iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** VI **Month of publication:** June 2020

DOI: http://doi.org/10.22214/ijraset.2020.6203

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VI June 2020- Available at www.ijraset.com

Smart Healthcare Monitoring and Patient Report Generation System using IOT

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Abstract: ***IoT in healthcare is a very important technology in providing better medical facilities to the patients and facilitates the doctors as well. The proposed system here consists of various medical devices such as sensors and web based or android based applications which communicate via network connected devices and helps to monitor and record patients' health condition and notify when health is at risk. In many organizations, companies and Government Agencies, first aid kit is used on daily basis. First Aid system is of very basic need. Making digitized advancement in the First Aid system using IoT based health care sensors and to verify the quantity of tools available in the First Aid box will be definitely very useful with much less human intervention. The key objective of our system is to measure various health parameters which include Heart Rate, Body Temperature, Blood Pressure of the patient. Also, to measure the load of medicines inside a first aid kit, and to perform data analysis on the generated patient data for identifying his/her health condition. As First Aid treatment need more concern due to increasing theft to human health, the many in one approach in this system will help at extent in health care domain. The proposed system comes with multiple sensors that helps to check patient's health from multiple health perspectives. In recent times, scientists have brought a revolutionary change in the field of healthcare with technology like the IoT. Therefore, it is well possible to make better first aid treatment with easy accessibility anywhere, that too at a very low cost. So, having a system which can make this task automated and efficient is the actual purpose of this system.***

Keywords: Internet of Things, IoT in Healthcare, Patient Monitoring, Android, Smart Health Monitoring.

I. INTRODUCTION

The Internet of Things also known as IOT, is the interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data using internet service. One of the most remarkable characteristics of the Internet of Things in the healthcare system is quick and accurate monitoring of various health parameters. Now-a-days many hospitals are using equipment with medical sensors on them. There have been so many emergency situations where doctors couldn't be notified in quick time. Also, the cases in which critical information about a patient's health couldn't get delivered to the designated doctor or even to the family members & closed ones. To resolve such issues in the healthcare sector there is technology available but isn't affordable to the developing nations like India. This is why, the best solution to this problem can be found by making the existing systems more advanced and user-friendly for everyone. This paper illustrates a Smart Healthcare Monitoring System using Arduino Uno. The Arduino Uno is a microcontroller board based on the ATmega328 which has 20 digital input/output pins. Out of these 20 pins 6 can be used as PWM outputs and 6 can be used as analogue inputs. It also has a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button. This smart system is designed to measure health parameters like Body temperature, heart rate, blood pressure and weight of the medicines and other related equipment in a first aid kit. This information is further stored on a cloud-based database and can be accessed using an Android application. An authorized personnel will be able to access this data about patients. All of this data about health is sent to a patient as well as doctor via a SMS. Though a similar idea has been proposed, our system comes with a unique feature which ensures the sufficiency of medicines and related essentials inside a first aid kit. Our main goal is to store real time data online and to inform the Doctor as well as the patient in case of risk for patient's health. The data is stored online with the help of MySQL database combined with Arduino and sending an alert message is done using an online message gateway. Additionally, the health data collected is used to research further using Machine learning algorithms which will help to study the data with intelligence and make sense out of it.

The aim of this paper can be summarised in following points

1) To measure the real-time medical information about a patient using multiple IOT sensors.
2) Processing and storing the data collected through the IOT system combined with microcontroller.
3) To send an alert message to the patient and doctor in case of emergency.
4) To maintain the first aid kit without running out of medicines and essentials.

II. RELATED WORK

Multiple researchers have proposed various models for IoT in the Healthcare sector and the prediction of various types of diseases using various techniques. This part is all about the work done in same area

Barger et al. [1] created a smart house facility using a sensor network to monitor and track the movements of the patient inside his/her house. A prototype of the same is also being tested. The primary aim of their research is to check if their system is able to outsmart the behavioural patterns of humans. It is discussed thoroughly in this paper.

Dwivedi et al. [2] has developed a framework in order to secure the clinical information that has to be transmitted over the internet for Electronic Patient Record (EPR) systems. In this paper they propose a multi-layered healthcare information system framework that is a combination of Public Key Infrastructure, Smartcard and Biometrics technologies.

Vikram Singh et al. [3] have analysed the wireless patient health monitoring system of temperature and heartbeat of humans using nRF24L01. They have used photodiode and bright LED to measure the heartbeat heartbeat while the temperature was measured by using the temperature sensor LM35. The data from both sources were processed in the Arduino uno and sent to the remote end wirelessly by using nRF transmitter and received at the remote end by using nRF receiver. The data measured was displayed successfully with the help of LCD at the remote end.

Lopes et al. [4] have proposed a framework based on IoT for the disabled people. The main aim of this is to study and find the IoT technologies in the healthcare segment that can benefit them and their community. They took two use cases to study the latest IoT technologies and its application that can be used specifically for the disabled people.

Ahn et al. [5] implemented a system for measuring the physiological signals in a seated position such as ECG and BCG by using a smart chair that senses the non- constrained bio-signals. And these signals can be monitored using a monitoring system like the way the have developed which is a perfect example of IOT in healthcare.

Kavita et al. [6] have developed an IoT-Cloud based smart healthcare model that performs monitoring of patients' health data which is collected from the various wireless sensory healthcare equipment. Their proposed architecture is cost-effective, scalable and supports interoperability. It has lightweight access with the help of Raspberry pi and Docker container.

Xu et al. [7] have presented a data model to record and use the IoT data. They designed and developed a resource-based Ubiquitous Data accessing method to collect and publish IoT data globally. Their objective is that it can be accessed anywhere, anytime. They also present an emergency medical service based on IoT and how to collect and use the IoT data on different platforms.

Ivan et al.[8] have presented some of the theory of load cells, and anl application of a three-ring spherical load cell in the construction of a versatile measurement system. The versatility of the load cell system produced is permitted to obtain data in different ways in the application of post-harvest processing of apples and oranges.

III. SYSTEM ARCHITECTURE

We propose an automatic system to monitor patient's body temperature and heart rate. Further we extend the existing system which will be monitoring the amount of medicines inside a Smart First-Aid System.(Add proposed system diagram and elaborate)

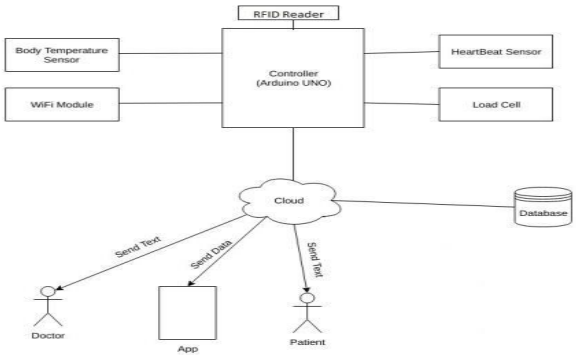

Fig. 1 System Architecture

Through this system it is possible to monitor the heart rate and body temperature continuously It is assumed that all the user of the system have a generalized knowledge to operate the First Aid System without harming it.

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IV. PROPOSED METHODOLOGY

Sense the multiple organs of a user through particular sensor as input value. Pre-processing the health-related data collected from all of the sensors inside the system. Extract and store the results of the sensors in the Database for further processing and operations. Analyse accuracy of measured data and generate correct and immediate results through decision tree prediction ǎlgorithm. Store the converted reading in database for further analysis and report generation. Measure the quantity of the medicines inside the First Aid System. Display the result as d detailed Report in the form of Values, Graphs, etc comparing measured data versus expected data. Notify the respective Doctor or Guardian about the Health status for instant appointment and treatment. unprocessed data from various IoT devices is obtained and stored on the server. These devices include various sensors such as temperature sensor, heartbeat sensor, Load cell. Since some of the sensors give analogue output which cannot be used by Arduino, we first convert the analogue values into digital form and using convertor IC. Then using the Arduino UNO , we write the code in embedded C that reads the values from the sensors and update them into the database at regular intervals. In level-
2, the relevant information is obtained as a result from the data stored by filtering, classifying and categorizing it. This information is nothing but the patient's readings and symptoms that the patient has. This information will be further used in the next level to predict if the patient health parameters. This helps to make the system smart and efficient. Loadcell will read the weight of the medicine and first aid tool kit. This continous monitoring of weight of first Aid Kit will help the administrator of the system to continously monitor the quantity of materials in the kit and maintain the level of items above it's threshold

A. System Modules

1) *Health Monitoring Section:* This module comprises of the hardware components of the system that makes it IoT enabled and is used to record the health parameters of the patient using various sensors. Here, Arduino UNO acts as a server to which all the sensors are connected. Information collected from sensors are further stored on a cloud- based database and can be accessed using an Android application.
2) *Emergency Alert Section*

There are two different types of emergency alert in the system

a) *Item Value Below Threshold:* In this section the Strain Gauge Load-cell will read the weight of the medicine and first aid tool kit. This continuous monitoring of weight of first Aid Kit will help the administrator of the system to continuously monitor the quantity of materials in the kit and maintain the level of items above its threshold. The capacity of the Load cell use in this system is 20 Kg.
b) *Patient Readings Above or Below Threshold:* We have set up certain threshold values in our program which if crossed will trigger an alert in the form of email/SMS to the doctor. The various values used here are:

Component	**Normal**
Blood Pressure	80-120 mm
Heart Beat	67-100 beats/min
Body Temperature	36.5-37.5 C

V. IMPLEMENTATION

In this paper, we have proposed a system in which patient's body temperature, heart rate, body movements and blood pressure reading results that are being monitored by the system. The various sensors are placed on the patient's body and they take the readings and send the corresponding signal to the cloud. The various Components to be used in system are :

A. Arduino

The Arduino UNO is a widely used open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board features 14 Digital pins and
6 Analog pins. It is programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable.

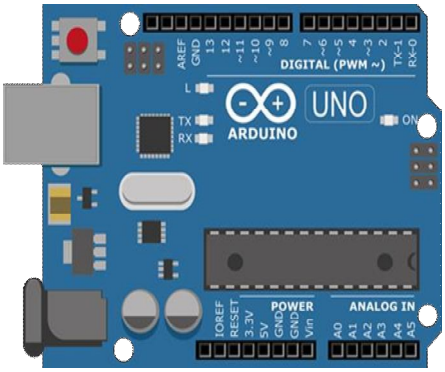

Fig. 5.1 Arduino Uno

B. Strain Gauge Load Cells

Strain gauge load cells are the kind most often found in industrial settings. This kind of load cell is ideal as it is highly accurate, versatile, and cost-effective. Structurally, a load cell has a metal body to which strain gauges have been secured. The body is usually made of aluminium, alloy steel, or stainless steel which makes it very sturdy but also minimally elastic. This elasticity gives rise to the term "spring element", referring to the body of the load cell. When force is exerted on the load cell, the spring element is slightly deformed, and unless overloaded, always returns to its original shape. As the spring element deforms, the strain gauges also change shape. The resulting alteration to the resistance in the strain gauges can be measured as voltage. The change in voltage is proportional to the amount of force applied to the cell, thus the amount of force can be calculated from the load cell's output.

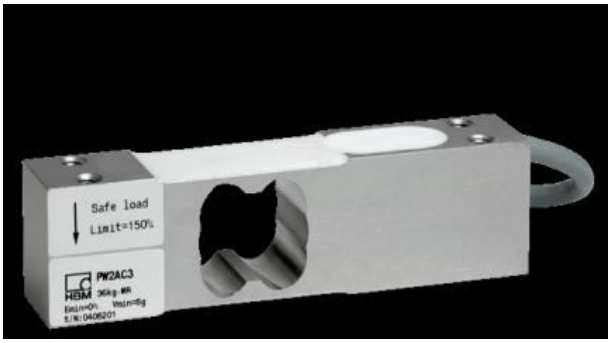

Fig. 5.2 Load cell

C. LM35 Temperature Sensor

1) The LM35 series are precision integrated- circuit temperature devices with an output voltage linearly-proportional to the Centigrade temperature.

2) The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling.

3) The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°Cover a full −55°C to 150°C temperature range.

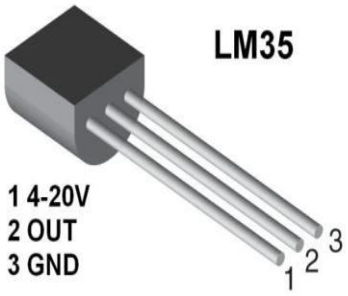

Fig. 5.3 LM35 Temperature Sensor

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D. Android Application | User Interface

Android is a mobile operating system based on a modified version of the Linux kernel and other open source software, designed primarily for touchscreen mobile devices such as smartphones and tablets. Android is developed by a consortium of developers known as the Open Handset Alliance, with the main contributor and commercial marketer being Google. For Building the Mobile Application UI to our system an android system used to develop an App through android studio suite.

Here are few sample Screenshots from the Android App built for this Smart HealthCare monitoring system.

Fig. 5.4 Android Application | User Interface

E. Cloud – 000webhost Cloudflare

By default, 000webhost provides a secure connection for all 000webhostapp.com 355 subdomains. However, for custom domains, this is not the case. But with this method, you can setup your custom domain with a secure HTTPS connection for free. This Cloud System is often used for prototyping and proof of concept IoT systems that require analytics.

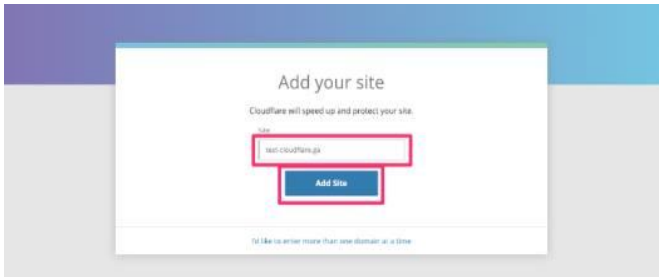

Fig. 5.5 000webhost Cloudflare Signup

F. Decision Tree Prediction Algorithm

The decision tree is an important algorithm for predictive modelling and can be used to visually and explicitly represent decisions. It is a graphical representation that makes use of branching methodology to exemplify all possible outcomes based on certain conditions. In decision tree internal node represents a test on the attribute, branch depicts the outcome and leaf represents decision made after computing attribute. Here it contains three attribute viz. blood pressure, heart rate, body temperature. Decision Tree helps in making decisions under a particular circumstance and improves communication. It helps to capture the idea that how different decisions can lead to different operational nature of the situation. It helps to take an optimal decision. This algorithm is well suited for our instances that are represented by attribute value and as our training data contains fluctuation and error. It is also applicable to the situation when the target function has discrete output value. Among all the algorithm the accuracy of decision tree is more accurate as compare to other algorithm. For Prediction of patient data health parameters decision tree algorithm is used in this project.

VI. SYSTEM DESIGN

A. *Block Diagram*

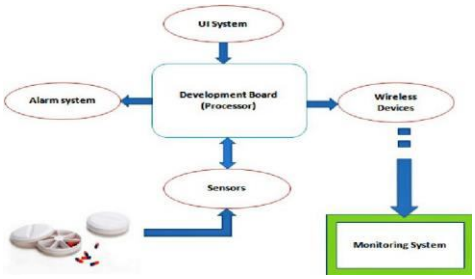

Fig. 6.1 Block Diagram

VII. SYSTEM MODULES

1) *Authentication Module:* An authentication module is a plug-in that collects user information such as a user ID and password, and compares the information against entries in a database. If a user provides information that meets the authentication criteria, the user is validated and, assuming the appropriate policy configuration, granted access to Smart First Aid System. If the user provides information that does not meet the authentication criteria, the user is not validated and denied access to the System.
2) *Data Collection:* A robust and real-time data collection and processing is an essential step to gather data sensed through various Sensors in the System.
3) *Data Acquisition:* Data acquisition is the process of sampling signals that measure health conditions and converting the resulting samples into digital numeric values that can be manipulated by an Android Device. Data acquisition systems, typically convert analog results from sensors like AD8232 ECG Sensor into digital values for processing. The components of data acquisition systems include:

a) Sensors to convert physical parameters to electrical signals.
b) Signal conditioning circuitry, to convert sensor signals into a form that can be converted to digital values.
c) Analog-to-digital converters, to convert conditioned sensor signals to digital values.

4) *Data Processing*

a) *Input:* Input is the first stage of the data processing cycle. It is a stage in which the collected data is converted into a machine-readable form so that a computer can process it. This is a very important stage since the data processing output is completely dependent on the input data ("garbage in – garbage out").
b) *Processing:* In the processing stage, the Smart First Aid System transforms the raw data collected via sensors into information. This collected data is compared with the standard values to identify any threat to the health of a user.
c) *Output:* In the last stage, output is received. This is the stage where the processed data is converted into human- readable form and presented to the end user as useful information. If the sensed value exceeds the threshold value then ill health is identified. For example: Human Body temperature exceeding 37.5 and 38.3 °C is condition of Fever.

5) *Report Generation:* This module allows users to generate reports and graphs at once the data is stored in the database. This report compares standard values of health parameters with the measured values of a user. Graphs can be generated to represent this comparison to make it more readable. Based on the measured data and previously recorded data, system will provide suggestions to the user.
6) *Notify respective Doctor/Guardian:* In any case of emergency identified an instant notification is sent to respective Doctor or Guardian. This notification is sent as an SMS to the registered Phone number. This feature reduces the amount of time of user and helps to get treatment instantly. Also, Doctor's appointment is taken for immediate diagnosis and to avoid any serious threat

VIII. OTHER SPECIFICATION

A. *Advantages*

1) The system will help everyone who need urgent First Aid treatment
2) Government Centers, Educational Institutes, Companies can easily get their documents on computer in editable form.
3) Future health parameter of patient can be predict easily

B. Limitations

1) The system will recognize only body temperature ,heart rate, blood pressure

2) As readings may vary of same person is not same all the time, accurate prediction is a challenge.

IX. RESULT

As the title says, the result of Smart Health Monitoring system is of extreme use to patients and doctors as well. The patient can check their health status anytime from the comfort of their premises and visit hospitals only when they really need to. This can be done by using our system whose result are brought online and can be seen from anywhere around the world. Since it is a prototype model, our system shows the almost real time values of various
health parameters and emulates how the same can be implemented in the real world. The doctors can also use the log of the patient body condition to study
and determine the effect of medicine or other such things. Continuous monitoring of item in the system that is use in First Aid kit notify the threshold level of that particular item this will help in refilling of that item in kit which will avoid the emergency shortage of that particular item as and when it is require.

X. CONCLUSION AND FUTURE WORK

In this project, we implement an IoT based smart first aid system that performs monitoring of patients' health data collected from various wireless sensors. The sensors used in this system include Body temperature sensor, Pulse rate sensor, ECG sensor and Blood pressure sensor. Also Load cell to monitor the quantity of medicines inside the first aid system. The proposed architecture is cost-effective, scalable and supports interoperability and lightweight access with the help of Raspberry pi and Arduino. This system is with the advancement in the traditional First aid system with accurate and instant treatment. The inclusion of feature to monitor the weight of first aid system is helpful to maintain the system more accurately. The ability of this system to send an instant notification and make an appointment is very beneficial for immediate treatments on the identified health issues. Further work might include biometric user authentication and face authentication to make the system more secure and deploying the platform in the real healthcare environment for assessing the framework with respect to user acceptability and performance.

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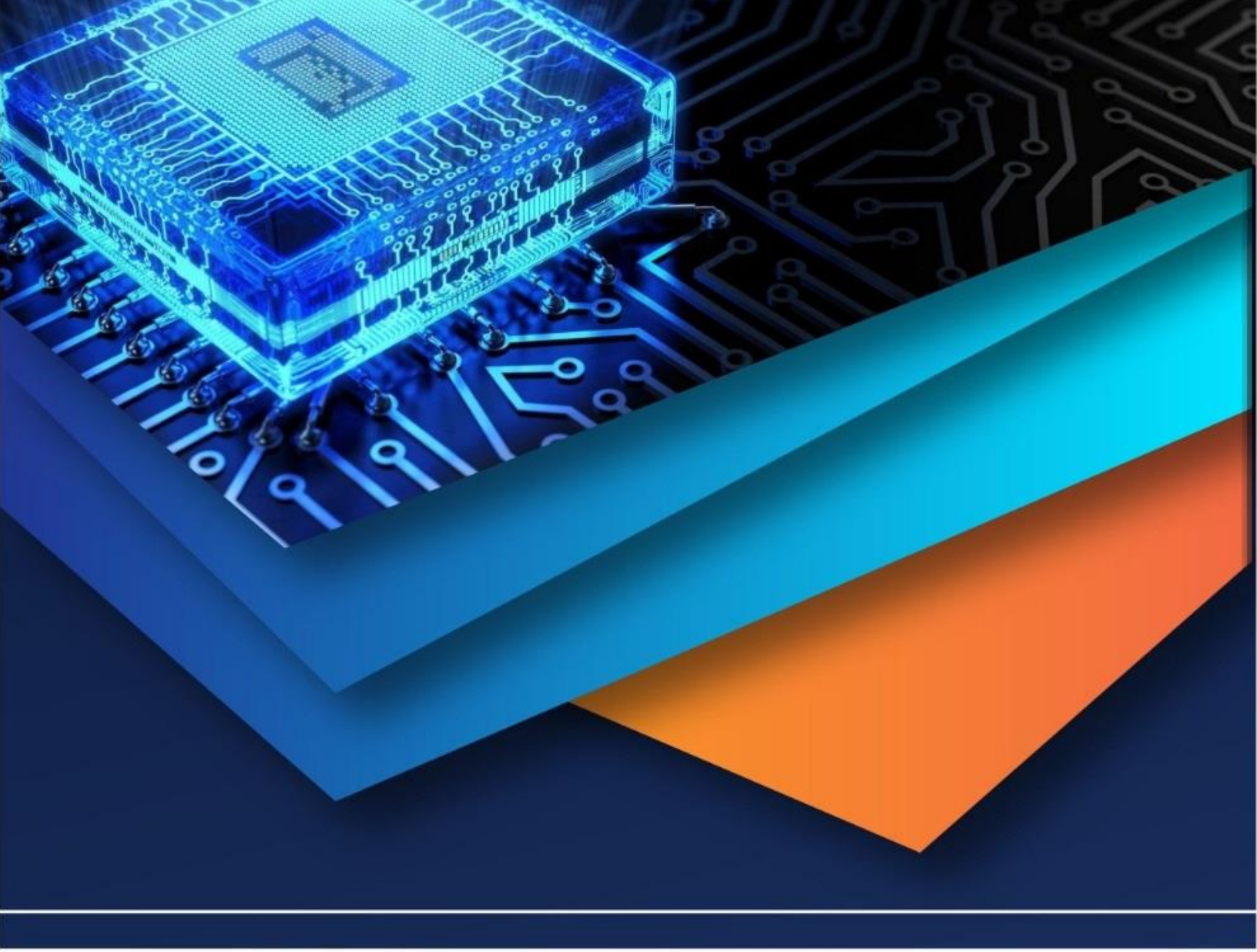

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