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A Third Eye Investigator Utilizing Vibration Energy Harvesting

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Abstract: Interest in through-wall imaging has been surging for about a decade. Earlier work in this domain focused on simulations and modeling. 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. 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, 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. More than a decade of research in the field of thermal, motion, vibration and electromagnetic radiation energy harvesting has yielded increasing power output and smaller embodiments. In this paper we have introduced Vibration Energy Harvesting (VEH).ie. The energy produced due to vibrations are converted into electricity.

Keywords: Seeing Through Walls, Wireless, MIMO, Gesture Based User Interface, Electrostatic converters, VEH, Electrets.

1. INTRODUCTION

The rise in robotic technology by 1990s became a boon for many different fields such as in Military, Automation, Medical etc. This paper introduces 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 which is done by a category of robot called the MARCBOT (Multi-Function Agile Remote-Controlled Robot) It looks like a toy truck with a video camera mounted on a tiny antenna-like mast. The tiny bot is used to scout out where the enemy might be and also to drive under cars and search for hidden explosives. Whenever insurgents were hiding in an alley, a MARCBOT shall be send down first, not just to scout out the ambush, but to take them out .The Law enforcement personnel can use the device to avoid walking into an ambush, and minimize casualties in standoffs and hostage situations. Emergency responders can use it to see through rubble and collapsed structures. Ordinary users can leverage the device for gaming, intrusion detection, privacy-enhanced monitoring of children and elderly people. This paper also introduces Wi-Vi, 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 off the large antenna array, typical in past systems, and instead uses a smaller 3-antenna MIMO radio.

In contrast the conventional methods of producing electricity , this research proposes a framework that provides a more eligent way of producing electricity through energy harvesting ie. we have focused on vibration energy harvesting using electrostatic converters. It synthesizes the various works carried out on electrostatic devices, from concepts, models and up to prototypes, and covers both standard (electret-free) and electret-based electrostatic vibration energy harvesters(VEH) .

2. EXISTING SYSTEM

MARCBOT: As considering the existing system, to address the limitation of flash effect, which prevents the capturing of objects in the scene; an initial attempt was made in 2012 to use Wi-Fi to see through a wall. However, to mitigate the flash effect, this past proposal needs to install an additional receiver behind the wall, and connect the receivers behind and in front of the wall to a joint clock via wires [1] .As the research on the paper proceeded; a new technology called the Wi_Vi was introduced. Wi-Vi,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. Further, Wi-Vi is the first to demonstrate a gesture-based communication channel that operates through walls and does not require the human to carry any wireless device. Wi-Vi is related to past work in three major areas:

- Through-wall radar.
- Gesture-based interfaces.
- Infrared and thermal imaging.

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

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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.

Gesture Encoding: At the transmitter side, the '0' and '1' bits must be encoded using some modulation scheme. Wi-Vi implements this encoding using gestures. One can envision a wide variety of gestures to represent these bits. A '0' bit - is a step forward followed by a step backward; A '1' bit -is a step backward followed by a step forward.

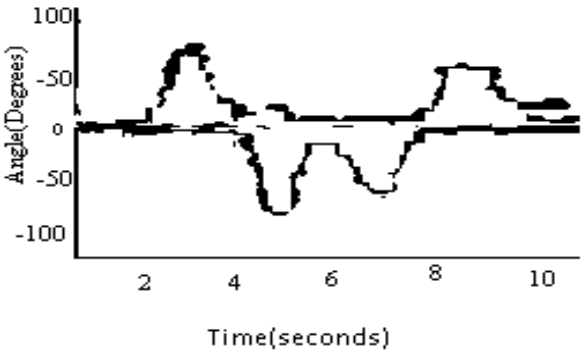


Figure: 1 : Gesture Encoding

Gesture Decoding: Wi-Vi's decoder takes as input. Similar to a standard decoder, Wi-Vi applies a matched filter on this signal. However, since each bit is a combination of two steps, forward and backward, Wi-Vi applies two matched filters: one for the step forward and one for the step backward.

VEH: The industrialists, engineers and researchers are looking for developing autonomous WSN able to work for years without any human intervention. One way to proceed consists in using a green and theoretically unlimited source: ambient energy [2].

3. PROPOSED SYSTEM

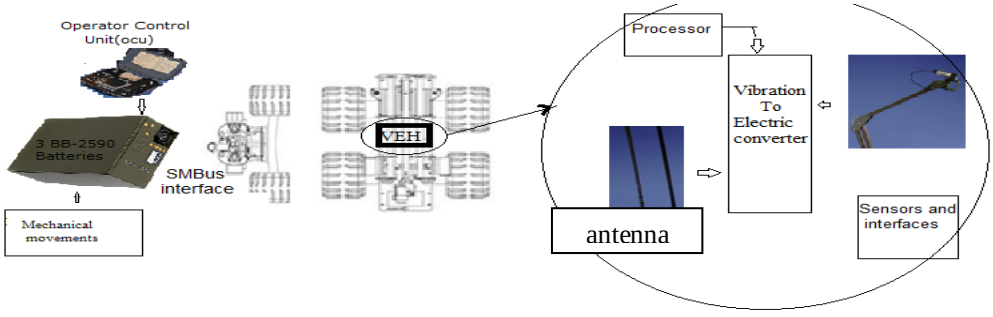
The MARCBOT is made of several communicating and interfacing components which consumes battery power at different rates . Hence a single battery must satisfy the power needed for each and every activity. This would inturn may overlaod the battery capacity. Thus to minimize the load on a single battery , we have introduced a technology called Vibration Energy Harvesting along with the existing technology of MARCBOT .This will help in reducing the battery load by feeding back the electricity produced from the vibrations in the MARCBOT to some of the interfacing components. The block diagram for the proposed model is as shown in the figure2.

Vibration Energy Harvesting converts vibrations in an electrical power. Actually, turning ambient vibrations into electricity is a two steps conversion . Vibrations are firstly converted in a relative motion between two elements, and then converted into electricity. Electrostatic converter which is used for VEH converters are capacitive structures made of two plates separated by air, vacuum or any dielectric materials. A relative movement between the two plates generates a capacitance variation and then electric charges. Electret-based electrostatic converter category uses electrets, giving them the ability to directly convert mechanical power into electricity . The electret layers added on one (or two) plate(s) of the variable capacitor, polarizing it. From the figure 2 we see that the VEH converter can supply battery power to sensors and interfaces, antennas, camera and processors of the MARCBOT. The main battery source ie. The Denchi Power BB-2590 is a world class battery specifically designed and manufactured for demanding military use. As a 'smart' battery it incorporates a SMBus interface which gives it the capability to communicate with the host equipment, as well as control how it is charged from any Level 3 Smart Charger. This reduces the risk of incorrect usage, increases its flexibility on the battlefield so prolonging its life and overall lifecycle costs .

4. CONCLUSION

The Wi-Vi technology bridges state-of-the-art networking techniques with human-computer interaction. It motivates a new form of user interfaces which rely solely on using the reflections of a transmitted RF signal to identify human gestures. We have presented Wi-Vi, a wireless technology that uses Wi-Fi signals to detect moving humans behind walls and in closed rooms.I 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 . to minimize the load on a single battery , we have introduced a technology called Vibration Energy Harvesting along with the existing technology of MARCBOT .This will help in reducing the battery load by feeding back the electricity produced from the vibrations in the MARCBOT to some of the interfacing components. Thus introducing the emerging technology of energy harvesting.

Figure 2: Block Diagram for proposed system



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5. FUTURE WORK

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. On the other hand, the signal reflected off all of these humans is correlated in time, since they all reflect the transmitted signal. The lack of independence between the reflected signals is thus important. However, Wi_Vi would not be able to see through denser material like re-enforced concrete. To improve the nulling, one may use a circulator at the analog front end [4] or leverage recent advances in full-duplex radio [3], which were reported to produce 80 dB reduction in interference power [5] . We envision that by leveraging finer nulling techniques and employing better hardware, the system can evolve to seeing humans through denser building material and with a longer range Improvements in the field will further allow Wi-Vi to capture higher quality images enabling the gesture-based interface to become more expressive hence promising new directions for virtual reality.

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