Highly Reliable Wireless Data Receiving for Friend or Foe Identification System

Introduction

On the battlefield, it is crucial for the soldiers to simultaneously identify a target and differentiate between an ally and an enemy and shoot only the enemy with accuracy. The soldiers can not always accurately distinguish a friend from a foe while in the heat of the battle. To help the soldiers correctly identify a friend from a foe, an identification friend or foe (IFF) system can be used. The system works by transmitting an encrypted signal wirelessly in the solders range of fire. Friendly soldiers with the IFF system installed on their armor can decrypt the signal and send back a correctly encrypted response to prevent friendly fire. In order for the IFF system to work, a highly reliable wireless transmission and receiving technology is needed. Wireless communication can happened actively or passively. This technical review summaries some commercially available active wireless communication receiver technologies, explaining the pros and cons in each technology, and provides methods of implementation in the IFF system.

Commercial Applications of RF and Laser Receivers

Due to the compact size of the IFF module it is important that the receiving hardware does not take up too much space. IR receiver module are the best ways to receive IR signals while keeping the size compact. Similarly, to receive RF signals a RF receiver module is used. Infrared receivers can often be found in television remote controllers, home theaters, cable and satellite receivers, and audio amplifiers. They are categorized by parameters such as supply current, transmission distance, supply voltage, and type of package [1]. The best IR receivers are manufactured by Vishay semiconductors that have a range of 40m and a supply voltage between 2-5V which is perfect to use with any microcontroller [2]. Additionally, the 38khz operating frequency is very commonly used and easy to implement. Vishay IR receivers is listed for around $2 a piece [2].

RF is widely used to transmit huge amounts of data. like for example a FM radio. The RF system used in the IFF system needs to be extremely small and does not have to broadcast huge amounts of data. Hence a simple RF module is sufficient. In the RF market the best RF module to use with microcontrollers is the nRF24L01 module. The module has a range of 100 ft and receives 2.4 GHz signals [3]. Having a long range is very important for the IFF system. If the receiver can only detect signals from short distances the IFF system would be useless since the soldiers can easily distinguish a friend from a foe is close proximity. The module is also Low-Power and operates at 5V which works with most microcontrollers. The nRF24L01 module is on sale for $7.59 per 2 pieces [4].

The Inner Workings of RF and Laser Communication

Functionality

A simple IR signal is received in pulses. In order to understand and work with what is being transmitted the pulses are translated into binary bits. All high pulses are translated into a 1 bits and the low pulses are 0 bits. This bit stream can be manipulated and used by the microcontroller. Similarly, RF signals are also transmitted at different frequencies with different amplitudes and wavelengths. Based on the amplitude and the frequency of the signal the data is translated into 1's and 0's. Independent of how the data is transferred through air the data first gets digital modulated from bits to waves and then analog modulated to specific amplitude and frequency before being transmitted through an antenna. Once the signal hits the receiver antenna, the signal is analog demodulated and then digital demodulated back to digital bits[5].

Improvements

Although the basics of wireless communication specifically in RF as described by [5] are old, the fundamentals of the RF communications has not changed for over two decades. However, IR has been gaining more attention in recent years. As the amount of data transmitted increased old technology become less efficient in handling the Big Data [6]. While implementing laser communication might be extremely limited since an undisturbed and direct in sight signal is required to communicate, it is still seen as the solution to modern day RF problems. Lasers have been in used for communication since old days in CD and DVD readers. It is only recently that lasers have been considered for long distance communication [7].

Implementing RF and Laser Receiver

Implementation of RF is inherently more complicated than IR, as the signal needs to be directional. A wide spread signal will cause the system to trigger even when the responder in not in the line of sight of the weapon. Custom axial mode helical antennas can be used to produce a sufficient directed RF signal, however helical antennas are very expansive and very large which are not suitable for a compact IFF system. The inherent coherence and collimation of the leaser is a better option for the IFF system compared to directed RF signal. The IFF system requires either a large leaser bean or a lot of IR receivers in order to cover the whole body armor of the soldier. Using a large leaser beam as opposed to lots of receivers keeps the circuitry compact. A large leaser beam can be produced by either using multiple leasers in parallel or by placing a concave lens followed by a convex lens after the laser [8],[9]. While laser is a better option it is difficult to ensure a suitable beam spread at long distances. This can be achieved by calculating the right amount of divergence necessary to cover the entire body armer of the soldier. Another issue with laser is only a small part of the electromagnetic spectrum is used to transmit the signal, so there could be lots of Collision between the signals. To avoid this the IFF systems can communicated once every few millisecond [8].

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