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A Systematic Review on Blood Bank Information Systems

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Abstract: ***Blood is a vital fluid. It transports oxygen and nutrients to cells. Human beings cannot live without blood. However, people may lose this valuable fluid at the time of accidents, pregnancies, or surgeries. So, blood is needed to transfuse to those people safely and quickly as latency in blood transfusion may lead to the death of that individual. Based on this, many systems were developed by different authors to help people in obtaining the required blood promptly. But all these developed systems solved this problem to some extent but they have their own merits and demerits. This paper is a review of those systems where different techniques and algorithms used by different authors in their proposed systems are discussed and compared. These systems uses either android application or GPS to track the donor's location. Blood donations and transfusions have become an increasingly serious problem, leading to blood shortages worldwide many people lose their lives. A major cause of these losses is the lack of a centralized blood donation system.***

Keywords: Blood Banks, Android smartphone, Donor, GPS.

I. INTRODUCTION

Blood is vital for our body to survive. It passes oxygen and nutrients between cells. Humans can't live without blood. Sometimes people will lose this valuable fluid due to accidents, pregnancies or other reasons [1]. During these times it is much needed to transfuse the required amount of blood from a suitable blood group. This process should be so secure and quick as the transfusion of blood from wrong blood group or delay of transfusion will lead to serious situations and may lead to death of the individual [2]. But in India there is no proper system to maintain and manage blood donations. The typical blood bank system is like as shown in the figure 1. This system is not efficient and cannot provide faster access to blood resources to the needed person [3]. So, there is a need for a blood bank system for countries like India which can enable faster and efficient way of blood resource transportation for the people who need blood [4]. This paper will study such systems which were proposed by different authors for faster and safer blood transportation. All these methods are almost alike to each other but differ in few areas.

There are many applications developed based on this idea but they locate the nearest blood banks or hospitals based on the GPS (*Global Positioning System*) [5]. In this system the shortest distance between two places on the globe is calculated based on their longitudes and latitudes using the Haversine algorithm [6]. This system treats the path between two points as a straight line which is not always possible in the real world. In the real world, two places can be nearer to each other but the path to reach one place from another can be longer [7]. So, we should consider the distance that we need to travel to reach the position instead. Also, the current system does not consider the partial availability of blood at the blood banks, what if the blood banks didn't have adequate amount of blood that the person needs. In this case one should reach more than one blood bank to fulfil the necessities. This situation may occur at the time of accidents where there will be a need for large amounts of blood of different blood groups and a single blood bank does not often have all the requirements [8]. So, there will be a need for a system that tracks the blood availability at the blood banks and shows the nearest blood bank that has the sufficient blood to the people in need through a Mobile Application [9]. Most of the methods proposed will locate the registered donors based on their GPS locations [10]. First, they find the locations of the donors and users by using technology called GPS which is available in almost every smart phone then from the available donors the donor's information who is nearest to the user is shown to the user. Then the user will collect the blood from that donor.

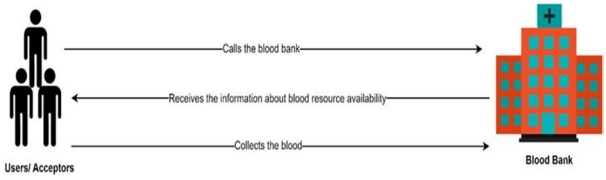

Fig. 1. Existing Blood Bank System

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II. ARCHITECTURE DIAGRAM

In the real world, the hospitals and the blood banks will store the details of availability of blood in a database. And the database should be updated regularly by checking the blood availability in the blood banks. This data will be accessed by the user through a web application or a mobile application and the user is provided with a user interface through which the user can query for the required amount of blood. The system will collect the user requirements such as blood type, quantity of blood from the user. Then the user will receive an information about the availability of blood from the nearby blood bank. All the information regarding the availability of blood will be stored in a database. Based on the GPS location of the user the system will suggest the nearest blood bank to the user. The user can collect the requisite amount of blood from the blood bank.

There are some systems which will trace the location of the donors who were available in the nearby areas. The user can contact the donors for immediate blood donation in the emergency situations like accidents, surgeries etc. The donor will be notified with an SMS for an immediate blood donation and the donor can donate the blood to the patient. The user can send an SMS in the format such as blood type, location, quantity of blood then the system will process the request from the user and it will provide the contact info of the registered donors. The user can make a call to the donors for blood in the medical emergencies. The gathered information regarding the availability of blood will be stored in a centralized database and user will not have any direct access to the database and the database administrator will regularly update the database. The user can access the application through user interface and search for the required amount of blood in various blood banks. All the records regarding the blood donation and blood transfusion processes will be stored in a database.

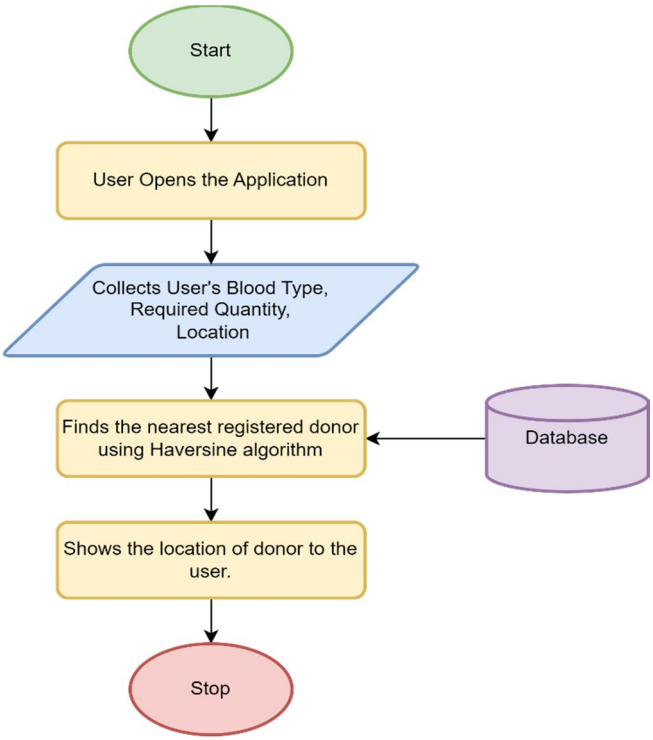

Fig. 2. Flow chart for many existing systems

However, blood bank staff will also get an alert whenever the blood stock is low and the blood group which was specified by the user was not available. The blood bank will also get a notification whenever the blood is about to expire. Multiple users cannot access the application at a time as there will be any chance of delay in response from the server. After considering the required blood group as an input from the user the system will query the list of blood bags in a centralized database.

The system receives a detailed list of nearby blood donors based on the user's location. The system then uses Haversine formula to calculate the distance between the user's location and the donor's location. The Distance is calculated by using the Google Maps API, by considering the user's location and the locations of various donors or blood banks. The system immediately processes this information and presents the user with donor or blood bank locations that satisfies the user's requirements.

The system takes the user's GPS location as input to provide the location details of the nearest blood donor or blood bank. The user can obtain the required amount of blood from the specified site.

III. LITERATURE SURVEY

A. Global Positioning System

Neetu Mittal and Karan Snotra *et.al* [1] proposed a blood bank information system to track the location of the donor and the authors themselves maintains a blood bank. The authors have used GPS to track the location of the donors and in this method the user is provided with a user ID and password to create an account. The requests that are obtained from the users will be stored in a database and checks for the availability of blood if the blood is not available in the blood bank, then a notification will be sent to the registered donors who were available in the nearby areas for immediate blood donation and checks for the conditions weather to accept the blood from the available donors or not. Otherwise, the notifications will be sent to other registered donor's if the specified criteria are not met.

GPS tracking refers to the global positioning system. This includes 24 orbiting satellites and a community of ground-based devices capable of locating people and things on Earth with astonishing accuracy. After GPS tracking, chant three separate factual phrases. Positioning, Navigation and Timing.

It requires the use of a large number of satellites orbiting the earth. These satellites continuously broadcast their position and status. This is continuously monitored by the main GPS control station and other position monitoring stations on the ground to ensure accuracy and proper function. The main control centre is also responsible for maintenance and troubleshooting.

The GPS devices on Earth receive these signals and interpret the unique data. By assigning four or more satellite positions to the tracker, you can triangulate its exact position in three-dimensional space. Often uses more satellites to verify data and provide more accurate location information.

When selective availability was lifted in 2000, GPS accuracy was about 5 meters (16 feet). GPS receivers that use the L5 band are much more accurate and can pinpoint your location to an accuracy of 30 centimeters (11.8 inches). By comparison, high-end users (typically engineering and land surveying applications) are within 2 cm of it. Accuracy in the sub-millimeter range can be achieved even for long-term measurements. [9,15,16].

B. Dijkstra's Algorithms

Md. Sabir Hossain and Nayan Das *et.al* [21] proposed an application which uses the Dijkstra's algorithm to find the nearest donor among various donors. Here, the blood seeker or the user is considered as a source and the blood donors who are available in the nearby areas are considered as nodes which are connected to each other. By considering the minimal distance between the user and the donor the nearest donor will be suggested to the user.

The Dijkstra Algorithm (/dakstrz/ DYKE-strz) is a method of computing the shortest path between nodes in a graph that represents a road network. Computer scientist Edsger W. Dijkstra developed it in 1956 and published it three years later. [4][5][6].

Algorithms are available in different types. Although Dijkstra discovered the shortest path between two specific nodes [6], the more general form is to select a single node as the source node, and then computes shortest pathways from source to other nodes in a graph. Then finds the shortest pathways to all nodes in a path tree.

Of course, the algorithm doesn't try to direct the "search" towards the goal. Rather, the only criteria for identifying the next "current" intersection is its distance from the starting point. As a result, this approach analyses each nearest node in terms of shortest-path distance to reach the destination and extends outward from the starting point. From this we can say that the algorithm always chooses the shortest path. However, you may see one of the algorithm's flaws such as its slowness in certain specific topologies.

As labels, Dijkstra's approach utilizes entirely sorted positive integers or real values. If the trailing labels (made by crossing an edge) are not monotonically decreasing, any partially ordered label can be utilized. This generalization is known as the generalized Dijkstra shortest path algorithm.

C. A * Algorithm

Annish Brislin and Albert Mayan *et.al* [33] proposed a life-saver application which will trace the location of the donors. If the donor is not available then a notification will be sent to another donor for immediate blood donation. This system uses GPS and KNN algorithm together to find the nearest donor among multiple donors and GPS uses A* algorithm for its implementation. In several fields of computer science, graph traversals and path-finding algorithms are utilized to ensure completeness, optimality, and efficiency. Because all created nodes are maintained in memory, the biggest practical disadvantage is the spatial complexity O(bd)O(bd). As a result, it beats algorithms that pre-process the graph to increase speed and memory-constrained techniques in real-world itinerary systems. However, in many circumstances, A* is still the best choice.

In several areas of computer science, graph traversals and path-finding algorithms are utilised to ensure completeness, optimality, and efficiency. The spatial complexity O(bd)O is the most major practical limitation since all created nodes are retained in memory (bd). As a consequence, it beats methods in real-world itinerary systems that pre-process the graph to boost functionality and techniques that are memory bound. However, A* is still the best option in many circumstances. In contrast to Dijkstra's algorithm, the A* method only finds the shortest path from a given source to a single destination, rather than the shortest path tree from a given source to all possible destinations. This is an unavoidable side effect of using focused heuristics.

A* is an intelligent search algorithm that is commonly referred to as the best initial search. It is written in the language of weighted graphs. Lowest price (quickest trip distance, shortest duration, etc.). This is accomplished by keeping a tree of routes that begins at the root node and extends one edge at a time until the path's end criteria are completed.

D. Global System for Mobile communication

G. Muddu Krishna and S. Nagaraju *et.al* [32] used GSM (Global System for Mobile Communication) and SMS service together to take the requirements from the user and checks weather the required amount of blood is present in the blood bank or not and if the specified blood group is not available in the blood bank. Then, the notification will be sent to the registered donors for immediate blood donation and the current location of the donor is determined using GPS.

=GSM (Global System for Mobile Communication) is a digital cellular network widely used by mobile phone users around the world. GSM is the next most popular of the three digital wireless telephony technologies. TDMA, GSM, Code Division Multiple Access (CDMA). GSM digitizes and compresses the data before sending it over the channel in its own time slot along with his two other user data streams. It operates at frequencies of 900 MHz or 1,800 MHz.

1) The GSM prototype uses analog technology, notably the US Advanced Mobile Phone Service (AMPS) and Total Access Communication System (TACS). in England. But as more customers were added, these communication networks could no longer grow. The deficiencies of these systems have highlighted the need for more efficient cellular technology that can be implemented internationally. The European Conference of Posts and Telecommunications (CEPT) established a working group in 1983 to develop European standards for digital communications. CEPT defined global roaming capabilities such as high voice quality, compatibility with portable devices, affordable service pricing, support for new services, and ISDN capabilities for new systems.

2) In 1987, representatives of 13 European countries decided to develop a telecommunications standard. The European Union (EU) has enacted legislation mandating the use of GSM as the European standard. In 1989 CEPT handed over his GSM project to the European Telecommunications Standards Institute (ETSI). Finland was the first country to offer her GSM-based mobile phone service in 1991. In the same year, the GSM standard frequency range was extended from 900 MHz to 1,800 MHz. GSM accounted for 80% of the global mobile market in 2010. Nevertheless, some telecommunications companies such as Australia's Telstra have turned off their GSM networks. In 2017, the company's 2G GSM network in Singapore was disabled.

E. Haversine Formula

Azrul Amri Jamal and Mokhairi Makhtar *et.al* [29] proposed a blood donation notification application which uses haversine formula and Dijkstra's algorithm together to find the nearest blood bank which satisfies the user requirements and it also helps to avoid the notifications and alerts from various blood banks which are far from the user location and the exact position of the donor is determined using the Global Positioning System (GPS). Here, the nodes are considered as blood banks and the blood bank which has adequate blood resources and takes minimal distance to reach will be suggested to the user.

Haversine's formula is used in spherical trigonometric functions. It is used to compute the shortest distance between two points on the sphere, and using longitude and latitude on the earth and it can also be used to calculate the distance between two locations. It is widely used in navigation systems.

The formula of Haversine is:

$$d = 2r \arcsin\left(\sqrt{\sin^2\left(\frac{\phi_2 - \phi_1}{2}\right) + \cos(\phi_1)\cos(\phi_2)\sin^2\left(\frac{\lambda_2 - \lambda_1}{2}\right)}\right)$$

where,

r = radius of Earth,Φ_1, Φ_2 = Latitudes of two points λ_2,λ_1 = Longitudes of two points

The distance given to the Haversine formula is incorrect because it considers the Earth to be a perfect sphere, but the Earth to be a spherical sphere.

Proposed systems using the Haversine formula treat the path between two points on the earth as a straight line, which is not always possible in the real world because in the real world it rarely exists. a straight line between two points on the earth. Therefore, the system using the Haversine formula does not guarantee accurate results, which can lead to risky situations.

So, we have to consider the real distance of the road that we have to travel to reach the destination rather than assuming it is a straight road also the methods proposed by different authors who donate must keep the mobile phone's GPS still. not possible because they will not be using a GPS-enabled cell phone or they do not carry their cell phone with them or they have GPS turned off and some sponsors may also be able to track their location as a threat to their privacy. Therefore, the haversine formula gives only the distance between two points, by considering their latitude and longitude. Blood bank information systems commonly use the haversine formula to calculate the distance between the blood bank and the donor. The results of this calculation are stored in a result matrix and it is used to search for donors or blood banks that have the required blood supply. Haversine formula will consider the earth as a spherical sphere and calculate the distance between the two places which is not always possible when two places are not connected in a straight line. So haversine formula has an error rate in providing the blood bank information and it provides the details of the all the blood banks without considering the quantity of blood available in the blood banks. The methods that used the haversine formula will not provide the accurate result as it is applicable for the smaller distances and it is not applicable when the places are far from each other and that two places are not directly connected to each other. So, it is not quite suitable to use haversine formula when distance between the places is long.

IV. RESULTS AND ANALYSIS

The existing systems that are available either uses Short Message Service (SMS) or Asterisk routing algorithm through which the user can make a call to a toll-free number and gets an information about the availability of blood. Many of the authors uses GPS to track the donor’s location in the emergency situations. Some methods used the haversine formula to find the distance between the blood bank and the donor. However, these methods have its own advantages and disadvantages when compared with one another. Some methods work only for donors and blood banks. But there is no centralized network that connects donors, blood banks and users together. So, it is necessary to connect all the resources to a centralized database which stores the records of all the blood resources like blood banks, hospitals and the blood donors who are ready for the blood donation.

Some methods used GPS technique to know an exact location of the user through which the user can easily navigate to the nearest blood bank and it will not work when the GPS gets turned off. It is not quite suitable when the user is available at the farther distances and it consumes more time to travel. Some methods also used the routing algorithms which navigates the user to a blood bank which has sufficient blood resources and user can get an get a required amount of blood from the blood bank. It doesn’t handle more amount of traffic when multiple users call at a same time. The main objective of the GIS (Geographical Information Systems) is to automate the tracking of blood resources which are obtained in the process of donation of blood. These GIS systems will keep the track of medical records of the donors and the recipient’s and this data will be stored in a centralized database to reduce the duplicate data in the database. There are many applications that are being developed which manages all the records of blood stock in the process of collection of blood. It will raise an alert to blood bank staff or to the database administrator when the blood stock is low or when the blood in stock is ready to expire. The GIS systems are also used for locating the blood donors who were in the nearby location of the donor. The user will have an access to check the medical records of the donor to know whether the donor is infected or not. In this method a database is created and collected data from various blood banks and hospitals will be stored in it. The user can get the details of availability of blood simply by calling to a toll-free number.

TABLE. 2 Feature Level Comparison Table

S.No	Author/Journal Name	GPS Requirement	Reliability	Need of database administrator	Algorithm used	User Friendly
1	S.A. Chaudhari et al.., A Secure Cloud Computing Based Framework for the Blood Tracking donors location[1]	Yes	No	No	Haversine Formula	Yes

2	M. A. Oukebdane et al.., Zomraty: E-Blood Bank Android Application for Donors and Life Savers[2]	Yes	No	Yes	Haversine Formula	Yes
3	Md. Sabir Hossain et al., Finding the Nearest Blood Donors using Dijkstra Algorithm [3]	Yes	No	Yes	Dijkstra Algorithm	Yes
4	Javed Akhtar Khan et al.., A New Concept of Blood Bank System using Cloud Computing for Rural Area(INDIA)[4]	Yes	No	No	Short Message Service (SMS)	No

A routing algorithm will be executed in the server side and the donors will be notified for immediate blood donation. Blood donors who wish to donate blood are considered and some of them will be picked for blood donation. By considering the locations of the donor and user a call will be routed, then the server will connect the call from the user to the preferred donor. The donor will be checked weather he/she is infected or not, if the donor is not infected then the user can accept the blood donation from that user. These systems are user-friendly when compared to other because the user can get the details of the blood donors by simply making a phone call to a toll-free number. These kinds of systems are very much useful for people who lives in the rural areas as they are not much aware of technology. So, it is a detailed comparison of the methods that are being proposed. Some of the methods satisfies some of the requirements of the user and some of the methods may not satisfy the requirements. But majority of the existing systems doesn't satisfy all the requirements of the user. So, there is a need for the system which satisfies all the user requirements and keep the records of all the medical records of the patients and notify the donor's when any blood donation campaigns are being conducted. The below table will specify all the features of the proposed methods. This paper will provide a review on blood bank information systems that are developed. This paper provides detailed survey on the methods that are being proposed.
The Table. 2 discuss about the performance parameters to compute the distance between the user and blood donors. The proposed systems considered the following parameters while developing their systems.

V. DISCUSSIONS

Some of the methods that are being proposed uses GPS to track the donor's location. But the donor must turn their GPS all the time and there will be a need of database administrator to regularly update the database. Some methods which are proposed will maintain their database in the cloud and the computational speed of the application will also be improved and there will not be any need of the database administrator. Some of the methods have also used the haversine formula which computes the distance between two points on earth. So, the authors used this haversine formula to compute the distance between the users and the blood donors. In one of the proposed methods the authors have used direct call routing algorithm through which the user can directly make a call to donor and get the required amount of blood then the donor's name will be removed from the list of donors for eight weeks after donating the blood. A major drawback of all these existing systems is that they are dedicated in finding blood donors without knowing if they are willing to donate blood. Instead, they will locate a blood bank or hospital where the required blood is available.

VI. CONCLUSION

This paper provides a detailed survey on blood bank management systems as we all know that most of the existing systems will work only for blood donors and some of them will works for blood banks as well. But, there is no common channel that that connects all the blood resources together. So, it is necessary to design a system which connects all the blood resources to a centralized network and the willingness of the donor should be known prior before suggesting to the user for blood donation.

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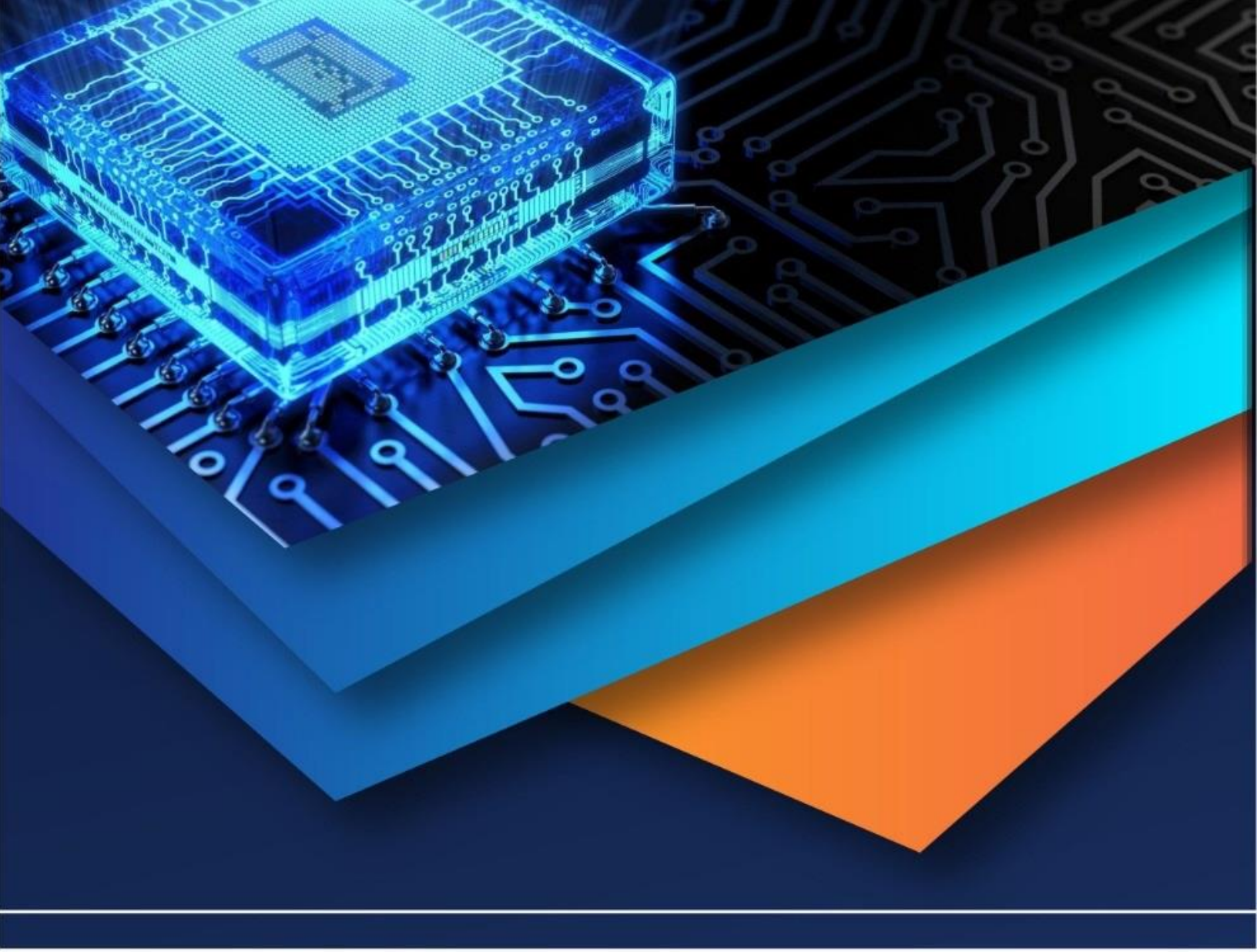

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