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OVERVIEW OF ELECTROMAGNETIC INTERFERENCE ISSUES IN AIRCRAFT

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Abstract

Purpose of Study: In the modern era, due to several conflictions or uncertainty in the aircraft, Electromagnetic Interference (EMI) or Radio Frequency Interference (RFI) issues occurred, frequently. The main reason behind it several disturbances generated by an external source that imitate wireless circuits with the help of conduction, electrostatic coupling, and electromagnetic induction. These disturbances may decrease the performance of the circuits or sometimes fully stop the operations.

Methodology: The main challenges in EMI are modeling and simulation for modern and future wireless communication systems and networks taking into account nonlinear interference effects.

Result: In this paper, overviews of several issues of EMI or RFI are illustrated.

Keywords: *Electromagnetic Interference, Radio Frequency Interference, Aircraft.*

INTRODUCTION

In the last few decades, applications of the wireless network increase rapidly due to autonomous, dynamic and quick response natures [1-5, 26-28]. There are several variations of wireless networks such as wireless sensor networks [6-7], wireless ad-hoc network [8-10], mobile ad-hoc networks [11-12], etc. which are rapidly used in aircraft. Electromagnetic Interference (EMI) is the disruption of the operation of an electronic devices when it is in the vicinity of an electromagnetic field in the radio frequency spectrum that is caused by another electronic device, which is a disturbance generated by an external source that affects an electrical circuit by electromagnetic induction, electrostatic coupling or conduction. The disturbance may degrade the performance of the circuit or even stop it from functioning. It affects the transmission channel or system. In the case of data path, these effects can range from an increase in error rate to a total loss of the data. It is also called Radiofrequency Interference (RFI) when the interference is in the radio frequency spectrum. There are different sources of EMI given below:

(a) Thunderstorm.
(b) Defective fluorescent lights.
(c) Arcing of contacts in electrical controllers stepping switches.
(d) The ignition system of Motor vehicles.
(e) Worn or improperly installed brush of motors or generators.
(f) Igniters for jet engines.
(g) Define power lines.
(h) Defective power transformer.
(i) Improperly bonded lifelines, rigging, jackstay and stanchions.
(j) Cell phones & passenger electronic devices etc.

Both manmade and natural sources generated changing electrical currents and voltages can cause EMI.

DIFFERENT TYPES OF EMI

Electromagnetic interference can be categorized as follows:

(a) Conducted EMI: It is caused by the physical contact of the conductors as opposed to radiated EMI, which is caused by induction (without physical contact of the conductors). Electromagnetic disturbances in the EM field of a conductor will no longer be confined to the surface of the conductor and will radiate away from it. This persists in all conductors and mutual inductance between two radiated electromagnetic fields will result in EMI.

(b) Narrowband EMI (NEMI): It consists of a single frequency or a narrowband of interference frequencies. It has a minor effect on communications or electronic equipment and can be turned out or faltered out. It typically emanates from intended transmissions such as radio & TV stations or cell phones.

(c) Broadband EMI (BEMI): It is unintentional radiation. [13-15], not a discrete frequency and occupies a relatively large part of the electromagnetic spectrum. It is caused by arcing or corona and causes most EMI problems in digital data equipment. An example of BEMI is electric power transmission lines.

DIFFERENT ISSUES OF EMI

EMI affects AM radios, cell phones, FM radios, televisions, etc. and also some common examples are as follows:

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(a) Disturbance in the audio/video signals on radio/TV due to aircraft flying at a low altitude.

(b) A welding machine generates undersigned noise on the radio.

(c) A kitchen mixture/grinder generates undersigned noise on the radio.

(d) Noise on microphones from a cell phone handcuffing with communication tower to process a call.

(e) In-flight (taking off or landing) it is required to switch off cell phones since EMI from an active phone interferes with navigation signals etc.

AIRCRAFT AS A SENSITIVE TO EMI

Airplanes contain a finite number of radios for a variety of tasks as:

(a) Pilots use to talk to ground control.

(b) Pilots use to talk to air traffic control plane uses to disclose its position to air traffic control computers.

(c) Radar units used for guidance & weather detection etc.

(d) All radios are transmission and receiving information at specific frequencies.

The use of any electronic device may create interference that overlaps with the radio frequency used by airplanes. The message between users or computers may be garbled.

Operators of airplanes have reported numerous cases of Portable Electronic Devices (PED) such as laptops, palmtop, audio players/recorders, electronic games, cell phones, compact disc players, electronic toys, laser pointers etc. that affect airplane system during flights. EMI from PED is responsible for anomalous events. Operations of PEDs produce uncontrolled electromagnetic emissions.

CATEGORIES OF EMI CONTROL

(a) Shipboard EMI control (SEMIC): This control is greatly simplified for typical electronic and digital data installations. Because of the ship's steel null and construction, much shielding and isolation are provided for typical shipboard equipment spaces. These blocks out must BEMI generated both internally and externally.

(b) Sore based EMI control (SOEMIC): This control as a shore-based installation requires the consideration of the same factors as for a shipboard system with two additional factors such as site location and soil quality.

CATEGORIES OF EMI CONTROL

Basic elements of EMI problems are given below and also pictorial representation is given in Table 1.

1. Source
2. Path
3. Victim

The basic elements of EMI control are shown in Figure 1. Figure 1 shows an overview of the electromagnetic environment in which a typical airplane flies.

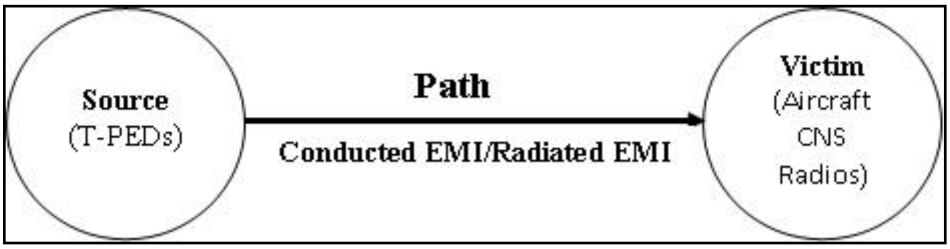

Figure 1: Basic elements of EMI problems

ANALYSIS OF HEURISTIC APPROACH FOR EMI

There are several soft computing and artificial intelligence techniques are used to optimize electrical parameters for controlling EMI. There are several components of soft computing such as fuzzy logic, genetic algorithm, artificial neural network and fusion of these paradigms are applied in this optimization to model the problem mathematically [16-20]. A proper small electrical loop antenna works as a sensor that is used as a transmitter or receiver. So, optimization of the physical size of this loop and electrical parameter must be considered to reduce uncertainly in aircraft [21-22].

STUDY ON EMI TO AIRCRAFT

The graphical analysis [23] of PED types, airplane types, phase of flight where incidents occurred, aircraft systems affected and degree of severity of the EMI event. Figure 4 shows a comparison of the aircraft system affected by PED EMI.

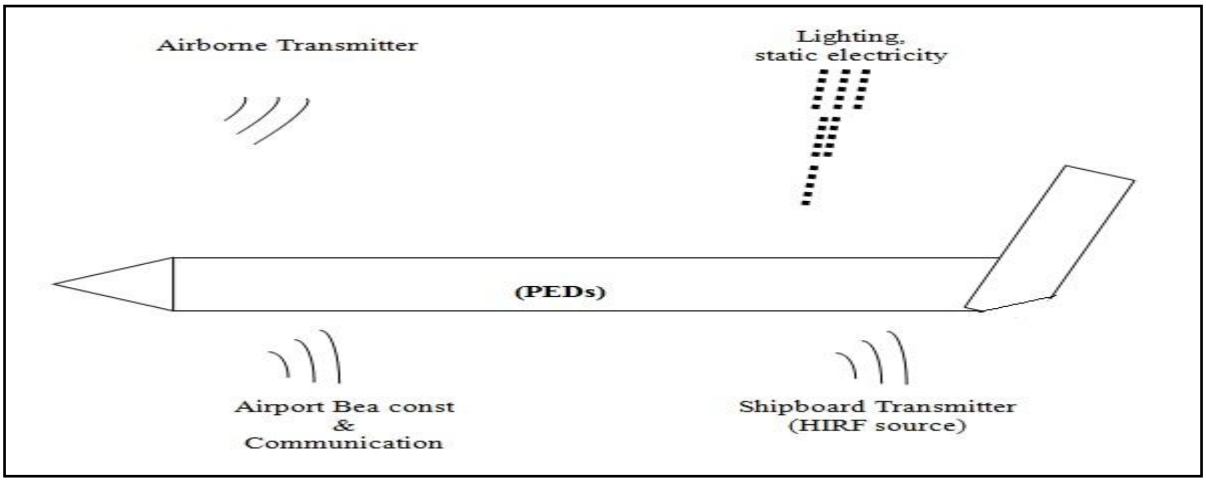

Figure 2: Shows electromagnetic environment in which a typical airplane flies.

EMI is created by transmitting PEDs (TPEDS) into the airplane cabin. PEDs & TPEDS are operated by battery power where used onboard airplanes, the path is radiated, rather than conducted. EMI concern is for aircraft electronic systems (victim), particularly Communication, Navigation & Surveillance (CNS).

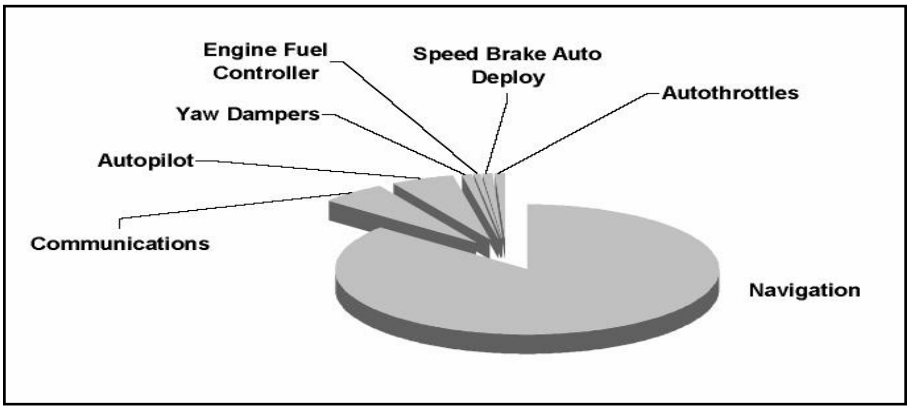

Figure 3: Shows aircraft system affective

Let P is a set of PEDs as P={p1, p2, p2, p4, p5, p6, …….pk} where p1=Cell Phone, p2=Laptop Computer, p3=Electronic Game, p4=Tape Player/Recorder, p5=Radio, p6=PED Not Identified, p7=CD Player, p8=Pager, p9=Digital Movie Player, p10=Dictaphone, p11=Calculator, p12=Portable Television, and p13=Personal Digital Assistant and i is the set of correspondence as:

I={i1, i2, i3, i4, ……………., ik} for all ik $\in$ N. Taking i1=25, i2=25, ………. from [4] in Figure 4.

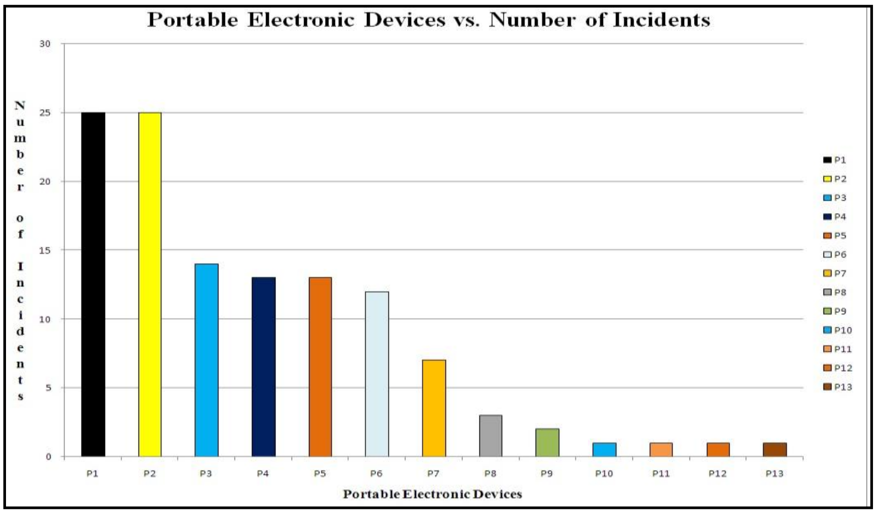

Figure 4: Shows PEDs affecting aircraft system.

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HIRF

HIRF is an acronym for High-Intensity Radiated Fields and refers to radiofrequency energy of strength sufficient to adversely affect either a living organism or the performance of a device subjected to it. A microwave oven is an example of this principle put to controlled, safe use.

EVIDENCE OF HIRF

As was discussed above, the nature of HIRF EMI is such that there have been virtually no studies of the frequency and nature of the occurrence. Most of the work in this area has involved modeling, simulation, and measurement of the electromagnetic fields in the airspace nearby typical emitters, the penetration of aircraft fuselages by these fields, amplification of these fields due to resonances which occur within an aircraft, and the voltages and currents induced in typical wiring or electrical and electronic circuits by the interior fields.

Most of the evidence to date of HIRF EMI Occurrence is anecdotal, (short stories or accounts about a happening, usually personal). Clearly, a collection of anecdotes begins to resemble a database from which one can draw conclusions. Unfortunately, there are only a small number of such stories some of which are discussed in [24].

DATA ANALYSIS

Data analysis based on author [25] is given Between May 5, 1992, and October 15, 1992, 57 responses were received, thus 25% of the participants replied, a high ratio for a survey. (Typically, survey forms have a response rate of a few percents.) The preliminary analysis of the final 30 of the 57 responses is given in **Table 1**, which illustrates some major features of the responses. For example, pilot/engineer #11 (where #11 indicates finite no. of accidents) reported 11 incidents but only listed 8 in the breakdown by categories.

Table 1: Number of EMI events reported by category

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
1	Pilot	20	Detailed	5	0	1	1	1	1	1
2	EMI Specialist	10	Medium	0	0	0	0	0	0	0
3	Manger/Engr.	30	Nil	--	--	--	--	--	--	--
4	EMI Specialist	5	Detailed	102	0	102	0	0	0	0
5	Engineer	20	Some	0	0	0	0	0	0	0
6	EMI Specialist	10	Detailed	4	0	3	0	0	0	1
7	EMI Specialist	30	Medium	5	--	--	--	--	--	--
8	EMI/Pilot	30	Detailed	12.5	1	3	0	2	2	0
9	Psy/Manager	10	Medium	0	0	0	0	0	0	0
10	EMI Specialist	30	Some	0	0	0	0	0	0	0
11	Pilot/Engineer	20	Detailed	11	0	1	2	1	1	2
12	Engineer	30	Some	1	0	0	0	0	0	0
13	EMI Specialist	30	Detailed	3	0	1	1	1	1	0
14	EMI Specialist	38	Detailed	32	3	4	0	1	1	0
15	Pilot/Engineer	30	Detailed	28 +	3	3	4	3	3	0
16	EMI Specialist	20	Detailed	10	0	3	1	1	1	0
17	EMI Specialist	30	Detailed	1	1	0	0	0	0	0
18	EMI Specialist	30	Detailed	13	0	1	0	0	0	0
19	Engineer	30	Detailed	1530	0	0	1	2	2	8
20	Engineer/Mgr	20	Detailed	2.5	0	2	0	1	1	0
21	Pilot/Manager	20	Detailed	5	0	0	1	1	1	0
22	EMI Specialist	30	Detailed	3	0	4	0	2	2	0
23	Pilot/Engineer	30	Detailed	100	0	5	1	1	1	0
24	Pilot/Engineer	10	Detailed	3	0	2	0	0	0	0
25	Pilot	10	Some	0	0	0	0	0	0	0
26	Pilot/Engineer	20	Some	0	0	0	0	0	0	0
27	Pilot/Engineer	10	Some	24	0	3	0	0	0	1

28	EMI Specialist	20	Some	0	0	0	0	0	0	0
29	Manger	30	Medium	2	0	0	0	0	0	0
30	EMI Specialist	20	Detailed	30	0	0	0	1	1	0

Expansion of the column of Table 1:
C1=Response number, C2=Work, C3=Experience > years, C4=Degree of completion, C5=Number of Incidents, C6=Pass, C7=Onboard, C8=External, C9=Lighting, C10=Equipment failure, C11=Unknown

CONCLUSION

Electromagnetic interference is a disturbance generated by an external source that affects an electrical circuit by electromagnetic induction, electrostatic coupling, or conduction. The disturbance may degrade the performance of the circuit or even stop it from functioning. In the case of a data path, these effects can range from an increase in error rate to a total loss of the data. Both man-made and natural sources generate changing electrical currents and voltages that can cause EMI: automobile ignition systems, cell phones, thunderstorms, the Sun, and the Northern Lights. EMI frequently affects AM radios. It can also affect cell phones, FM radios, and televisions.

REFERENCE:

1. S. K. Das and S. Tripathi (2016). Intelligent energy-aware efficient routing for MANET. *Wireless Networks, pp. 1-21.*
2. S. K. Das, A. K. Yadav and S. Tripathi (2016). IE2M: Design of intellectual energy efficient multicast routing protocol for ad-hoc network. Peer-to-Peer *Networking and Applications, vol. 10, no. 3, pp. 670-687.* https://doi.org/10.1007/s12083-016-0532-6
3. K. Yadav, S. K. Das and S. Tripathi (2017). EFMMRP: Design of efficient fuzzy based multi-constraint multicast routing protocol for wireless ad-hoc network. *Computer Networks, vol. 118, pp. 15-23.* https://doi.org/10.1016/j.comnet.2017.03.001
4. S. K. Das and S. Tripathi, "Energy efficient routing formation technique for hybrid ad hoc network using fusion of artificial intelligence techniques," International Journal of Communication Systems, 2017, pp. 1-16, https://doi.org/10.1002/dac.3340
5. S. K. Das and S. Tripathi, "Adaptive and intelligent energy efficient routing for transparent heterogeneous ad-hoc network by fusion of game theory and linear programming," Applied Intelligence, 2017, pp. 1-21, https://doi.org/10.1007/s10489-017-1061-6
6. S. K. Das, A. Kumar, B. Das, and A. Burnwal, "Ethics of reducing power consumption in wireless sensor networks using soft computing techniques," International Journal of Advanced Computer Research, 2013, vol. 3, no. 1, pp. 301–304.
7. S. K. Das, B. Das, and A. Burnwal, "Intelligent energy competency routing scheme for wireless sensor networks", International Journal of Research in Computer Applications and Robotics, 2014, vol. 2, no. 3, pp. 79-84.
8. S. K. Das, S. Tripathi, and A. Burnwal, "Intelligent energy competency multipath routing in wanet," in Information Systems Design and Intelligent Applications, Springer, 2015, pp. 535-543, https://doi.org/10.1007/978-81-322-2250-7_53
9. S. K. Das, S. Tripathi, and A. Burnwal, "Fuzzy based energy efficient multicast routing for ad-hoc network," in Computer, Communication, Control and Information Technology (C3IT), 2015 Third International Conference on, IEEE, 2015, pp. 1-5, https://doi.org/10.1109/C3IT.2015.7060126
10. S. K. Das, S. Tripathi, and A. Burnwal, "Design of fuzzy based intelligent energy efficient routing protocol for WANET," in Computer, Communication, Control and Information Technology (C3IT), 2015 Third International Conference on, IEEE, 2015, pp. 1-4, https://doi.org/10.1109/C3IT.2015.7060201
11. S. K. Das and S. Tripathi, "Energy efficient routing protocol for manet based on vague set measurement technique," Procedia Computer Science, 2015, vol. 58, pp. 348-355, https://doi.org/10.1016/j.procs.2015.08.030
12. S. K. Das and S. Tripathi, "Energy Efficient Routing Protocol for MANET Using Vague Set," in Proceedings of Fifth International Conference on Soft Computing for Problem Solving, Springer, 2016, pp. 235-245, https://doi.org/10.1007/978-981-10-0448-3_19
13. "Radio Frequency Interference - And What to Do About It". Radio-Sky Journal (4). Radio-Sky Publishing. March 2001. Retrieved 21 January 2014.
14. "Radio frequency interference" / editors, Charles L. Hutchinson, Michael B. Kaczynski ; contributors, Doug DeMaw . [et al.]. 4th ed. Newington, CT American Radio Relay League c1987.
15. "Radio frequency interference handbook". Compiled and edited by Ralph E. Taylor. Washington Scientific and Technical Information Office, National Aeronautics and Space Administration; [was for sale by the National Technical Information Service, Springfield, Va.] 1971.
16. S. K. Das, A. Kumar, B. Das, and A. Burnwal, "On soft computing techniques in various areas," Computer Science & Information Technology (CS & IT), 2013, vol. 3, pp. 59-68, DOI : 10.5121/csit.2013.3206.

17. S. K. Das, S. Tripathi, and A. Burnwal, "Some relevance fields of soft computing methodology," International Journal of Research in Computer Applications and Robotics, 2014, vol. 2, pp. 1–6.
18. Burnwal, A. Kumar, and S. K. Das, "Assessment of fuzzy set theory in different paradigm," International Journal of Advanced Technology & Engineering Research, 2013, vol. 3, no. 3, pp. 16–22.
19. Burnwal, A. Kumar, and S. K. Das, "Assessment of Mathematical Modeling In Different Areas," International Journal of Advanced Technology & Engineering Research, 2013, vol. 3, no. 3, pp. 23-26.
20. Burnwal, A. Kumar, and S. K. Das, "Survey on application of artificial intelligence techniques," International Journal of Engineering Research & Management, 2014, vol. 1, no. 5, pp. 215–219.
21. Comlekci, S., U. Ozen, and E. Koklukaya. "Analysis of soft computing EMI sensor." Electromagnetic Compatibility, 2003. EMC'03. 2003 IEEE International Symposium on. Vol. 1. IEEE, 2003. https://doi.org/10.1109/ICSMC2.2003.1428286
22. Micu, Dan D., Georgios C. Christoforidis, and Levente Czumbil. "Artificial Intelligence Techniques Applied to Electromagnetic Interference Problems Between Power Lines and Metal Pipelines." Recurrent Neural Networks and Soft Computing. InTech, 2012.
23. Jay J. Ely. "Electromagnetic interference to flight navigation and communication systems: new strategies in the age of wireless." AIAA Atmospheric Flight Mechanics Conference and Exhibit. 2005.
24. Shooman, Martin, "A Study of Occurrence Rates of EM1 with a Focus on HIRF, Final Report, NASA Langley, Grant No. NAG-I -1272.
25. Martin L. Shooman. "A study of occurrence rates of EMI to aircraft with a focus on HIRF." Digital Avionics Systems Conference, 1993. 12th DASC, AIAA/IEEE. IEEE, 1993.
26. Gautam U, Singh, G, A Comparison of TCP Performance over Routing Protocols for Mobile Ad Hoc Networks, International Journal of Advanced Research in Computer Science & Technology, Vol2 Issue 2, Ver 2, pg-436-442.
27. Singh, G., Dubey, D. O. P., & Dey, M. (2017). USING NS-2 COMPARISON OF GEOGRAPHICAL AND TOPOLOGICAL MULTICAST ROUTING PROTOCOLS ON WIRELESS AD HOC NETWORKS. *International Journal of Students' Research in Technology & Management*, *5*(4), 01-07. https://doi.org/10.18510/ijsrtm.2017.541
28. Singh G(2014), STUDY OF PERFORMANCE OF ROUTING PROTOCOLS FOR MOBILE AD-HOC NETWORKING IN NS-2, IJAICT, Vol 1, Issue 3, pg 299-306.

