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Method & Implementation of Efficient Approach to Provide Max Flow in WSN

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Abstract: ***The WSN network fails due to the depletion of energy in the central ring of nodes around the sink node, leaving the sink node segmented from the remaining viable network nodes. With the existing protocol, at the extinction of the network (when the sink is isolated from the remaining live network nodes), the remaining energy is effectively consumed with zero efficiency because it is no longer available for useful work which negates the premise that their approach minimizes energy consumption within the network. In this work, the main goal is to construct a fast tabu search algorithm for computing solutions so that max flow rate may achieve. In this work, it helps to provide optimal cost in network using tabu algorithm. The results of max flow vs degree of nodes and max flow vs no. of nodes are presented.***

Keywords: WSN System, Routings in WSN, Tabu Search, QoS in WSN etc.

I. INTRODUCTION

In recent years wireless communication networks have become increasingly popular. Many types of wireless services have become available, including cellular systems, satellite communication networks, and wireless local area networks (WLANs) [1, 2]. The increasing popularity of WLANs and wireless devices has led to greater interest in wireless ad hoc networks. An ad hoc network [3]is formed by wireless, potentially mobile hosts, without requiring the use of any fixed infrastructure, and can be set up in the environment where the wiring of a conventional network is difficult or not economically feasible.

The wireless sensor network (WSN) has become the talk of the day in the Distributed Systems Group (DSG) community and in the industry as well. In September 1999 [25], Business Week heralded it as one of the 21 most important technologies for the 21st century. As the sensors become highly available, widely spread, cheap and easy to use and deploy, the day when each of us will encounter sensor networks on daily basis is just a matter of time. The wireless sensor networks today are used for sensing a variety of environment conditions such as temperature, humidity, light and density of air pollutant, for early fire detection, smart homes, military needs and for other varied purposes. The main reasons for its popularity are the low price and the ease to form the network, where in most places it is just plug_and_play in WSN it is scatter and play.

The main drawbacks from the WSNs are the resource constraints they impose on us. Unlike the traditional WSN, in most applications of wireless sensor networks, WSNs have limited energy, low storage capacity, and weak computing capability. Many times, due to the sensors accessibility difficulties, the resources, especially the energy of sensors, may not be replaced or recharged. Hence, the lifetime of the WSN highly depends on the energy consumption of sensors. Like the other wireless networks, the position of sensor nodes has great impact on the performance of WSNs in terms of coverage, communication cost, network‘s lifetime and resource management. Due to the randomness of sensors deployment, there might exist some nodes connecting two or more partitions without any backup nodes. This causes a delay of message propagation between the partitions. It might also cause a message loss and in the case when one of the nodes dies out, the whole network will be partitioned. These nodes are called bottleneck nodes, and it is important to locate the bottleneck nodes in order to prevent network partitioning or message transmission delay, that will lead to retransmission of messages in the future.

The topology of the WSNs can vary from a simple star network to an advanced wireless mesh network. The propagation technique among the nodes of the network could be routing or flooding. The power of the wireless sensor networks lies in the capability to deploy large numbers of small nodes that assemble and configure themselves. In addition to drastically decreasing the installation costs, wireless sensor networks have the capability to dynamically adapt to changing environments. Adaptation mechanisms can lead to changes in network topologies or can cause the network to shift between different modes of operation.

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Figure 1.1: Wireless Sensor Network [1]

The paper is ordered as follows. In section II, it represents major challenges in WSN network. In Section III, It defines the various routing protocols. Section IV defines the proposed system. The results of proposed system is defined in section V. Finally, conclusion is explained in Section VI.

II. CHALLENGES IN WSN

A. Hardware Constraints

Sensor node consists of 4 basic components: sensing unit, processing unit, communication unit and power unit. Sensing unit consists of sensors which observe the physical phenomena and converts that information into an analog signal. This analog signal is converted into digital signal using ADC which is then passed to the processing unit. The processing unit consists of microcontroller or microprocessor with memory which provides intelligent control to the node. Communication unit performs data transmission and reception over radio channel. The power unit consists of battery to drive all other components of the network [3].

All these components should fit in small-sized embedded system. In addition to small size, these nodes should consume low energy, have low production cost, operate in high density, be autonomous and should be adaptive to the environment. The major concern of wireless sensor nodes is to reduce energy consumption. With limited battery power, the network lifetime is also limited.

B. Fault Tolerance

Fault tolerance is the ability to sustain the functionalities of the sensor network without any interruption due to failure of sensor nodes. The hardware and the software constraints greatly affect the failure rate of a sensor node. Since sensor nodes are embedded with the low cost devices, so majority of the node failures are caused by hardware problems. The fault tolerance of a sensor network is also application dependent, for example, if sensor nodes are deployed in home applications, the fault tolerance requirement may be low because here sensor network is not easily damaged. But if sensor nodes are deployed in military applications, then the fault tolerance requirement will be high because sensor nodes can be destroyed by hostile action.

C. Scalability

Although high density deployment of sensor nodes improves the fault tolerance of the network, this also creates scalability challenges. The number of sensor nodes deployed in target area may be on the order of hundreds or thousands. So networking protocols developed should be able to handle such a large number of nodes efficiently. The node density depends on the applications for which sensor network is used [3].

D. Production Costs

Sensor network consists of a large number of sensor nodes. More the number of sensor nodes used, more will be the overall cost of the network. The overall cost of the sensor networks must be justifiable in comparison with traditional networks. Also, a sensor node may have additional units like mobilize or location finding system depending on the application which adds cost to the sensor

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devices. As a result cost of the sensor network is a very challenging issue with respect to the number of functionalities [3].

E. WSN Topology

The major challenge of the sensor network is the deployment of these sensor nodes in the field so that target region can be monitored efficiently. This comprises of pre-deployment and deployment phase in which sensor nodes can be thrown in mass or one by one placed in the sensor field. After initial deployment, topology maintenance is carried out in post-deployment phase. Then re-deployment phase may also be necessary when node failure occur, in order to prolong network lifetime. So deploying a high number of nodes requires a lot of topology maintenance [3].

F. Transmission Media

A successful communication between nodes relies on the transmission medium used. Since nodes communicate in a wireless medium, so links can be formed between them by optical, infrared, radio and magneto-inductive links. The transmission medium must be available worldwide for the global operation of these networks. For communication through radio links, Industrial, Scientific and Medical (ISM) radio band can be used. The advantages of using this band are global availability, huge spectrum allocation and free radio.

III. OPERATION BASED ROUTING PROTOCOLS

A. Multipath Based Routing

These protocols offer fault tolerance by having at least one alternate path (from source to sink) and thus, increasing energy consumption and traffic generation. These paths are kept alive by sending periodic messages. The path is switched whenever a better path is discovered. The primary path will be used until its energy is below the energy of the backup path. By means of this approach, the nodes in the primary path will not deplete their energy resources through continual use of the same route, thus achieving longer lifetime.

B. Location Based Routing

In the protocols, the nodes are addressed by their location. Distances to next neighboring nodes can be estimated by signal strengths or by GPS receivers. Minimum Energy Communication Network protocol sets up and maintains a minimum energy network for wireless networks by utilizing low power GPS. Although, the protocol assumes a mobile network, it is best applicable to sensor networks, which are not mobile. Geographic Adaptive Fidelity (GAF) protocol is energy-aware location-based routing designed primarily for mobile ad hoc networks and can be applicable to sensor networks as well.

C. Energy-Aware WSN Routing Protocol

Energy Aware Routing is a reactive protocol to increase the lifetime of the network. This protocol maintains a set of paths instead of maintaining or reinforcing one optimal path. The maintenance and selection depends on a certain probability, which relays on how low the energy consumption of each path can be achieved. The protocol creates routing tables about the paths according to the costs. Localized flooding is performed by the destination node to maintain the paths alive.

IV. DESCCRIPTION OF PROPOSED SYSTEM

As presented by literature, the network fails due to the depletion of energy in the central ring of nodes around the sink node, leaving the sink node segmented from the remaining viable network nodes. With the existing protocol, at the extinction of the network (when the sink is isolated from the remaining live network nodes), the remaining energy is effectively consumed with zero efficiency because it is no longer available for useful work which negates the premise that their approach minimizes energy consumption within the network.

Tabu search is an adaptive search technique, using the best improvement local search as the basic ingredient. By allowing temporary solution degradation, tabu search avoids the search process being trapped into the local optimum. Two mechanisms, the short term memory and long term memory, can be applied to keep track of attributes of previously visited solutions and guide the tabu search process.

Tabu Search is a meta-heuristic that guides a local heuristic search procedure to explore the solution space beyond local optimality. One of the main components of Tabu Search is its use of adaptive memory, which creates a more flexible search behavior. Memory-based strategies are therefore the hallmark of tabu search approaches, founded on a quest for "integrating principles," by which alternative forms of memory are appropriately combined with effective strategies for exploiting them. A novel finding is that such principles are sometimes sufficiently potent to yield effective problem solving behavior in their own right, with negligible reliance on memory. Over a wide range of problem settings, however, strategic use of memory can make dramatic differences in the ability to solve problems. Pure and hybrid Tabu Search approaches have set new records in finding better solutions to problems in production planning and scheduling, resource allocation, network design, routing, financial analysis, telecommunications, portfolio planning, supply chain management, agent-based modelling, business process design, forecasting, machine learning, data mining, bio-computation, molecular design, forest management and resource planning, among many other areas.

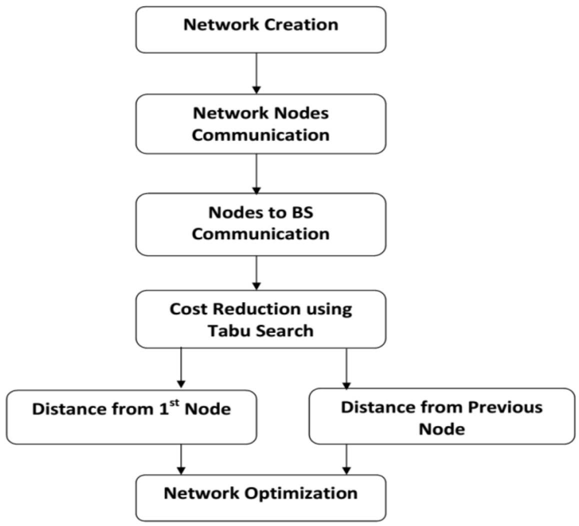

Figure 2: Proposed Flow Chart of System

The TS technique is rapidly becoming the method of choice for designing solution procedures for hard combinatorial optimization problems. A comprehensive examination of this methodology can be found in the book by Glover and Laguna (1997). Widespread successes in practical applications of optimization have spurred a rapid growth of the method as a means of identifying extremely high quality solutions efficiently. TS methods have also been used to create hybrid procedures with other heuristic and algorithmic methods, to provide improved solutions to problems.

The localization steps followed by using Tabu Search Algorithm are that it takes the results of Mobile Anchor Positioning as its input. The results of MAP, giving the approximate solution of the location of each sensor at each specified time instance is given as the input to the post optimization method. At any iteration it has to find a new solution by making local movements over the current solution. The possible solution of a node which was predicted by MAP algorithm is maintained in a tabu list. The average distance of neighbour nodes of the corresponding nodes are calculated. The difference between the location and the average distance of the node are calculated. If the solution is less than the average value then that value is considered as a best solution. The "next solution" is the best among all (or a subset of) possible solutions in the neighborhood in order to carry out the exploration process, the recently visited solutions are avoided. Tabu list is maintained. Therefore once a solution is visited, the movement from which it was obtained is considered as tabu. N(Ω) will be changing along the exploration, so in a certain sense dynamic neighbourhood is compared to the previous local search algorithms where remains static. Typically there are two kinds of tabu lists, a long term memory and short term memory. Long term memory maintains the history through all the exploration process as a whole and a short term memory is to keep the most recently visited tabu movements. A movement with a tabu status (tabu movement) is avoided to be applied, unless it satisfies certain aspiration criteria. This aims to avoid falling into local optima. Tabu list size is fixed before the hand each element of the list belongs to it for a number of iterations bounded by given maximum and minimum values. Repeat the iterations until the stopping criteria are met.

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A. Tabu Search Algorithm

ENSURE: THE NEIGHBORHOOD N(T).

1) *: n(t)←*
2) *For all {i, j} do*
3) *Determine the set of edges {f1, . . . Fk} that are on the path from i to j in t*
4) *For all f ∈{f1, . . . , fk} doadd t ∪{i, j} \ f to n(t)*
5) *End for*
6) *End for*
7) *Return n(t)*

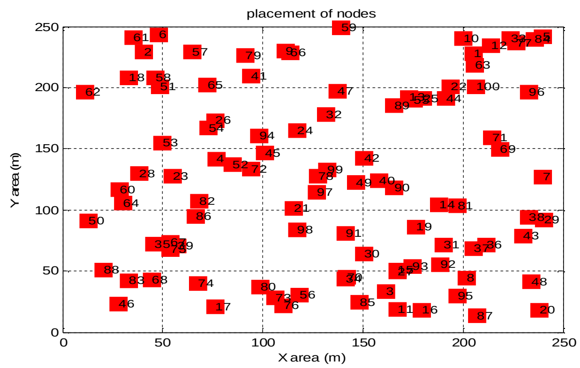

Figure 3: Network Creation

V. RESULTS & DISCUSSION

The dissipation energy in communication process is the main factors we need to minimize. In addition, the number of CHs can factor into the objective function. Fewer CHs result in greater energy efficiency and higher CHs consume more energy as CHs drain more power than non-cluster heads. Following are the implementation results for the scenario. In this work, take the scenario for 100 nodes as shown in fig 3 and following result will show the information about the placement of sensor nodes in an area.

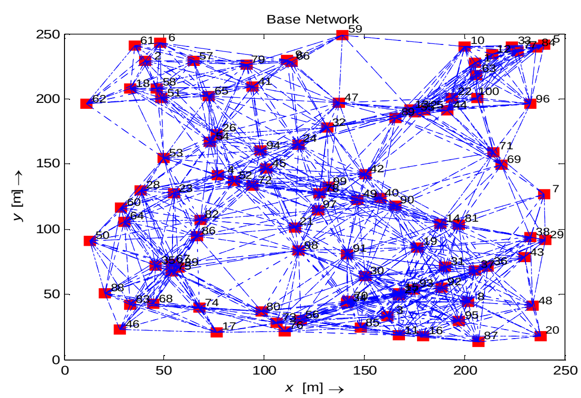

Figure 4: Network Communication

Each sensor has a sensor ID shown along with it. It will be used to address any sensor throughout the process. Here we take large number of sensors so that proposed scheme will evaluate easily. The information of all the nodes will be update to single nodes to which we assume as a cell manager. This placement is an average function of coordinate variables defined in the vectors. They are random in nature. No two nodes overlap each other. Here we take the 250*250 m^2 area for deployment of sensor nodes. But we can change it easily for large number of nodes (shown in fig 4).

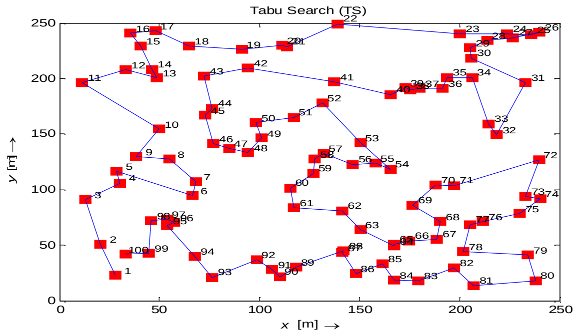

Figure 5: Network Optimization using Tabu Search

Network cost is defined in terms of load value. Lower the cost means network is optimized and performance is better. So, Tabu search optimize the network by updating the locations of nodes and also with the help of distance from previous nodes as shown in fig 6.

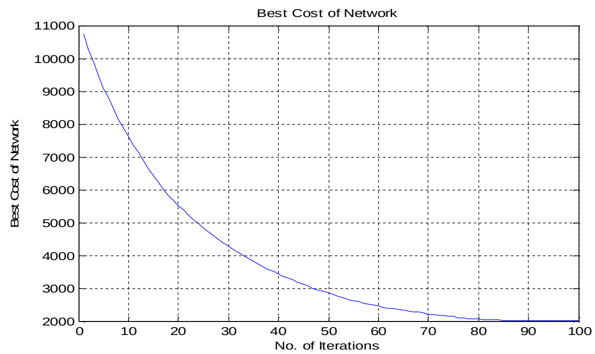

Figure 6: Network Cost Performance

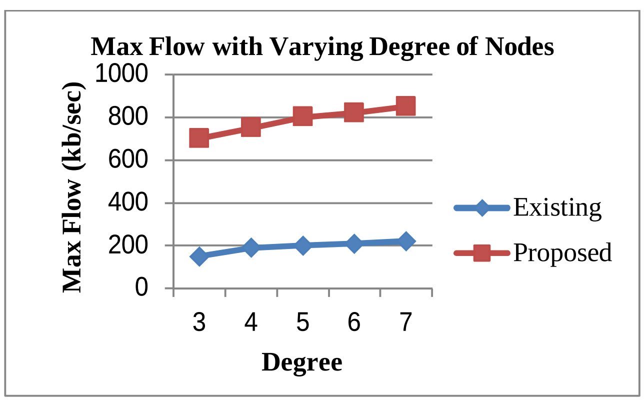

Figure 7: Performance Comparison of System

In this paper, the main goal is to construct a fast tabu search algorithm for computing solutions of good quality for large instances of the minmax problem in WSN (shown in fig 5). The maximum flow problem is intimately related to the minimum cut problem. A cut is ant set of directed arcs containing at least one arc in every path from the origin node to the destination node. First, if there is only one route from a source to the sink, the flow is limited by the node with the minimum energy. In contrast, as we increase δ, a source has more neighbors such that the number of routes from sources to the sink increases and thus more data can be forwarded. Moreover, as per constraint, the available energy of a node determines the amount of data it can forward. An intermediate node may not exhaust its energy when δ is low. If this intermediate node has a higher node degree, it uses any remaining energy to forward data via other routes as shown in fig 7.

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VI. CONCLUSION

In rechargeable Wireless Sensor Networks (WSNs), a key concern is the max flow or data rate at one or more sinks. However, this data rate is constrained by the available energy at each node as well as link capacity. After deployment, some sensor nodes may impede the amount of data that arrive at a sink because of their low energy harvesting rate. In this work, the main goal is to construct a fast tabu search algorithm for computing solutions so that max flow rate may achieve. In this work, it helps to provide optimal cost in network using tabu algorithm. The results of max flow vs degree of nodes and max flow vs no. of nodes are presented and prove better as compared to existing one. It will investigate the problem of upgrading sensor nodes to maximize the flow rate. It will use the concept of path and Tabu to analyse the performance of system.

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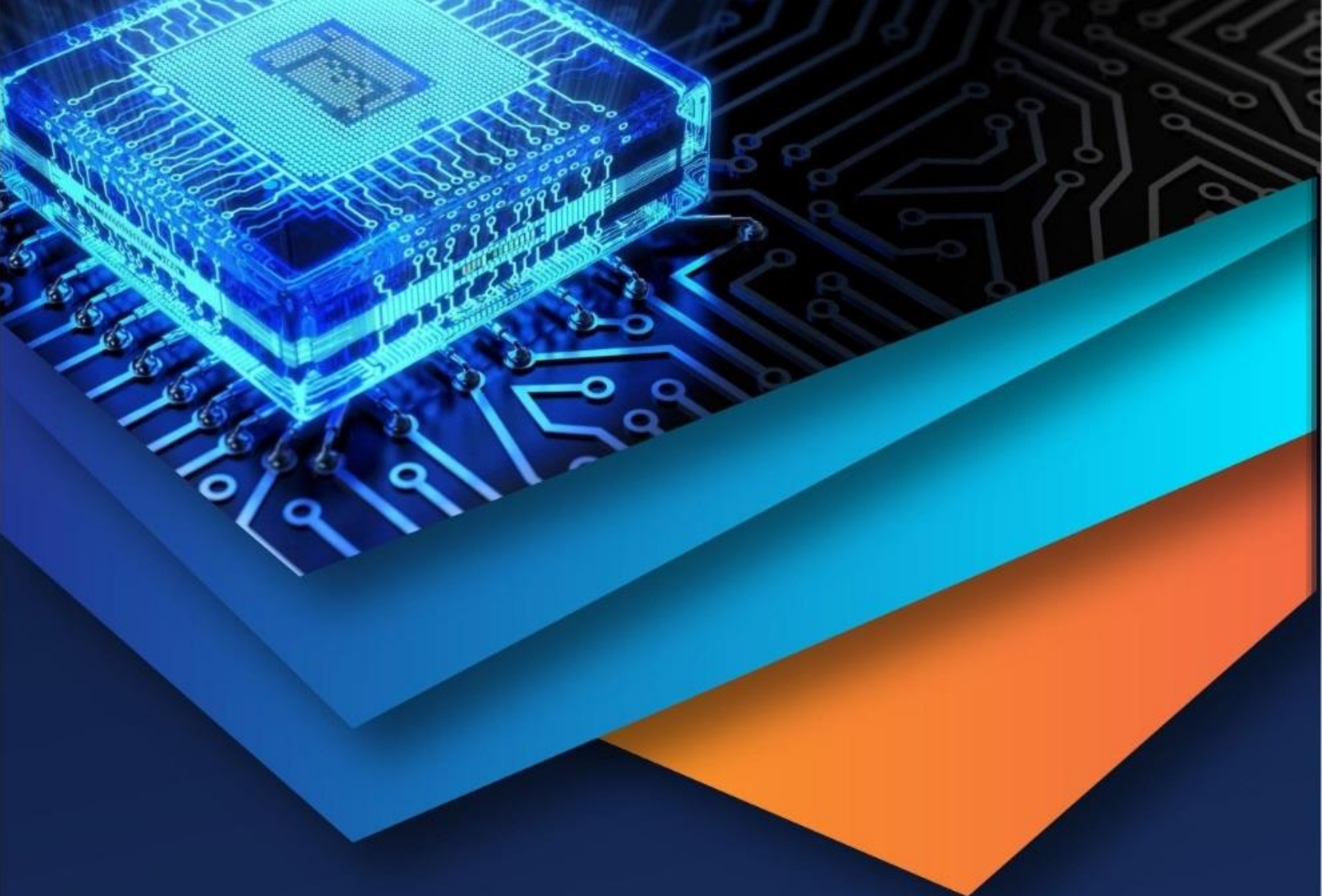

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