Modification of Electronic Warfare (EW) Suite on Jaguar Fighter Aircraft

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Abstract.

The performance of electronic reconnaissance equipment as a component of the Electronic intelligence (ELINT) and the Electronic Support Measure (ESM) systems is directly influenced by radar signal sorting, which is a critical mechanics in campaign prioritization .Regularities of signal sorting are significantly undermined as radar systems become more complicated, countermeasure measures in modern electronic warfare become harsher, and low-probability of intercept (LPI) develops. As a result, the outcomes of sorting radio signals based on five customary characteristics aren't particularly impressive. The basic restriction of signal filtering in ESM and ELINT systems is de inter leaving advanced radar signals, which is restricting the capability of ECM apparatus. As a result, we investigate the history and the magnitude of radar signal cataloguing in compound systems.

Keywords Electronic warfare, User-defined Database, Electronic Intelligent Database, Electronic Support Measures, Radar Emitter Signal Sorting

1. Introduction

This paper describes how to prosper a coalesce Electronic Warfare (EW) Suite for Jaguar Fighter Aircraft by combining multiple Line Replaceable Unit (LRUs) executing discrete EW operations into a sole Line Replaceable Modules (LRM) with the notion of smallermagnitude,mass,andenergy,higherextensibility,andgreaterenduranceforopenquality, which fosters communal, profitable off-the-shelf (COTS) conducts for communication and calculation resource advancement. A study of modern technology employed in electronic warfare systems is also carried out. Current electronic and optical technology in use in the detection, localization, processing, and identification of a set of signals are all steps in the detection, localization, processing, and identification of a set of signals, both active and passive countermeasures are two terms that are used interchangeably analyzed. Popular aredesignsandarrangementsinspiredbythe"marineworld."Intermsofefficacyanddependabilit y, as well as design and operational trade-offs. The following are the topics: classified according to the current classification of electronic warfare covers confusion reflectors which are intercepted by masking and misleading jammers. The special attributes of the Navy of Surface are discussed in addition to the burgeoning issue of Spectra-Optical Electronics Warfare. The Appendices are a collection of documents located in the book's back. An experiment with a circuit developed for signaling a list of missiles with recognition as well as a description of the recognition, is shown .Electronic and guidance characteristics are discussed.

Electronic warfare is typically defined as military activity that uses electromagnetic radiation to allow friendly forces to use their electronic or optical equipment while limiting or denying enemy usage of the electromagnetic spectrum. The most often utilized EW divisions are as follows:

a. Electronic support measure (ESM)

Although Signal Intelligence (SIGINT) is a planned fourth branch, it is often included in ESM.

Electronic Support Measures are designed to collect data that will be useful in the case of an electromagnetic battle. This data can be used individually for threat detection and warning or in tandem with ECM or ECCM. As a result, duties including searching for, intercepting, locating, and evaluating transmitted electromagnetic radiation are common in ESM. In a broader sense, these support measures include all forms of reconnaissance missions, including industrial reconnaissance.

b. Electronic Counter measures (ECM)

Electronic Countermeasures (ECM) is a branch of EW that deals with efforts made to diminish or avert an enemy's exploitation of electronic warfare. Electromagnetic Spectrum is put to good use. It's true. These acts may be carried out by force. They can try to trick orconfusetheenemybyapproachingclose.It'ssometimesusefultocategoriesECMasactivesorpassives.

c. Electronic Counter Counter measures (ECCM)

Electronic Counter-measures (ECM) is a component of electronic warfare that includes efforts to counter the enemy's ECM while ensuring that friendly soldiers can successfully use the electromagnetic spectrum.

Electronic warfare systems include radar, scanners, communications, weapons guidance and navigation. The existing literature, on the other hand, is mostly concerned with the dangers posed by radar. Even though all systems follow the same basic principles they each have their distinct traits.

In contrast to the radar situation, numerous components of communications, for example, should be fine-tuned:

- At the opposite extremities of the spectrum, the transmitter and receiver are located .As a result the transmission line is just one-way ,jammers and communicative ns transmitters compete on an equal basis, with both having an inverse square of distance dependence factor. The two-way path in the Radar Equation creates an inverse fourth power distance dependency factor, which is a considerable disadvantage at ordinary working ranges.
- Communication systems are now available in a far broader range of styles and sizes. A wide range of modulation schemes is not only feasible but also widely used. The typical pulsed mode is employed by a considerable percentage of radar systems now in operation. In addition, communications links might be found in almost any section of the spectrum, from low frequencies to infrared and optical wavelengths.
  Interm so femission time, communications lines are more flexible suggesting that transmission is more within the control of the operator and less dependent on external variables. Because of these qualities, communications EW is more complex and unpredictable than radar EW and the findings are more difficult to interpret.

2. LITERATURE REVIEW

[1] 'Electronic Warfare Self-Protection of Battlefield Helicopters: A Holistic View,' by Johnny Heikell .Applied Electronics Laboratory ,Helsinki University of Technology, Department of Electrical and Communications Engineering, 2005. Author Johnny Heikell has analyzed and commented on the features and limitations of helicopters, as well as the existing Electronic Warfare system on helicopters, as well as its conceptual model and methodology, in this journal. He has also conducted research and presented on threat systems, technologies, and counter measure advances.

[2] The Journal of the JAPCC, Edition 27 Autumn/Winter2018, Giuseppe S gamba, 'Transforming Joint Air and Space Power'. In his publication, pages 41-45, the author and Brigadier General, ITA AF, Assistant Director JAPCC surveyed and elaborated on North Atlantic Treaty Organization (NATO) operations and strategic view of Electro-magnetic System, scope, advantages, and over look on Electronic Warfare and Electromagnetic spectrum and environment.

[3] R. Pitchammal and S. Sarala, Defense Avionics Research Establishment, Bangalore, India, 'A Blue Print for the Future Electronic Warfare Suite Development.'2013.The writers of this article, R. Pitchammal, and S. Sarala, covered the Integrated Modular Avionics system and development considerations, as well as an examination of the existing Electronic Warfare Suite and IMA implementation for the construction of a unified EW Suite.

[4] 'Electronic Warfare' is a term used to describe the use of technology in combat. DEPARTMENT OF THE NAVY Headquarters the United States Marine Corps Warfighting Publication(MCWP)3-40.5 ,Electronic Warfare, Edward Hanlon Jr. Lieutenant General, USMC Commanding General Marine Corps Combat Development Command Quantico, Virginia, DEPARTMENT OF THE NAVY Headquarters the United States Marine Corps Warfighting Publication (MCWP) 3-40.5, Electronic Warfare, 2002.Author and Commanding General Edward Hanlon Jr. spoke about the development of electronic warfare and the technology used in naval operations, battlespace and function concerns, joint and multinational operations, and the Radio Battalion.

[5] 'Management Information Systems for Electronic Warfare Command and Decision Support,' University of KwaZulu-Natal Durban, South Africa, 2015. 5. Brett Van Niekerk and Christo Cloete, 'Management Information Systems for Electronic Warfare Command and Decision Support,' University of KwaZulu-Natal Durban, South Africa, 2015. The writers of this journal article explore the Electromagnetic Spectrum and its impact on modern society.

3. SEPECAT JAGUAR

The SEPECAT Jaguar was first developed in the 1960s by the Royal Air Force of the United Kingdom and the Air Force of France as part of their first significant joint military initiative, dubbed 'SEPECAT.' Jaguar was developed with two engines primarily for ground-attack or bomb-dropping missions .Jaguar's particular benefits are its ability to go great distances ,fly fast even at low altitudes, and carry a large load. Jaguar is also equipped with refueling probes ,allowing it to carry out any type of air refueling missionin any weather.

In July 1979, India purchased its first two Jaguar fighter aircraft from the British, and by1981, it had purchased 40 Jaguars for a total cost of one billion dollars. India was later granted permission to build 120 Jaguars at HAL under the name 'Shamsher.' HAL has produced 90 Jaguars to date, many of which are still in use. With its dual Adour Mk-

102engines, the Jaguar aircraft can reach speeds of up to 1,700 mph. DARIN-III upgrades are now being carried out in Jaguar aircraft ,with the first successful upgrade flight taking place in November 2012. The Aero India Exhibition in February 2019 featured new updated cockpit design features as well as advanced avionic technologies. HAL plans to upgrade 60Jaguarsto DARIN-III standards, with the EW Suite being the first to be upgraded.

4. ELECTROMAGNETIC SPECTRUMINEW SUITE

The control and exploitation of the Electromagnetic- Spectrum is the focus of Electronic-Warfare .All types of electromagnetic radiation ,including radio waves ,infrared, ultraviolet ,and gamma rays, as well as their frequencies and wavelengths, are included in the electromagnetic spectrum.

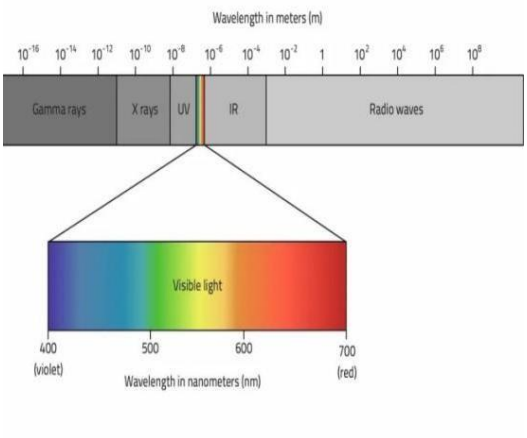

Fig.1 Electro magnetic Spectrum

This spectrum is used by the military, navy and airforce to detect and attack hostileorces. With today's technology and threat exposure, it's more important than ever to be able to distinguish friendly forces from enemy forces and successfully defend our aircraft .Electronic warfare employs the electromagnetic spectrum for IFF (Identification of Friend or Foe) via the Radar Warning Receiver to detect hostile aircraft and deploy counter measures such as chaff to mislead enemy radars. Electronic warfare aid sour forces by assisting our fighter aircraft in gaining control of the electromagnetic environment, which advantages our aircraft while diminishing adversary control. Controlling the electromagnetic environment in warfare is extremely helpful and vital and it is dependent on Electronic Warfare's successful exploitation of the Electromagnetic-Spectrum.

- ***PROBLEM STATEMENT***

A range of communication-navigation systems have been developed for aircraft. Fighter aircraft, on the other hand, are primarily built for military use and must be equipped with powerful defense and offensive capabilities. Aircraft, on the other hand, lack defense mechanisms to ensure their safety. A system must be able to successfully allow the aircraft to avoid hostile radar sorelude their missiles to give security to the aircraft.

- ***SOLUTION***

Hindustan Aeronautics Limited (HAL) fighter aircraft have been receiving a major upgrade as part of the DARIN-III Modern Avionics System program, which aims to provide advanced defense systems to the Indian Air Force (IAF) fighter aircraft. HAL is introducing the Counter Measure Dispensing System (CMDS) with different equipment's like as chaff, flares, and decoys to supply the combat aircraft with the capacity to escape missile launches and compromise enemy radars on all of their fighter aircraft and helicopters.

Electronic Warfare Suites had their origins in 1943 when the British aircraft Avro Lancaster was equipped with chaff capable of disorienting enemy radar systems. Since2013, SEPECAT Jaguar has been undergoing the DARIN-III upgrade and is now being upgraded to include the EWsuite. HAL Overhaul Division is implementing these improvements and upgrades, which involve hardware and software design, mechanical and electrical design, and requirements. The SEPECAT Jaguar EW suite has been delayed because of a paucity of essential components for this upgrade, but it is now being actively worked on as the Indian Air Force gets airframes from the British and French for the modifications. By 2038, it is predicted that all Jaguar aircraft in the Indian Air Force will have received improvements.

- ***METHODOLOGY***

A combat aircraft armed for EW, or demeaning the efficiency of opposing radar-radio electronics through radio jamming-deception techniques, is known as an electronic-warfare aircraft.

- The **Radar Warning Receiver (RWR)** gathers radar signals from the ground and the air and sends them to the aircraft cockpit's Cockpit Display System (CDS) or Smart Multifunction Display (SMD).

- The aircraft radar system detects any unidentified or foreign signal or object as seen by the **ELINT or Electronic Intelligence Database** and the **UDF or User-defined Database.**

- The threat is then analyzed by the aircraft defense system, and an **Electronic Counter Measure (ECM)** is undertaken. **CMDS (Counter Measure Dispensing System)** is fitted with 'Chaff and Flare' or other counter measures like jammers and transponders.

As a result of the actions done, hostile radar systems are confused. InFig.2 and 3 can see the block diagram of both RWR and CMDS. RWR and CMDS work hand in hand to form the EW system although they are two different systems independent of each other. RWR focuses on the threat detection and the CMDS works on preventive measures for protection against the threats detected.

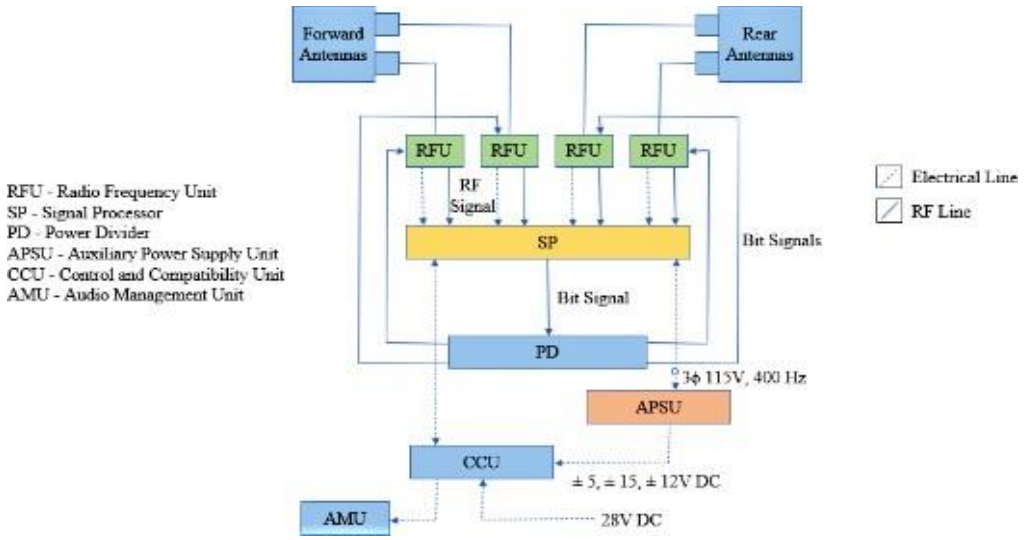

Fig.2 Block Layout of RWR

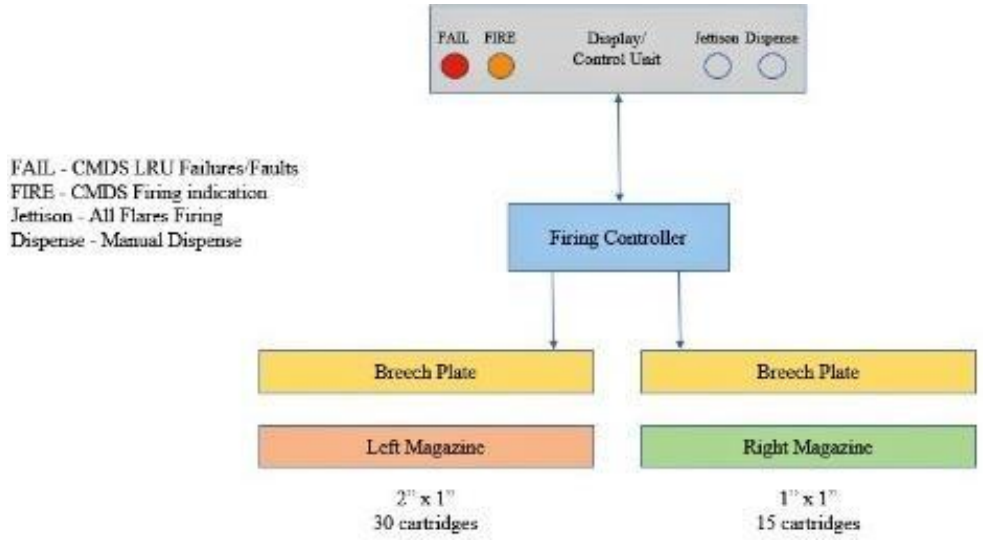

Fig.3 Block Layout of CMDS

5. BACKGROUND WORK

Procedures and technology that brought about the improvement of equipment able to electronically recognize and counter a weapon device, in addition to the improvement of counter-countermeasures, are called "electronic war." The electromagnetic spectrum has been controlled/utilized by the primary electronic protection systems that carry out digital conflict duties, and that they can be labeled into the subsequent classes:

- **Electronic-Support (ES)** offers the skill and hazard detection wished for a hit assault and conservation. The main goal is a diplomatic interference. Commanders can use it to look

for, become aware of, and stumble on both premeditated and accidental electromagnetic intensity assets.

- **Electronic-Attack (EA)** uses electromagnetic radiation to obstruct or degrade opposing forces' powerful utilization of the electromagnetic spectrum via jamming and deception. Deception is a huge part of electronic attacks.
- **Electronic-Protection (EP)** is a wide period that consists of everything from constructing jam-resistant systems to hardening equipment to with stand excessive-energy microwave assault to destroying foe jammers with anti-emission ammunitions.

The EW suite for each battle platform with complete EW potential includes the auxiliary-systemsindicatedinFigure4.

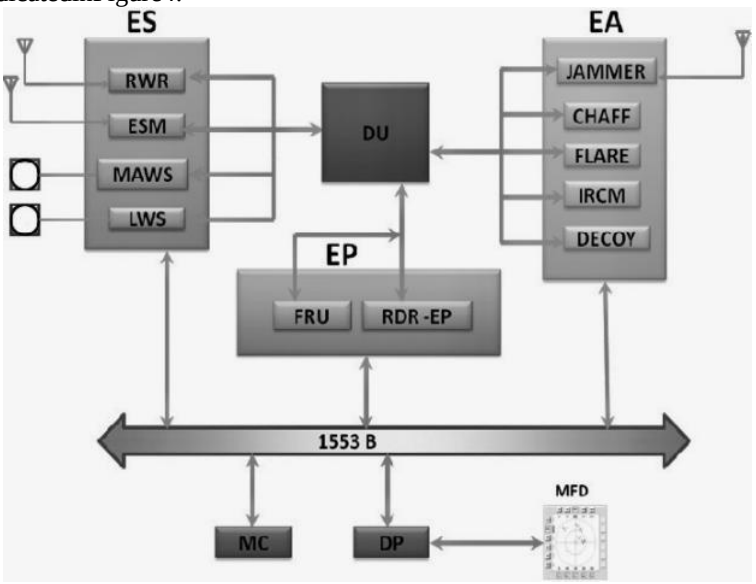

Fig.4 The architecture of the current EW suite.

MAWS (Missile-Approach Warning System) is an apathetic system which recognizes and follows an approaching missile's burning plume as it surfaces within a protective circle around the airplane (using just EM spectrum reception). The MAWS distinguishes between dangerous and safe missiles by examining ammunition paths.

The **Laser-Warning System (LWS)** is a static system that detects, tracks, and warns of adverse laser resources aiming at the platform (only EM spectrum reception).

A **jammer** is a lively device that makes noise and uses misleading jamming strategies to both reduce the automated monitoring abilities of chance structures and generate enough monitoring mistakes to impede a hit engagement.

Decoys - In the very last degrees of a conflict, towed decoys are deployed to spoil opposing missiles.

Chaff – Metal or metalized plastic ribbon-like debris thrown by using planes to hide or display other planes or motive monitoring radar to lose latch.

Flare is the most not unusual counter-measure for an IR missile that can discriminate among IR indication of the plane and IR indication of a historical past disturbance.

The energetic device **IRCM (infrared countermeasure)** can lessen the strength of IR hazard electronics. The primary is to lessen power degree to reduce the aircraft's warmth

signature intensity. This flare-rejection countermeasure system is referred to as a flare rejection unit (FRU).

RDR-EP (RADAR EP) is a Counter-Counter-Measure gadget that could guard radar receivers, avoid jamming, the most jamming signals and over power jamming alerts.

The general trend towards increasing the complexity of these EW systems have large implications for plane costs throughout the board, which includes improvement (range of the various device), upkeep (quantity of alternative gadget), evolution (system specificity, technology dependence), overall performance, and so on. To remedy this issue in the current EW suite concept, the progression is necessary.

MIL-STD 1553 is an avionics machine data bus protocol that defines the electric, useful, and mechanical components of serial facts- bus for navy avionics.

The Multi-function show, or MFD, is the cock pit display panel in which several avionic gadget functions can be finished in addition to other communique and navigation structures maintained and changed.

6. SOFTWARE

a. Keil u Vision

A microcontroller can be programmed using a number of software tools which is usually associated with the chip used or the programming board or the method of transfer of the code to the chip. For this project, Nuvoton manufacturer has a designated software tool for transfer of the code in HEX file format to the chip via the COM port of the CPU.

C or C++ code can be used for a microcontroller. We have used C code which can be compiled using any software tool. Keil u Vision is a software tool used for C or C++ programming especially for 8051 microcontroller applications. The programmed code once complied and verified of all errors must be converted to HEX file format and with the help of the Nuvoton ISP/ICP software tool, can be uploaded to the 8051-microcontroller chip W78E052DDG via the COM port.

b. RWR Display

The RWR display in real-time aircrafts or helicopters is represented or visualized as a group of varying diameter concentric circles along a mid-point defined as the aircraft itself. Any threat detected by the 4 antennas is displayed on the RWR on the 4 divided quadrants. This display can be represented in visual graphics C or MATLAB.

In MATLAB , we can construct antenna-based radars using Sensor Array Analyzer which serves as a sample for the real-life RWR system.

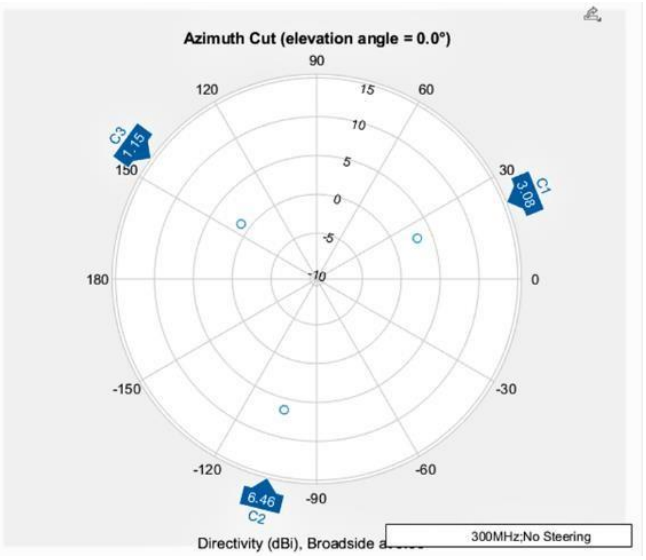

Fig.5 RWR MATLAB DISPLAY

7. CONCLUSION

Many attack mechanisms and equipment are created without considering the Electronic Warfare Suite. However, a relatively simple Radar Warning System in conjunction with a Counter Measures Dispensing System is extremely beneficial in not only degrading the energy are a and strategy but also in providing a secure battle environment for our military and naval aircraft and missions. While improved avionic systems focused on precision and dependability are being aggressively introduced, more improvements in EW systems are being worked on to improve and eliminate the limitations of this defense mechanism.

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