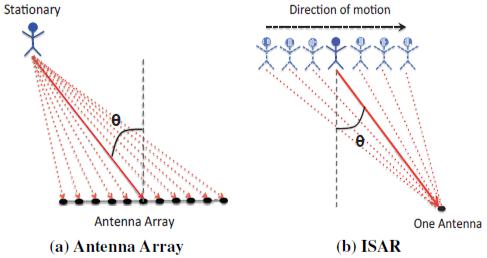
variety of gestures. The academic community is also user’s choice.

developed some systems capable of identifying human gestures either by using 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 [1]. Wi-Vi technology presents the first gesture-based interface that works in non-line-of-sight scenarios, and also through a wall. This technology does not require the human to carry any wireless device or to wear a set of sensors.

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

|  |  |
| --- | --- |
| **Building Materials** | **2.4 GHz** |
| Glass | 3dB |
| Solid wood Door 1.75 inches | 6dB |
| Interior Hollow Wall 6 inches | 9 dB |
| Concrete Wall 18 inches | 18dB |
| Reinforced concrete | 40 dB |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| C. Infrared and thermal imaging |  | In mode 1, it can be used as image moving objects behind | |  |
| Similar to Wi-Vi, these technologies develop the human | |  |
| a wall or door; it is possible to track them. In mode 2, Wi- | |  |
| vision beyond the visible electromagnetic range. It also | | Vi can use as a gesture-based interface from behind a wall | |  |
| allows us to detect objects in the smoke or in the dark. | | that enables humans to create messages and send it to the | |  |
|  |  |  |
|  |  | Wi-Vi receiver. |  |  |
|  |  | **IV. ELIMINATING THE FLASH** |  |  |
|  |  | In every through-wall system, the signal reflected off the | |  |
|  |  | wall which is nothing but the flash, is much stronger than | |  |
|  |  | any signal reflected from objects behind the wall. 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. | |  |
| Fig1. A Moving Object as an Antenna Array | | For example- once the signal is traversed through solid | |  |
|  |  | wood door or interior hollow wall, the Wi-Fi signal power | |  |
| They operate by capturing or collecting infrared or thermal | | is reduced by 6dB and 9dB. As mirrored signal on each | |  |
| energy reflected off the first obstacle in line-of-sight of | | the reflection constant because the cross-sectional of | |  |
| their sensors. |  | object owing to that the particular mirrored signal | |  |
| However, cameras based on these technologies cannot see | | becomes weaker. Hence, Wi-Vi increases the sensitivity to | |  |
| through walls because they have very short wavelengths in | | the reflection of interest by victimization the development | |  |
| few μm to sub-mm, whereas Wi-Vi which employs signals | | of nulling the interference or by power boosting. |  |  |
|  |  | |  |  |



**V. IDENTIFYING AND TRACKING HUMANS** **VIII. APPLICATIONS**

Since, the elimination of the impact of static objects is There are some of the applications of wi-vi technology

described. So, now focus on moving objects as humans. described here.

A. Tracking A Single Human

In advanced, through all systems antenna array is employed to trace the human motion. They steer the arrays beam to see the direction of most 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.

**VI. THROUGH WALL GESTURE-BASED**

**COMMUNICATION**

Wi-Vi can enable a human who does not carry any wireless device to communicate short messages or commands to a receiver using simple gestures. Wi-Vi represents these try of gestures by „0‟ bit and „1‟ bit. These gestures are later composed by human to make messages that are having completely different interpretations. In addition, Wi-Vi will develop by exploitation different existing practices and principles like adding an easy code that may guarantee dependability, or by reserving an exact pattern of „0‟ and „1‟s. At this stage this technology continues to be terribly basic, nevertheless we have a tendency to believe future advancement scan build it a lot of reliable and communicative.

**VII. 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.

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

**Emergency situations:** Emergency responders can usewi-vi to see through rubble and collapsed structures. **Smart Sensing:** This Wi-Vi technology can be extendedto 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 intrusiondetection 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 beleveraged in the future to enable the controlling household appliances via gestures, and non-invasive monitoring of children and elderly.

**IX. 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**

1. Sudarshan Adeppa, “Detection of Objects across the Walls with Wi-Fi Technology”, International Journal on Emerging Technologies, 2015.
2. K. Chetty, G. Smith, and K. Woodbridge, “Through-the-wall sensing of personnel using passive bistatic wifi radar at standoff distances,” IEEE Trans. Geoscience and Remote Sensing, 2012.
3. Adib, Fadel, and Dina Katabi, “See through Walls with WiFi,”

Proceedings of the ACM SIGCOMM Conference, 2013.

1. S. Ram and H. Ling, “through-wall tracking of human movers using join doppler and array processing,” IEEE Geoscience and Remote

Sensing Letters, 2008.

1. Prerna Garg, Shikha, “Wi-Vi Technology”, International Journal of Advance Research In Science And Engineering, Vol. No.2, Issue No.9, September 2013.