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IoT-Based Buffalo Health Monitoring System

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Abstract: ***Ensuring the health and well-being of dairy buffaloes is crucial for farms, but manual monitoring is challenging, especially in large herds. To address this, we introduce an innovative IoT-based system designed for buffalo health monitoring. This system consists of essential components. Special sensors and devices are attached to buffaloes to collect vital health data continuously. This data is sent to a cloud-based system, acting as a central hub for secure data storage and real-time access. Farm managers and employees can use a user-friendly application to monitor the buffalo's health and receive alerts for any issues. The key feature lies in the data analysis algorithms. These algorithms process the data, spotting patterns and early signs of diseases, enabling swift intervention. This system brings multiple benefits. It frees up farm employees from intensive monitoring, ensuring early disease detection for timely treatment. It also enhances farm productivity by reducing disease risks and optimizing resource usage.***

The IoT-based buffalo health monitoring system thus represents a significant advancement in agriculture. It eases the burden of monitoring, improves animal welfare, and contributes to more sustainable and efficient farming practices.

Keywords: Dairy animals, Health Monitoring System, IOT, Cloud Computation, algorithms.

I. INTRODUCTION

In today's fast-evolving agricultural landscape, technology is playing a transformative role in how we manage farms, with a particular focus on buffalo farming. The unique challenges posed by buffalo farming, which often involves a large number of buffalos and limited direct contact with each animal, have prompted the search for innovative solutions. Central to this challenge is the need to ensure the well-being of these animals, particularly in dairy farming, where precise timing of pregnancy is vital for maintaining a consistent milk supply (Choudhary et al, 2020; Dutta et al., 2022; Kartik et al., 2023).

This is where IoT (Internet of Things) technology comes into the picture, proving to be a game-changer in modern livestock management. IoT leverages the power of connected devices, in this case, specialized sensors that are attached to buffalos. These sensors play a critical role in continuously monitoring various aspects of the buffalo's health and behavior, such as body temperature, movement patterns, and vital signs (Keertana et al., 2017; Kuldharan et al., 2023).

The beauty of IoT technology lies in its ability to provide real-time data. Farm managers can conveniently access this data on their mobile devices, granting them immediate insights into the well-being and behavior of each buffalo in their care. This level of monitoring is especially beneficial in cases where the farm manager cannot maintain direct contact with every buffalo due to their sheer number. One of the most pressing issues in buffalo farming is the need for precise timing in insemination. When a buffalo goes into heat, there's a very short window of opportunity for successful insemination. IoT sensors, with their real-time data capabilities, help farm managers identify this critical period, allowing for precise and timely intervention. This means that the farm manager can optimize the breeding process, which, in turn, enhances the overall productivity of the farm. IoT technology doesn't stop at providing real-time data to farm managers. It also utilizes intelligent messaging systems that send alerts to the farm manager as soon as a buffalo is ready for insemination. This streamlined approach to managing the breeding cycle not only saves time and resources but also ensures that the farm operates at peak efficiency (Dulari et al., 2019; Dulari et al., 2020; Dutta et al., 2022).

Another critical advantage of employing IoT sensors in buffalo farming relates to the administration of medication, particularly antibiotics. Overusing antibiotics in livestock can lead to the development of antibiotic-resistant microorganisms, which poses a significant threat to both animal and human health. IoT sensors, with their ability to track various health indicators, including body temperature, heart rate, activity levels, and even the chemical composition of sweat, can distinguish between healthy and sick buffalos. This data-driven approach empowers farm managers to provide targeted treatment to sick animals when necessary, rather than administering antibiotics indiscriminately to the entire herd(Unold et al., 2020; Chatterjee et al., 2021).

Furthermore, this approach aligns with the growing consumer preference for products labeled as 'antibiotic-free.'

Consumers are becoming increasingly concerned about the presence of antibiotics in their food, and products bearing this label are not only more desirable but also often command a premium price in the market. Thus, the use of IoT technology in buffalo farming is not just a technological novelty; it's a strategic response to the unique challenges that this sector faces. IoT empowers farmers and farm managers to overcome the limitations of direct contact, especially when managing a large herd of buffalo. By offering real-time monitoring, precise timing for insemination, and data-driven healthcare, IoT significantly enhances the overall well-being of the animals and the productivity of the farm.

This paper's primary objective is to present a new IoT-based livestock monitoring system designed for the automated measurement of dairy buffalo health. By harnessing the power of IoT, this system promises to revolutionize the way we care for and manage livestock in conventional loose-housing buffalo sheds.

II. PROBLEM MOTIVATION

In previous years, dairy farms and farmers relied on specialized techniques for detecting animal health-related diseases. These methods often demanded continuous or daily observations, which, in the case of monitoring buffalo health, translated into the need for excessive labor. Unfortunately, these traditional techniques weren't always foolproof and occasionally provided inaccurate results, differing from the actual health status of the buffaloes. Such discrepancies in health assessment could have detrimental effects on the well-being of the buffalo population. It became evident that there was a pressing need for an automated health monitoring system, one that could swiftly and accurately record health parameters, ensuring that the proper treatments were administered.

The limitations of manual observation and the risk of incorrect health assessments were clear motivating factors for the development and adoption of advanced technologies, particularly in the form of IoT (Internet of Things) solutions. IoT technology has proven to be a game-changer in the field of livestock management, addressing the shortcomings of traditional monitoring methods. By utilizing specialized sensors and data analysis, IoT systems can provide real-time and accurate health data, allowing farm managers to make informed decisions promptly. The introduction of an automatic health monitoring system not only streamlines the process but also significantly reduces the need for continuous manual labor. It minimizes the risk of misdiagnoses, ensuring that buffaloes receive the appropriate treatment in a timely manner. This not only improves the overall health and well-being of the animals but also has the potential to enhance the farm's productivity.

In summary, the transition from manual observation techniques to automated health monitoring systems, facilitated by IoT technology, represents a crucial step in modernizing dairy farming. It addresses the inherent limitations and risks associated with traditional methods, providing fast and accurate health assessments for buffaloes. By doing so, it contributes to the effective management of livestock health, ensuring the welfare of the animals and optimizing farm operations. This shift towards automation is not just a matter of convenience; it is a fundamental improvement in the way we care for and manage our livestock, ultimately benefiting both animals and farmers((Keertana et al., 2017; Unold et al., 2020; kartik et al., 2023).

III. PROPOSED SYSTEM AND METHODOLOGY

Sensors base technology use for biomedical application, size is the one of the important constraint. The sensors base device must be moderate in size and weight. However the sensors use in such device must able to detect body temperature and heart beats which is play important role in medical treatment and diagnosis. Another constraint is such device shall be controller and access remotely. Basically our project is divided into three domains (sensors technology, communication and software)[Plate-1].

A. Sensor Technology

The sensors are used for automatic measurement of various health factors. Such type of sensors would be mounted on the cattle's body, which continuously observe the body issues of the cattle like heartbeat rate, body temperature etc. and delivers output in the type of electrical signs. These signs are then compared to a standard limit of normal values. The Sensors such as respiration sensor, humidity sensor and rumination sensor are used in the advanced cattle health monitoring system. These sensors are connected to the Arduino UNO(controller)(Kumar et al., 2012; Kumar et al., 2012; Shinde et al., 2017; Kumaria et al., 2018; Pratama et al., 2019; Unold et al., 2020; Shabansi et al., 2022; Kuldharan et al., 2023; Petrocchi et al., 2023)

1) Body temperature Sensor

The thermistor is used to sense the body temperature of the buffalo. They are classified into NTC and PTC based on the way they respond to temperature changes. NTC thermistors are most commonly used to measure body temperature.

The usual buffalo temperature is 99.5 - 102.2° F. The diseases related with body temperature are milk fever, poisoning, indigestion, influenza and foot and mouth disease. So it is essential to measure body temperature (Choudhary et al., 2019).

2) Heart Beat sensor

The heart beat sensor counts number of heart beats in a minute. It contains IR pair which detects heart beat from blood flow. Both IR transmitter and receiver have to place in straight line in order to measure the heart beat rate accurately. Cattle have heart beat in the range of 40-50 beats per minute. If the heart beat is beyond this value it indicates stress or animal anxiety.

3) DHT 11 sensor

The environmental conditions of the farms also play a great role in buffalos being affected by various kinds of diseases. In this system the environmental temperature and humidity of the farm is monitored by DHT 11 sensor. The DHT 11 temperature and humidity sensor features a temperature and humidity sensor complex with a calibrated digital signal output. When there is a drastic increase in temperature or humidity, the farmer is being notified with an SMS.

4) Motion sensor

Motion sensors use electronic accelerometers to record the lying, walking and standing behavior of animals. These sensors are used with aim of monitoring the movement behavior of cattle for improving animal's health and production. If the data is automatically collected on large numbers and in continuous period of time then the health of the cattle can be improved to a large extent. This data can be used by the stakeholders for management and disease control decision.

B. Communication

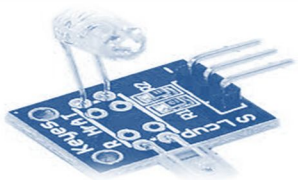
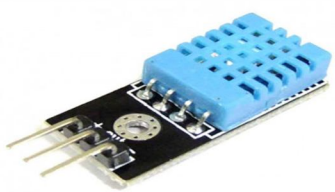
We can send the animal health graph to the doctor's mobile using ESP8266 WI-FI module. This WI-FI module sends the signals through the IOT technology. So by observing this graph doctor can tell about the animal health. Arduino UNO has enough memory to transform the signs arriving from the data gaining unit through sensors into an ESP8266 WI-FI module for communication and then the signals are given to the software for examining and displaying the data. The main function is when the animal will suffer from disease people use to take that animal to the doctor for diagnosis but sometimes doctors will not be available in hospitals so using this advance monitoring system we can sense the various activities of animals like body temperature, respiration, heartbeat, motions etc. and send the animal health graph to the doctor mobile using ESP8266 WIFI module. So by observing these graphs doctor can tell about the animal's health(Bhushan and Dulari, 2012; Kumar et al., 2012; Kumar et al., 2012; Dulari and Bhushan, 2019; Shabansi et al., 2022; Kuldharan et al., 2023).

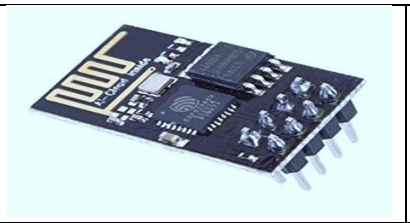
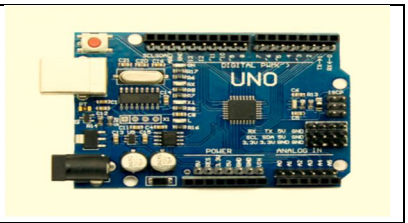
The Arduino UNO micro controllers are readily available for a wide variety of applications. The Arduino UNO microcontroller cost is low. Now a days instead of PIC microcontroller Arduino UNO is used because it is more flexible. The signals arriving from the sensors are finally sent to the WIFI module through Arduino and from the WIFI module to health monitoring app.

The ESP8266 Wi-Fi modules are low cost, small and maintain Wi-Fi connection and encryption in client mode and access point mode. Wi-Fi module communication is done through simple serial RX and TX lines using "AT" i.e. attention type commands and data.

C. Software

A web page is created wherein the buffalo's data is being stored using cloud computation. This web page can be accessed from anywhere. In cloud computation the data is scalable and there is no need of backups. If the count of buffalo's is increased then due to cloud computation the space for data is also increased. Once the normalized values of the health parameters of cattle is stored, this sensors sense the information and is compared to the normalized values and the graph is created which is sent to the doctor. The doctor will analyze the graph and take immediate action for the same and provide a proper treatment of the disease.

		
Body temperature sensor	Heart beat sensor	DHT 11sensor

		
Motion sensor	ESP8266 WI-FI module	Arduino UNO
Plate 1: Various hardware used in monitoring system		

IV. RESULTS AND CONCLUSION

The Architecture of e-Buffaloes health monitoring system using IOT consists of three significant units that are namely:

1) Data Gaining Unit.
2) Data Interact Unit.
3) Administering Unit

Data gaining unit consist of different types of biomedical sensors like body temperature sensor, blood pressure sensor, humidity sensor, heart beat rate detection sensor which is interfacing with microcontroller. The data gaining units obtain data and makes it accessible for the data administering and data interact unit (cloud, server and web page). The sensors are used for simple and general automatic measurement of numerous health factors. Such type of health sensors will be mounted on the cattle body which continuously observe the body issues of the cattle like temperature, heart beat rate etc. and deliver output in the type of electrical signal. These signals are then compared to a standard limit of normal values set as the starting point in data administering unit. If administering unit observes major changes or abnormal changes in particular cattle then they can contact to nearer animal care doctor. In some cases, however if veterinary doctor is not available in nearest hospital, then using IOT administering unit controlling person/farm manager can send the health graph to the doctor[Fig. 1; Plate 2; Table 1]. Thenafter, by observing this graphs and other related information veterinary doctor can analyze the health of animal(buffalo) and in absence of doctor proper treatment can also be processed on cattle during emergency (Choudhary et al., 2019; Suresh and Sarth, 2019; Unold et al., 2020; Sukumar et al., 2021).

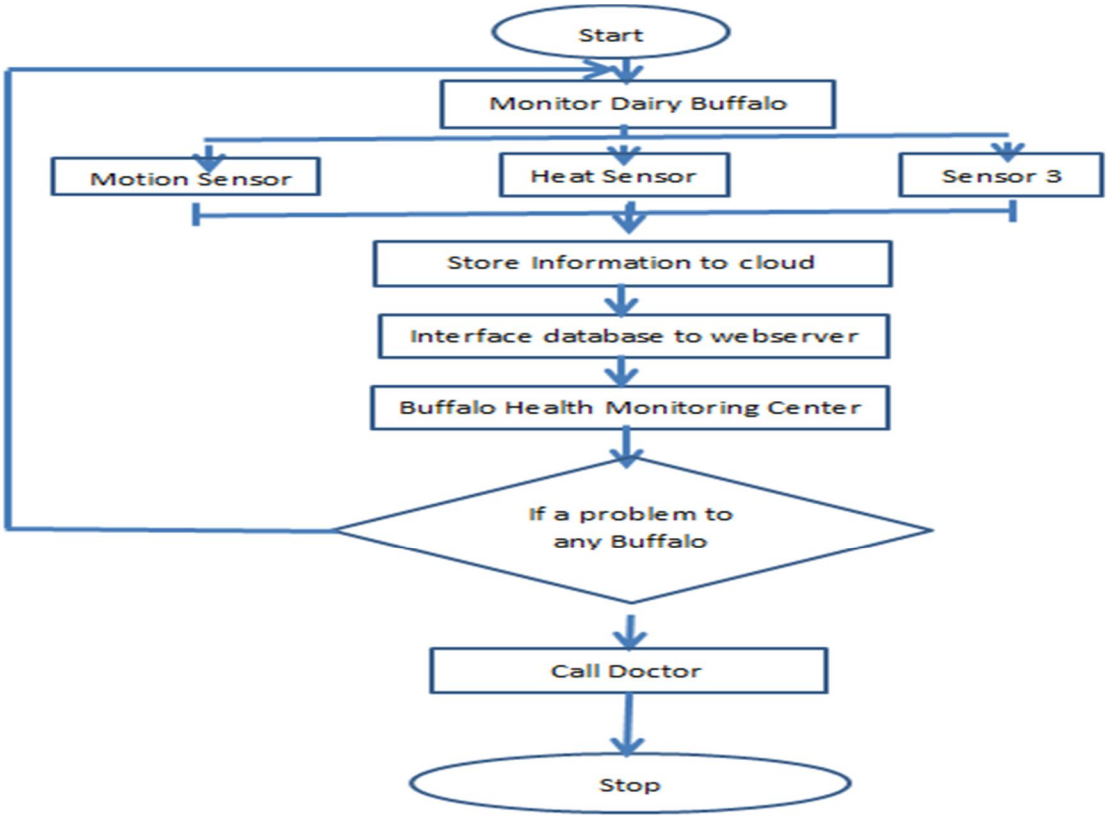


Fig.-1: Flowchart of Buffaloes Monitoring using IOT

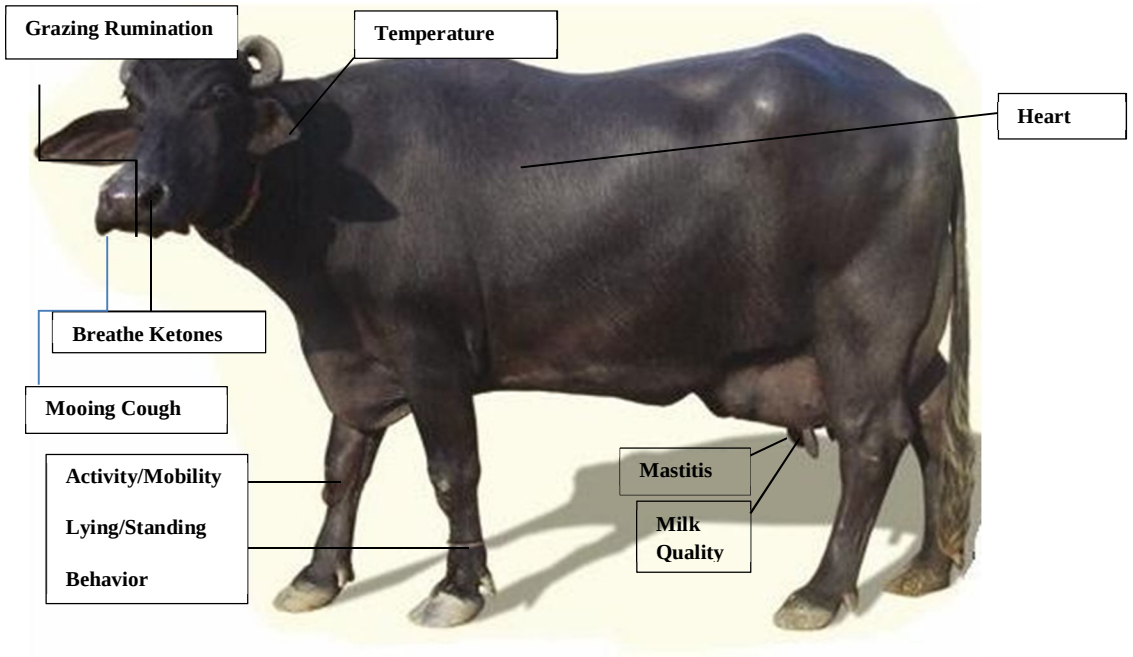


Plate 2: Showing various parameters of buffalo considered in this study

Table 1: Basic information for Buffallo health forecasting:

Sensor	Category	Value		
Temperature	Hypothermy	86-68 ° F		
	Normothermia	99.5 - 102.2 ° F		
	Febricula	104-106 ° F		
	Middle Fever	Thermal heat index of about 72		
	Hyperthermy	Thermal heat index of above 82		
Posture	Posture Category	Three Axis Accelerometer		
		x	y	z
	Move Freely	v	v	v
	Do not want to Move	c	c	c
	Laid Down and cannot move	c	c	c
	Keep Standing	c	-	c
	Limp	v	-	v
	Lift leg with neck movement	-	-	v
	S Line posture	-	v	-
	Turn in one direction	v	-	-
	Stumble	v	v	-
	Cross leg do not move	c	c	c
Sound	Mooing	Yes		
		No		

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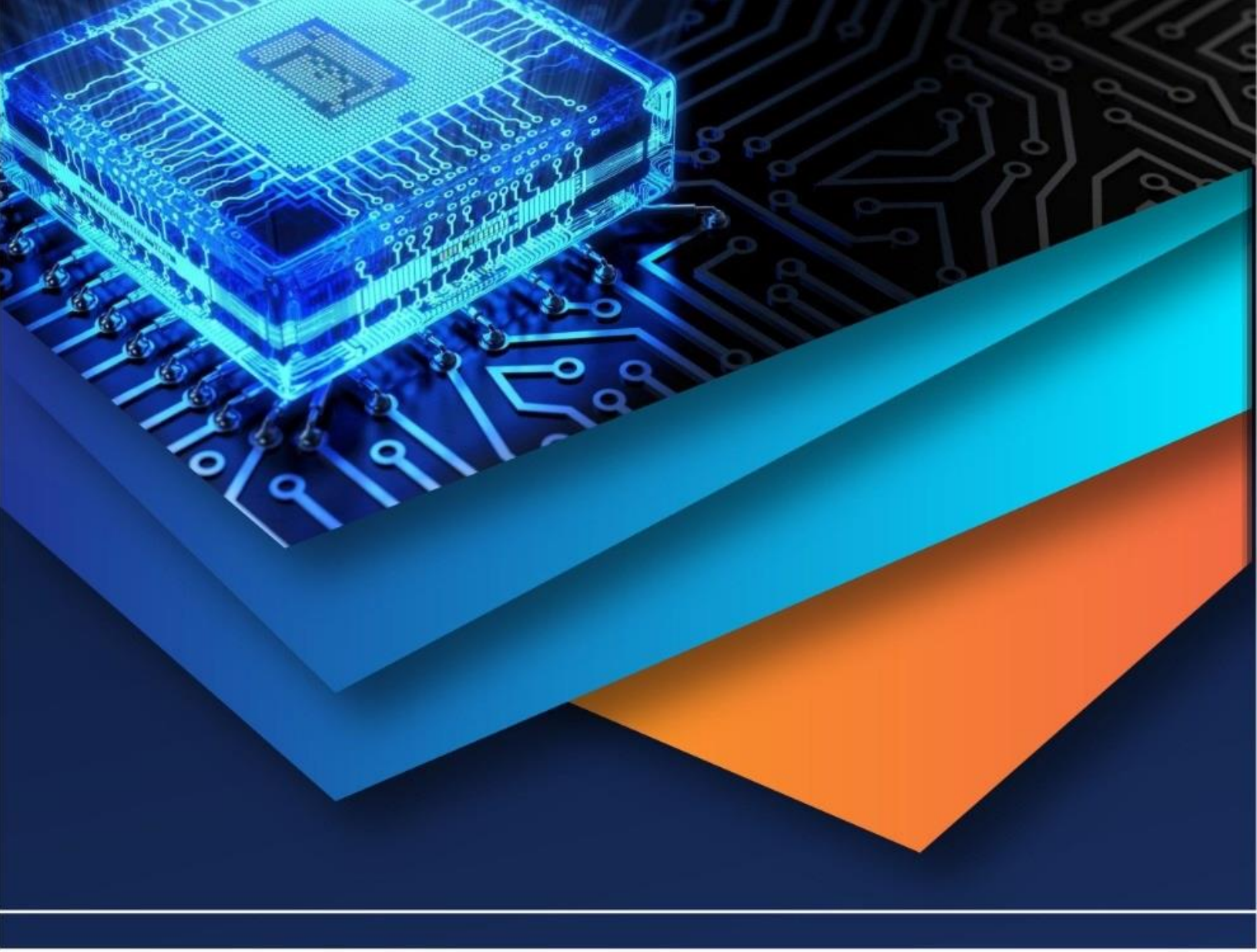

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