IDENTIFICATION OF FRIEND OR FOE RADAR

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ABSTRACT

Identification of friend or foe (IFF) radar is also named as secondary surveillance radar (SSR). IFF is basically radar bacon system employed for the purpose of general identification of military targets. With earlier supersonic aircrafts it was not possible to identify the ship or plane whether it is friend or foe. IFF (Identification Friend or Foe) is an electronic system which can determine the intent of an aircraft with the speed of the fastest computer. IFF radar has come through a long process of changes in its technology and has overcome drawbacks of earlier radars. This paper includes the latest technology involved in the IFF radar and the future uses and modes of operation for IFF and air traffic control. Along with the brief introduction of IFF radar system and its advantages in military. The focus is on research in: IFF radar privacy, security and antennas.

Keywords: Identification of Friend or Foe, Secondary Surveillance Radar, IFF Advantages, Privacy and Security.

I. INTRODUCTION

RADAR BASIC: RADAR (Radio Detection and Ranging) is an electromagnetic system for detection and location of reflecting objects such as aircraft, ships, spacecraft, vehicles, people, and the natural environment.It operates on the principle of radiating energy into space and detecting the echo signal reflected from an object or target. With the reflected help of reflected signal it is easy to detect the ship or plane of enemy. IFF radar gives the exact information about the detected object whether it is a ship, plane, missile or any other object. It is also able to give the exact location that is height and distance of the object. The IFF radar has overcome the shortcomings of the primary radars.IFF radar has a frequency band of 1-2 GHz.

- Radar consists of a receiver and a transmitter each connected to a directional antenna.
- A transmitter (in the upper left portion of the figure) is capable of sending out a large UHF or microwave power through the antenna.
- A portion of transmitted energy is contained by the target and reradiated in many directions.
- The receiver receives, analysis, and displays the information in the reflected echoes picked up by the antenna. Then process is carried out to know the presence of the target and determine its location.

- The duplexer is used as a switch between transmitter and receiver.

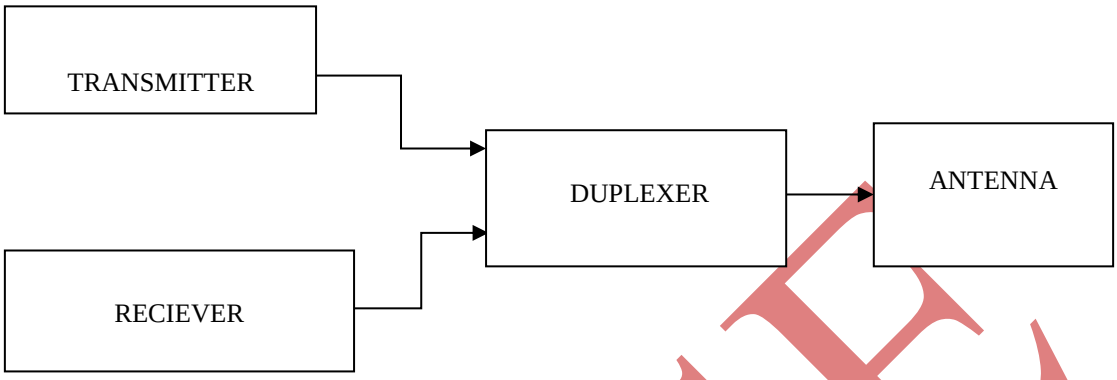

Figure 1: Block Diagram of RADAR

II IFF UNIT

2.1 Primary radar locates an object by transmitting a signal and detecting the reflecting **ECHO**. The Secondary radar system is very similar in operation to primary radar except that the return signal is radiated from a transmitter on board the target rather than by reflecting. Alternatively, we can say that secondary radar operates with a co-operative "active target" while the primary radar operates with a "passive target".

2.2 Secondary radar system consists of an INTERROGATOR and the TRANSPONDER. The interrogator transmitter at the ground station interrogates transponder equipped aircraft, provide a two way data connection to separate transmit and receive frequencies. The transponder, on the aircraft, on reception of a chain of pulses from the ground interrogator, automatically the transmits a reply. The coded feedback, for use of identification is received back at the ground interrogator where it is decoded and displayed on a radar type presentation.

ECHO AND DOPPLER SHIFT

The echo occurs because some of the sound waves in our shout reflect off of a surface (either the water at the bottom of the well or the canyon wall on the far side) and travel back to our ears. The length of time between the moments you shout and the distance between us and the surface that creates the echo determines the moment that we hear the echo.Doppler shift occurs when the sound is created by, or reflected off of, a moving object. Doppler shift in the extreme generates sonic booms.

III IFF Mk-X SYSTEM

3.1 Basic Principle: IFF Mk-X system basically operates on the principle of a Secondary Radar. The Interrogator sends out RF pulses, called mode pulses with suitable spacing as per the desired mode of interrogation. The transponder receives these pulses and sends out suitable replies. The RF reply pulses from transponder are received, amplified and detected in ground receiver chain. The detected reply code and corresponding mode information are then `Passed on' to the MK-X Decoder unit for further decoding. The targets whose codes are

matched are displayed on the PPI near the respective primary radar echo in the form of two slashes. Special codes like Emergency, Communication Failure and Hijack are decoded automatically whenever targets are interrogated on mode 3/A.

3.2 Operational Description: The output of the IFF Interrogator consists of three RF pulses P1, P2 and P3 at 1030 MHz's The R.F output is applied to an IFF Antenna through a RF switch unit. The transmitted pulses P1 & P3 are received by the transponder fitted in the aircraft/ship. The coded replies at 1090 MHz from the transponder are received, amplified, detected and fed to Mk-X decoder. The P1 and P3 pulses occur at discrete pulse intervals and the P1, P3 combination is known as MODE. The P1 and P3 pulses are known as the INTERROGATE PULSES and pulse P2 is known as the CONTROL PULSE.

3.3 Operational modes- The IFF Mk-X Interrogator have four types of interrogation modes:

1. Modes 1 and 2 are used for Military Interrogations.
2. Mode 3/A is common to both Military and civil systems, and
3. Mode C is used for eliciting the digitally encoded altitude from the airborne transponder.

a) MODE 1 REPLY

When the aircraft is interrogated in mode 1 then the pulse P1 and P3 are spaced 3 microseconds apart, and then the transponder sends back the feedback. SI is another name for mode 1 and is the abbreviation for SECURITY IDENTIFICATION .The returning SI code is the basic FRIEND AND FOE identification.

b) MODE 2 REPLY

When the IFF ground interrogator transmits mode 2 interrogations, consisting of P1, P3 spaced at five microseconds apart, the aircraft transponder replies with a PERSONAL IDENTITY (PI) code train.

c) MODE 3 REPLY

The aircraft transponders response to mode 3 interrogation, having spacing between P1 AND P3 at 8 micro second apart is aT1 code train. The T1 is abbreviation for TRAFFIC IDENTITY

d) MODE C REPLY

The mode C interrogation, has two interrogation pulses P1, P3 spaced at 21 microseconds apart, is common for both military and civil use.

IV IFF (MK-XI) UNIT

4.1 Purpose: The Identification Friend or Foe Mk-XI (IFF - Mk XI) Ground Equipment is used to interrogate and identify the ship/aircraft (target) fitted with compatible transponder. The coded replies from the interrogated target are received back, processed and displayed on a PPI in a convenient form to the operator.

4.2 Operation: The SSR system can operate in association with both static and mobile primary radar or independently with its own display. The triggering of transmitter can be done either internally or externally.

Interrogations were pre-triggered with respect to the primary radar pulse transmission to provide for a timing match between radar echoes and SSR replies at the PPI display. PRF of the transmission after interrogation is either the same as the primary radar or counted down to maintain a nominal value as the situation may be. The interrogating modes provide for the separation of replies by its function.

Mode 'S' processor was then invented to avoid the abovementioned drawbacks in the Mk-X decoder system and then came the advance version of the IFF system which was a modification over the Mk-X system as it comprises both the Mk-X system as well as the Mode 'S' processor which was given the name Mk-XI radar system.
In the Mode 'S' system the concept of POLY COEFFICIENT called POLY and KEY was introduced to achieve (or generate) VARIABLE REPLY CODE to avoid spoofing.

4.3 Advantages of Identification Of Friend Or Foe

1. Reply pulses are stronger than the echo signals of primary radar.
2. Separate transmitting and receiving frequencies eliminate ground clutter and weather return problems.
3. Reply signal is independent of target cross section.
4. Interrogation and reply path coding provide discrete target identification and altitude data.

The transmitter of the interrogator operates in the L band at 1030 MHz and the airborne transponder operates at 1090 MHz's.The SSR operates with the similar frequency channel for both military and civil air traffic control by using compatible airborne devices in the aircraft.

V. APPLICATIONS OF RADAR

1. Air Traffic Control (ATC): Aircraft and ground vehicular traffic at large airport are monitored by means of high - resolution radar. Radar has been used with aircraft for a safe landing in bad weather.

2. Ship Safety: Radar is used for enhancing the safety of ship travel by warning of ship potential collision with any other ships, and for the detection, navigation buoys and mainly in poor visibility.

3. Space: Space vehicles have used radar for rendezvous and docking and for landing over the moon. Some of the greatest ground based radar is for the detection and tracking of satellite.

4. Law Enforcement: In addition to the wide use of radar to measure the speed of automobile traffic by highway police and the radar has also been employed as a source for the detection of intruders.

5. Military: Many of the civilian application of the radar are also employed by military. The basic role of radar for military application has been for navigation, surveillance and for the guidance and control of the weapons.

VI. CONCLUSION

IFF radar system has the potential to uplift our standards in areas of air traffic control, ship safety, law enforcement and space. It is our hope that this paper has highlighted the technologies potential, ongoing research to address the challenges and the areas in need of more attention in terms of research. The paper gave an overview of the current

state and the trends of IFF radar system. With more research the advantages and the further developments can be made in present radar system. This will make it very useful for military sector.

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