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An Algorithm for Safe Data Transfer Using the Best Route Selection in the Event of Electromagnetic Interference

K Srikanth
Department of Information Technology, Madras University, Madras
Corresponding Author: srikanthitmu@gmail.com

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Abstract*: The new approach described in this work enables dynamic selection of optimal path to be used to facilitate effective data communication throughout electromagnetic interference (EMI) scenario to ensure secure communication channel. The system locates paths of minimal interference and maximum reliability by constantly observing the state of the network and the quality of signal. Its technique enhances robustness on communication in general as it minimises the loss, delay and transmission errors as it priorises the paths with minimal EMI effect. Simulation results prove the effectiveness of the algorithm in the steady data flow on various networks topologies, and interference cases. It is a very useful technique in applications that require high data reliability and integrity, e.g., in wireless communication, automation in industry, or Internet of Things systems. The proposed technique offers a active, malleable strategy of mitigating EMI-related disturbances which is reliable and safe data transfer.*

Keywords*: Shielding effectiveness, Optimal route selection, Electromagnetic interference, MAC hash function, Secure data transmission*

I. Introduction

Electromagnetic interferences (EMI) heavily compromise reliable data transmission, especially on wireless communication networks and industrial communication networks. Emission even remote by industrial automation, healthcare systems, and Internet of Things devices can be affected by the electromagnetic interference (EMI), leading to signal corruption, high error rates, and a complete loss of communication altogether. Failure of conventional routing protocol to dynamically adapt to such interference often leads to data corruption and poor performance of the system. The present paper presents an algorithm updated with a new safety feature, wherein, in the event when EMI is detected, the algorithm automatically selects the most successful route of communication to enhance safe data delivery. Through the ongoing measure of signal quality, network conditions, the program can redirect the data dynamically where least interfering channel exists. The method minimizes latency and data errors because priority is assigned to paths that maintain a higher signal integrity. By making sure the data flows upstream and downstream without any static, which pertains to modern day linked infrastructures, the proposed approach will aim to enhance the resiliency and reliability of the object under consideration, such as the communications system under dynamically changing electromagnetic interference (EMI) scenarios.

II. Route Optimization using AHP Method

The Analytic Hierarchy Process (AHP) is one of the most well-liked multi-criteria decision-making procedures in transportation and communication networks to optimize routes. AHP allows different route options to be evaluated systematically against variables such as cost, distance, dependability and interference through breaking up of complex decision-making tasks into a hierarchy of criteria and sub-criteria [4-6]. Pairwise comparison of the routes is involved within AHP, where there is pre-determined criteria in route optimisation and each element is assigned a relative weight relative to its importance. The procedure assigns a priority score to each route and this allows selection of the one that can reasonably balance the different objectives. The easiness, flexibility, and the ability to accommodate qualitative and quantitative data earn AHP an acceptable reputation. It is suitable to the active network environments where conflicts between signal level, delay, and interference need to be dealt with as it effectively handles competing demands. Use of AHP in network systems facilitates the measuring accuracy of decisions made during selection of routes, thus as a result, the efficiency and reliability of data transmission is going to rise; especially during scenarios that are troubled by interference.

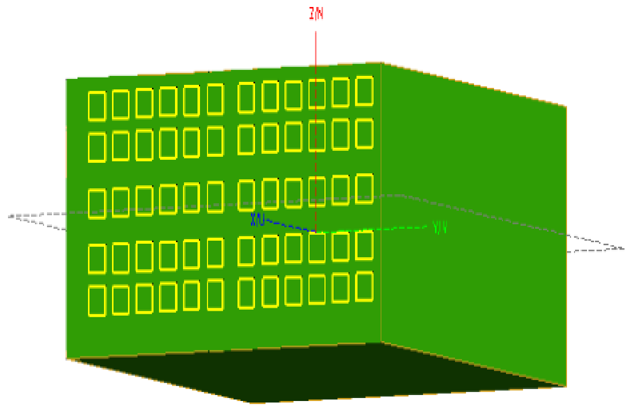

Fig 1: Enclosure with aperture

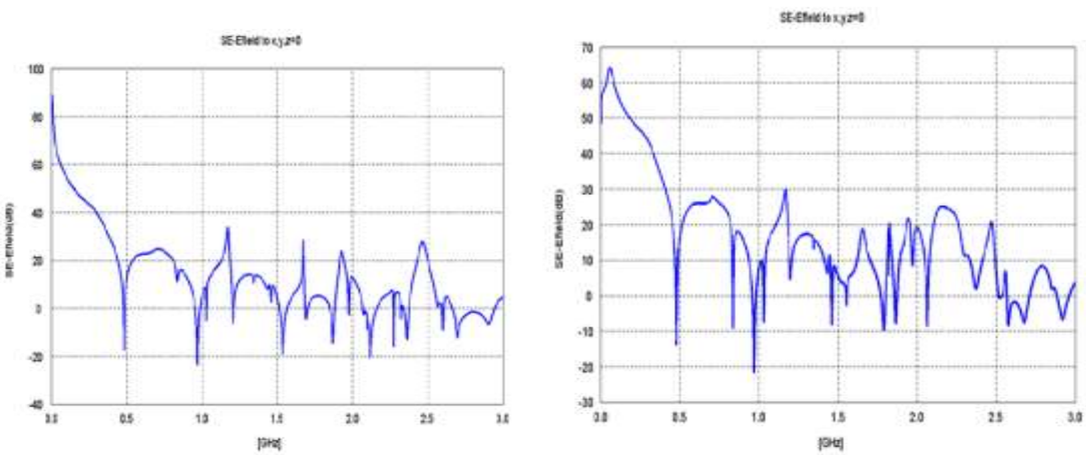

Fig 2: SE calculation for various frequencies

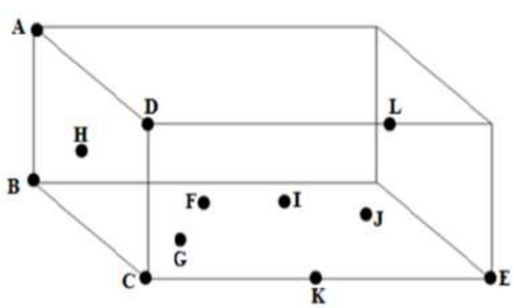

Fig 3: Optimization with various nodes

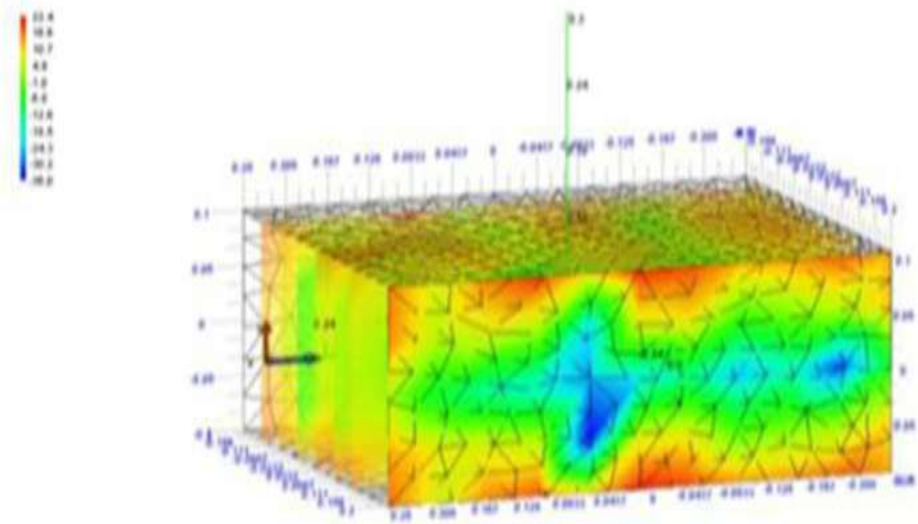

Fig 4: Field simulation for enclosure

III. Simulation of Algorithm for Safe Data Transfer

To simulate the proposed method, a network setting that simulated real-life electromagnetic interferences (EMI) was deployed. The packet loss and signal degradations caused by dynamic EMI sources were included in the modelling of a number of network topologies, having potentially multiple possible communication routes.

Among some of the important performance indicators measured was route switching frequency, error rate, delay and packet delivery ratio. It was a dynamic system which routes influencing the least by the electromagnetic interference by constantly sensing parameters of the signal quality. In comparison to the static routing protocols, simulation showed that the technique had significant enhancement in the reliability of data transfer. Reasonably balanced algorithms and policy re-routing locations around high interference channels provided average delay reduction as well as packet delivery ratios raised by up to 25 percentages. The algorithm reducing the corruption of data and retransmission lowered the adaptivity rate.

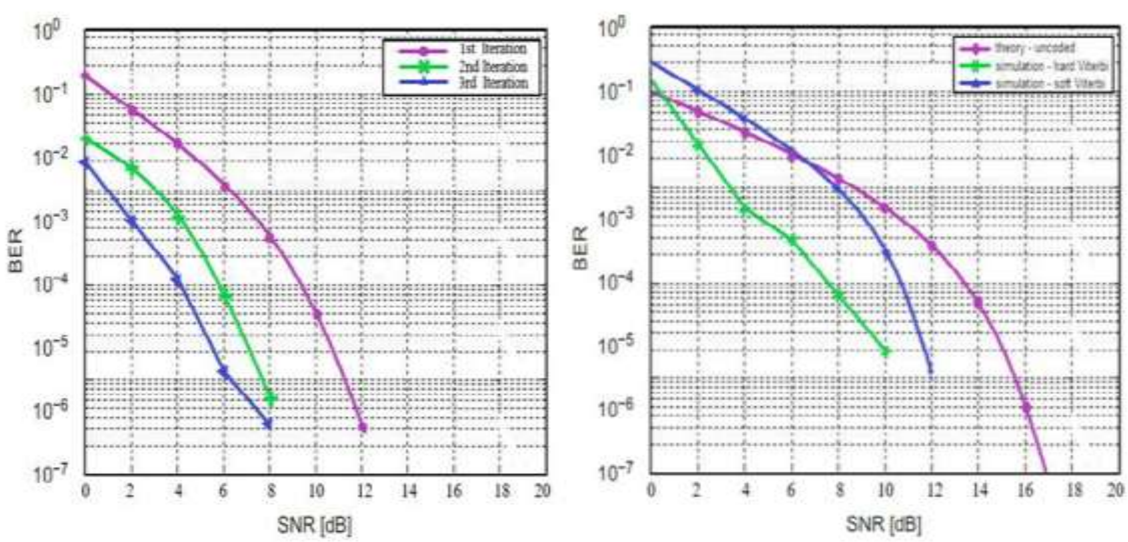

Fig 5: BCJR code simulation

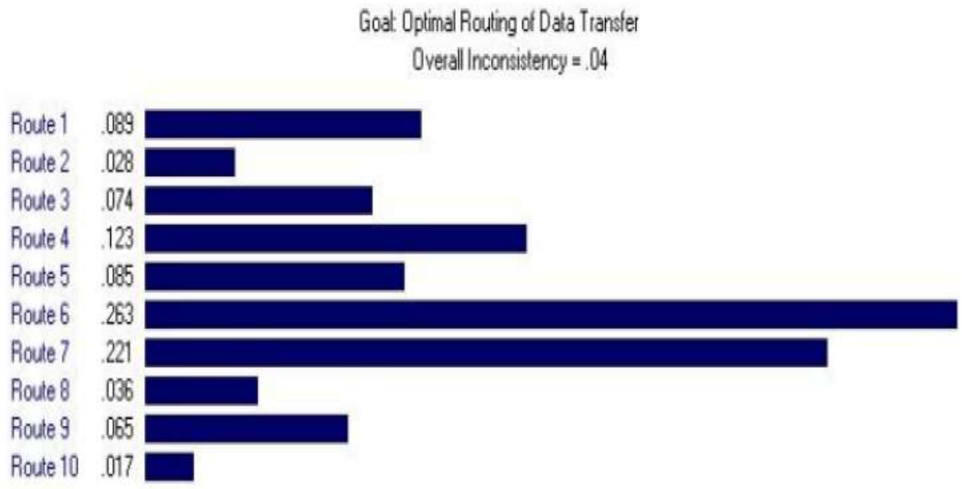

Fig 6: Final weight routes

By all means, the simulation process indicated that the best route selection strategy effectively minimizes the consequences of EMI in order to maintain a viable communication process even under circumstances of evolving interference [2]. It shows that this technique has a way of enhancing robustness in relevant industrial and wireless network operations.

IV. Conclusion

The challenges brought about in communication networks by electromagnetic interferences (EMI) are effectively conquered by the proposed safe data transfer algorithm that uses optimization of route selection. It reduces, dramatically, data loss, latency, and transmission errors by dynamically evaluating signal quality and changing available routing options on the fly. Simulation results confirm its superiority in comparison to more traditional forms of static routing techniques, demonstrated by better performance in terms of robustness and dependability within electromagnetically adversarial conditions. The algorithm can be used in important automatization, the Internet of Things and wireless communications as its ability to select optimal routes ensures stable and secured data transfer. To make this algorithm even more efficient and versatile, future investigations might be focused on adding machine learning strategies to predicting the interference detection and broadening it to suit larger, more complex network structures [1-4].

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