International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 03 | Mar-2016 www.irjet.net p-ISSN: 2395-0072

IFF System for Infantry

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Abstract - *An encrypted laser-based friend-foe identification system is used to prevent friendly fire in battles. An Identification Friend-or-Foe (IFF) system to be used by soldiers to prevent friendly-fire is implemented in this project. Identification Friend-or-Foe (IFF) transponder systems is the inspiration for this project which is currently used on fighter aircraft and military vehicles. An IFF system fitted on the Fighter aircraft will transmit a coded radio frequency (RF) message to other aircraft which will be detected within a preset range. Friendly aircraft will decrypt the RF message and a correctly encrypted response is provided to prevent fratricide. An IFF query will be send out by a laser which is fitted on each soldier's rifle. The IFF system will produce a feedback signal when a friendly soldier is in the line of sight of such rifles. This signal can make way for an audible/visual warning, or to momentarily jam the rifle.*

Key Words: IFF, soldiers, military vehicles, fighter aircraft, laser based system.

1. INTRODUCTION

Friendly fire incidents have been responsible for numerous casualties amongst soldiers. Such incidents are caused by a variety of reasons including miscommunication and aggressive battle tactics which represent an opportunity to minimize the human cost of war. In the form of disgruntled Afghan soldiers or disguised Taliban militants NATO forces in Afghanistan have encountered a more sinister form of friendly fire. IFF system was first developed during World War II. IFF can only detect friendly soldier not a host soldier. If an IFF interrogation receives no reply or an invalid reply then the object cannot be identified as friendly, but is not positively identified as foe. There are many reasons that friendly aircraft may not properly reply to IFF.

IFF is a tool within the broader military action of "Combat Identification (CID). CID is the process of attaining an accurate characterization of detected objects in the operational environment sufficient to support an engagement decision." The broadest characterization is that of friend, enemy, neutral, or unknown. CID can reduce friendly fire incidents and also contributes to overall tactical decision-making.

1.1 IFF AS A DECISION MAKING TASK

On the battlefield, it is imperative that soldiers be able to continually and rapidly detect targets, correctly discriminate friend from foe, make a "shoot-no-shoot" decision and then shoot only the foe with accuracy. Decision theory is the study of how decisions are made and the situations that surround such decisions which has evolved from the classical, or "behavioural" model of decision making . Research in the former areas focused only on the "decision event," and adopted the perspective that the crucial part of decision making occurs when the decision maker identifies the problem and chooses a course of action. In this context, research events focus on the ability of the decision maker to use all available information in selecting the best course of action. Hence, a perfect decision making can be adopted here.

1.2 IFF SYSTEM FOR INFANTRY

In a battlefield, a soldier comes across with both enemy soldier and friendly soldier. At the time of shooting, the soldier's gun sends a laser signal. A friendly soldier is provided with a transmitter and receiver which will detect the laser signal sent by the other soldier and give the acknowledgement to the soldier that the soldier at the gun point is a friendly soldier or not.

The system is divided into two components as the responder and the initiator unit. Although each individual is equipped with both the responder and initiator unit, they are having separate functions and will not interact with each other during its normal operation. The hardware circuitry generates an interrupt on the INT0 pin when a laser beam is detected on any one of the vest's phototransistors. A software timer is used to keep track of the intervals between consecutive interrupts. As the interval detection is accurate up to 50 microseconds, a unique millisecond interval can be assigned to each transmission module. This will avoid false identification. The initiator module will buzzes as the user receives the signal; when the laser leaves the sensor and the calculated laser period changes again,

the responder unit will send a "cease" signal to the initiator unit to stop the buzzing.

- Initiator

Along the weapon's line of firing, the initiator unit generates a laser signal. The microcontroller generates a PWM signal that operates a MOSFET switch, which in turn regulates the laser output. This creates a laser beam that appears to be steady to the observer, but is actually a very rapid series of pulses with an interval unique to each soldier.

- Responder Unit

The main function of the responder unit is to register laser signals that land on a user. The vest is lined with phototransistors spaced 7.5cm apart, in order to guarantee at least one phototransistor being hit if the laser module is at least 2m away. Each phototransistor is biased as a common collector. The collector is connected to an op-amp to amplify the signal. The potentiometer determines the correct biasing voltage for the op-amp. The output is then routed into a reverse-oriented diode, which forms part of the OR-gate that consolidates the signals from all the phototransistors. Our current implementation uses 8 phototransistors, although this can easily be expanded to higher numbers by repeating the sub-circuit.
The various components used in IFF system are the following:
LASER:
Using phototransistors the responder unit detects laser beams which are incident on a soldier's body armor. The IFF system requires either a large laser beam or a lot of phototransistors on the armor in order to protect the entire body. We use a large laser beam to minimize the circuitry needed for the body armor. A large parallel laser beam could be generated by placing a concave lens followed by a convex lens after the laser. This approach preserves the collimation of the laser beam and the distance over which the IFF system can prevent friendly fire can be increased.

Atmega32 Microcontroller:
Its main features are

- high-performance,
- low-power Atmel 8-bit AVR RISC-based microcontroller
- 32KB of programmable flash memory,
- 2KB SRAM,
- 1KB EEPROM,
- an 8-channel 10-bit A/D converter
- JTAG interface for on-chip debugging.
- The device supports throughput of 16 MIPS at 16 MHz and operates between 4.5-5.5 volts.

PLETHYSMOGRAPH
A plethysmograph monitors the soldier's pulse continuously. When the soldier's heart rate falls to zero, the microcontroller unit swipes the program memory which will avoid the usage of the system by hostile units. We use a plethysmograph to ensure that the IFF system will be deactivated immediately when the user is separated from the system. Each pulse from the user generates an interrupt, which resets a software-based watchdog timer. If the timer count exceeds a predetermined amount, it indicates that the system has been detached and it will wipe the program memory to prevent fraudulent use by imposters.
BUZZER
It is an audio signaling device which may be mechanical, electromechanical or piezoelectric. A buzzer is activated when a friendly soldier is identified.

2. BLOCK DIAGRAM

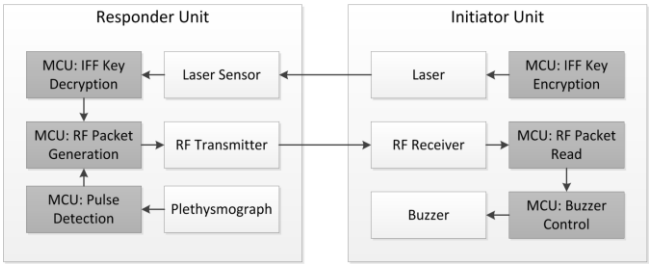

Figure 1: BLOCK DIAGRAM

The system implemented in software on a microcontroller unit (MCU) is represented by gray boxes and the hardware implementation is in white boxes. The IFF system has a responder unit on their body armor, and an initiator unit which is mounted on their rifle. The encoded message as an IFF query is transmitted by a laser using a rifle module. The phototransistors which are mounted on the target soldier's body armor will detect an incident laser beam as the rifle point's towards friendly soldier. The laser message is decrypted by an MCU in the responder unit using a pre-set private key. If successful decryption takes place, the MCU will identify which friendly soldier is currently aiming at the target soldier, and will broadcasts this information in RF. RF receivers in the initiator units of all friendly soldiers within firing range parse this information to determine if the rifle they are mounted on is pointing toward a friendly soldier. If potential fratricide is detected, a buzzer mounted on the rifle goes off which signals that the current rifle position might result in friendly fire. This feedback signal used to trigger the buzzer may also be used to prevent the next round from being loaded in the weapon's firing chamber. Two major fault cases for IFF system are:

1. By detecting the laser IFF query hostile forces may try to masquerade as friendly forces and will respond with an RF broadcast. Using a pre-set private key encryption system hostile forces can be prevented from decrypting the IFF key. To safeguard RF communications a similar encryption system can be used. This problem can be handled by generation of secure keys and at the operations level it can be handled by regular key changes like IFF systems which is currently in operation of fighter aircraft.
2. There is a chance for the hostile forces to recover the responder modules of the IFF system from dead soldiers and use it to masquerade as friendly soldiers. Here a plethysmograph is used to monitor the soldier's pulse. If the heart rate falls to zero, the MCU in the responder unit will wipe out its program memory to prevent use of the unit by hostile forces. A similar scheme can be implemented to prevent hostile forces from using the initiator unit which is fitted on the rifles. Our prototype implements the plethysmograph system on the responder unit only, instead of wiping program memory it turns on a red LED.

3. CONCLUSIONS

The IFF system is designed to minimize friendly fire in a military scenario. Although it is attached to weapon systems, it does not contribute to the performance of the weapon in anyway. We can reduce the occurrence of injuries caused by friendly fire by alerting soldiers to possible friendly-fire situations. As a system that safeguards human lives and reduces unnecessary risks during combat situations, we believe that it is completely ethical to develop and implement it.

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