Passive RF Retroreflectors for Durable IFF Systems

I. Introduction

In the chaos of battle, identification of forces can be a challenge, especially when warring sides share similar camouflage patterns and are usually hidden behind obstacles. Over the past century, RF technology has become a popular method for military forces to command and communicate amongst each other. Combat areas demand equipment carried by armed forces to be reliable, compact, durable, and sustainable, and passive RF reflectors have emerged as a potential answer to all these requirements [1]. The following technical review paper summarizes products that implement RF reflector technology and examines various properties of passive RF reflectors that make it so ideal for military operations.

II. Commercial Applications of Passive RF Receivers

Although RF technology was born from a necessity for communication on the battlefield, it has since advanced into the civilian market through a variety of products. The need for quick, easy identification is always present, for both soldiers and everyday citizens. An example of common, everyday implementation of passive RF reflector technology is smart door locks. METechs is one of many companies that incorporate proximity RFID cards and door sensors to deliver convenient, top-level security [2]. The passive RFID cards used to open the security systems are simple cards that do not need a separate power source. Their keyless RFID door lock model MID300 is currently priced at $98.99, and the RFID card needed to open the doors are only $1.38.

In addition to being used in security, passive RF reflectors have started to make its way into more commonplace products, such as clothing. With the increase in demand for IoT products, Elwha LLC has produced a shirt with a Van Atta reflector array that can reflect the RF signals emitted by vehicle radar systems to alert drivers of the locations of pedestrians [3]. The main advantage of such passive reflectors is that they do not require a separate power source and are rugged enough to sustain the wear and tear subject from daily use.

III. Technology of RF Communication

Van Atta Reflector Array

Many passive RF reflectors use a Van Atta reflector array configuration to reflect signals back to its interrogator, regardless of what angle the signal was transmitted from. The Van Atta reflector array is a structure in which pairs of antennas are connected by equidistant transmission lines, then laid out in an array topology [4]. This configuration allows the device to work as a corner reflector, receiving waveforms and reflecting them back to the original location with a small margin of error. Due to its wide

polar diagram and small size, Van Atta reflector array configuration devices are popular when if communication frequency ranges are rather narrow. This is because the antenna of choice used in the devices are critical to absorbing all the energy transmitted from the signal [5].

Van Atta reflector arrays are passive devices, meaning that they do not require a power source to function. Despite not having its own power source, long range passive RF reflectors are able to return communication by superimposing modulations on incoming RF signals. Despite its rather small size compared to traditional reflector dishes, passive RF reflectors have a large retroreflective gain, which allows it to communicate with interrogators with only a small increase in its size. Such distances can reach from 100 to 800 meters [6].

Advantages of RF Communication

Signaling using passive RF reflectors provides distinct advantages over other forms of communication. Passive reflectors are able to respond to multiple stimuli when interrogated by more than one transmitting device [7]. This is ideal for identification friend-or-foe (IFF) systems, as multiple devices are continuously communicating with one another in a given area of operations. In addition to its ability to multitask, passive RF reflectors are ideal because of its durability and ruggedness. Not only does it remove the need for a separate power source, which would add weight and gate its time of operation, the lack of a power source makes it more durable than other responder units. RF communication is also able to communicate in between physical barriers, such as fog, rain, and obstacles. The ability of a signal to penetrate visual barriers is a distinct advantage over optical systems which makes it ideal for IFF systems.

IV. Implementation of RF reflectors in IFF Systems

The ability of Van Atta reflector array-based passive RF reflectors to modulate and amplify received transmissions, then send them through physical barriers over a moderate distance makes it an ideal choice for ground-based IFF systems. Its durability and lightweight configuration are perfect for soldiers that are equipped with heavy loadouts. A transceiver with a set range and wide angle can transmit signals in a soldier's line of fire, and then receive any reflected signals from RF reflectors worn to identify friendly forces in a given area.

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