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Stress Detection Smartwatch

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Abstract: When a person is unable to handle their circumstances, responsibilities, and workload, stress is a natural emotion that is produced. A person's physical and mental health may suffer when the body is triggered, which can be deadly. The physical impacts of stress on a person's body can include an increase in blood pressure, a rapid heartbeat, increased muscle tension, headaches, a decrease in bodily immunity functions, and a decrease in sleepiness, among other things. The latest technology, known as smartwatches, provides the user with easy access to mobile features. Users can employ the stress-detecting capabilities of high-end smartwatches. Although they can be used to understand things better, these stress applications for smartwatches are not precise in how they operate. Heart rate variability, or HRV, is used by smartwatches and involves the intervals between each heartbeat that the sensor records. A person who has a low HRV is likely under stress. Although stress applications may not be as precise as medical equipment, they are dependable when necessary because there is a good likelihood that the data is accurate. An Electro Dermal Activity (EDA) sensor, found in some smartwatches, monitors tension by electrically altering the amount of sweat on our skin. You must spend two minutes with your palm on the watch dial to achieve the same. As an increase in heart rate is a direct outcome of stress, stress is recognized in the project utilizing heart rate. Since it is also an immediate outcome of stress, heart rate is used in the implementation. In this sector, mobile applications give users a way to explore this data graphically or in greater detail. The user of mobile applications might utilize them for medical purposes and to understand the data.

Keywords: Stress, Smartwatch, Heart rate, Mobile applications, Heart Rate Variability, Electronic Dermal Activity, Wearable Stress and Affects Detection, Galvanic Skin Response, Body Temperature.

I. INTRODUCTION

Stress is a general term that refers to any type of change that puts strain on one's body, mind, or emotions. Your body will react to stress whenever something needs your focus or attention. Everyone goes through periods of stress. Stress can be temporary or persistent. Both can result in a variety of symptoms, but prolonged stress can be harmful to one's health over the long run. Stress symptoms include changes in mood, an increase in heart rate, tightness in the muscles, headaches, and more.

The majority of smartwatches assess stress using Heart Rate Variability (HRV) technology. The difference in time between each heartbeat, or HRV, is measured. The body's autonomic nerve system (ANS), which automatically controls our heart rate, blood pressure, respiration, and digestion, is in charge of this variance. Simply put, the HRV is the variation in the time between each heartbeat rather than the same heart rate (BPM). A higher HRV is beneficial, but a lower HRV is a sign of exhaustion, thirst, and stress.

The cloud used for the data storage is Firebase's real-time database. The data is stored in JSON format inside the cloud. Data is stored and synchronized in real-time at each event that occurs in the smartwatch application. The Realtime Database provides an expression-based rules language called Firebase Realtime Database Security Rules to indicate how your data should be arranged and when data can be read from or written to. When Firebase Authentication is incorporated, developers may decide who has access to what data and how they can access it. The Realtime Database offers various features and optimizations than a relational database because it is a NoSQL database. The Realtime Database API only permits actions that can be completed quickly. As a result, it is possible to design an amazing real-time user experience that can serve millions of users without compromising responsiveness. As a result, it's crucial to structure your data effectively and take into account how others will access it. The mobile application can be used to view the stored data and present it to users as graph information which users can use to understand their heart rate activity at any time in the day.

II. OBJECTIVES

A. Existing System

Heart rate, blood pressure, and other biometrics may now be monitored and analyzed by smartwatches. The user should always open the appropriate application on the smartwatch in order to measure or read heart rate or stress. Most smartwatches do not have stress detection.

B. Proposed System

To run the app continuously while saving the sensed data to the cloud. As connected, this data is updated in real-time, allowing users to access the mobile application when necessary and analyzed the data, which is shown as a graph to comprehend their heart rate activities.

III. SYSTEM ARCHITECTURE

User Smartwatch: Here the user interacts with the smartwatch by starting the timer and stopping when required. Smartwatch contains sensors that read data as heart rate, in order to detect stress.

Storage: This is where data is stored and collected from the sensors. Storing of data will help us in fetching the data which when has to be displayed on the mobile application.

Mobile Application: This is a user interface platform where he/she can view the history of all health parameters read during the timer. Warning and stress level is displayed on the screen. Can operate the start and stop of the timer using this application. The mobile app will communicate with the local database for data and correspondingly display it.

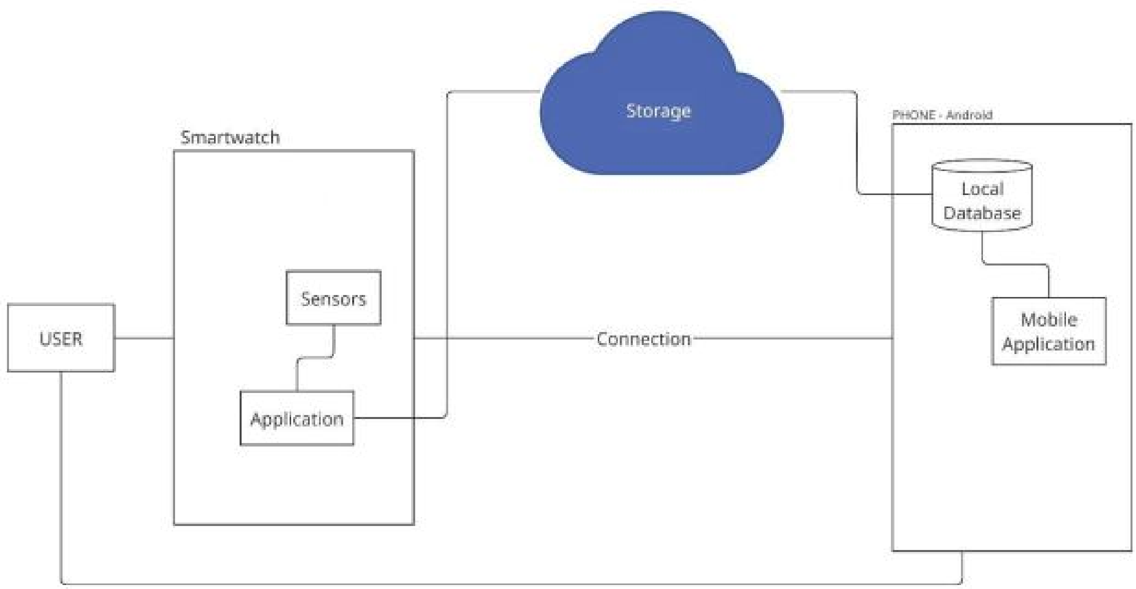

Fig 1: System Architecture

A. DFD Level - 0

The entity smartwatch is connected to various attributes such as sensors, user interface, and storage. The actions are performed on and by the smartwatch. Sensors read the data from the wrist and transfer it to storage. The storage is then linked to a mobile application to show that data is fetched to display appropriate stress warnings.

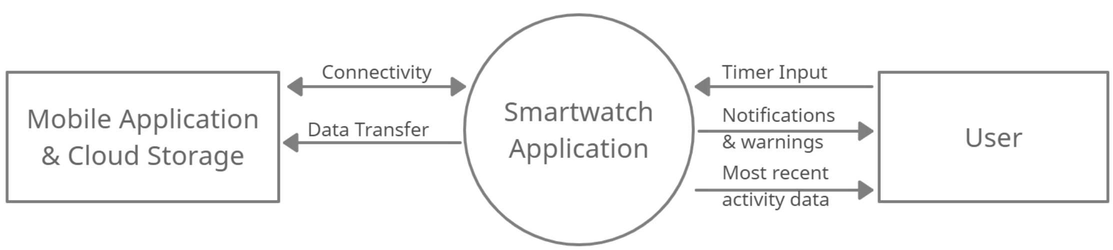

Fig 2: DFD Level – 0

B. DFD Level – 1

Smartwatch application: This performs various tasks, one is user-interaction where the individual can operate the start and stop of the timer. It functions based on closing and exiting the application. It will establish a connection between android and itself for content display and maintain consistency.

Storage: The data collected from sensors are stored and further it can be accessed for evaluation and displaying the content on the mobile application.

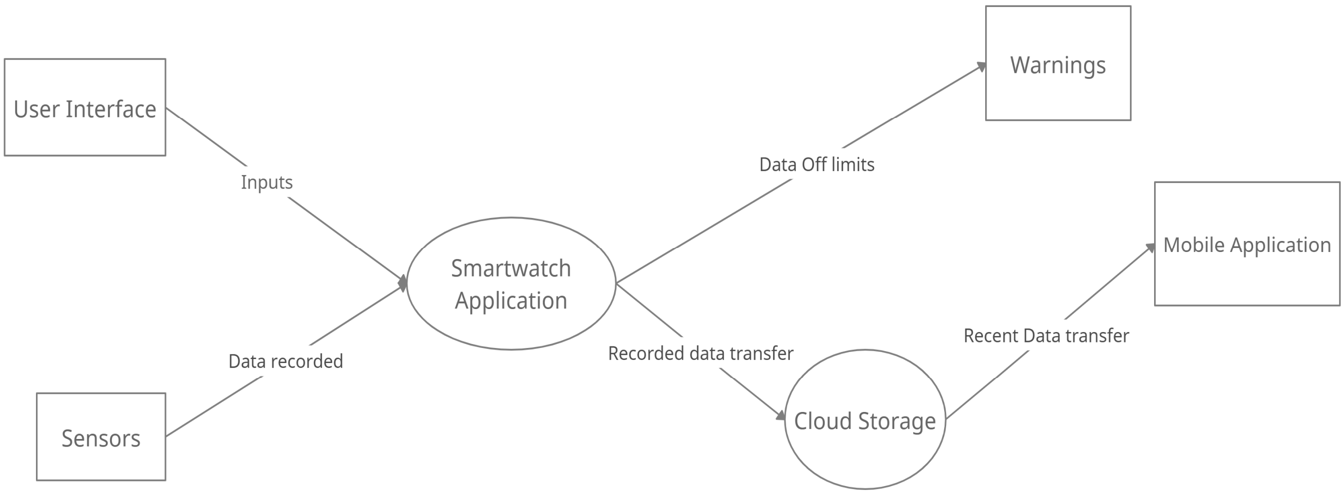

Fig 3: DFD Level – 1

C. DFD Level - 2

Smartwatch application: This performs various task, one is user-interaction where the individual can operate start and stop of the timer. It will establish a connection between android and itself for content display and to maintain consistency.

Storage: The data collected from sensors are stored and further it can be accessed for evaluation and displaying the content on the mobile application.

Mobile application: The mobile application will provide a detailed display of the recent information recorded by the smartwatch by receiving the data from the cloud storage.

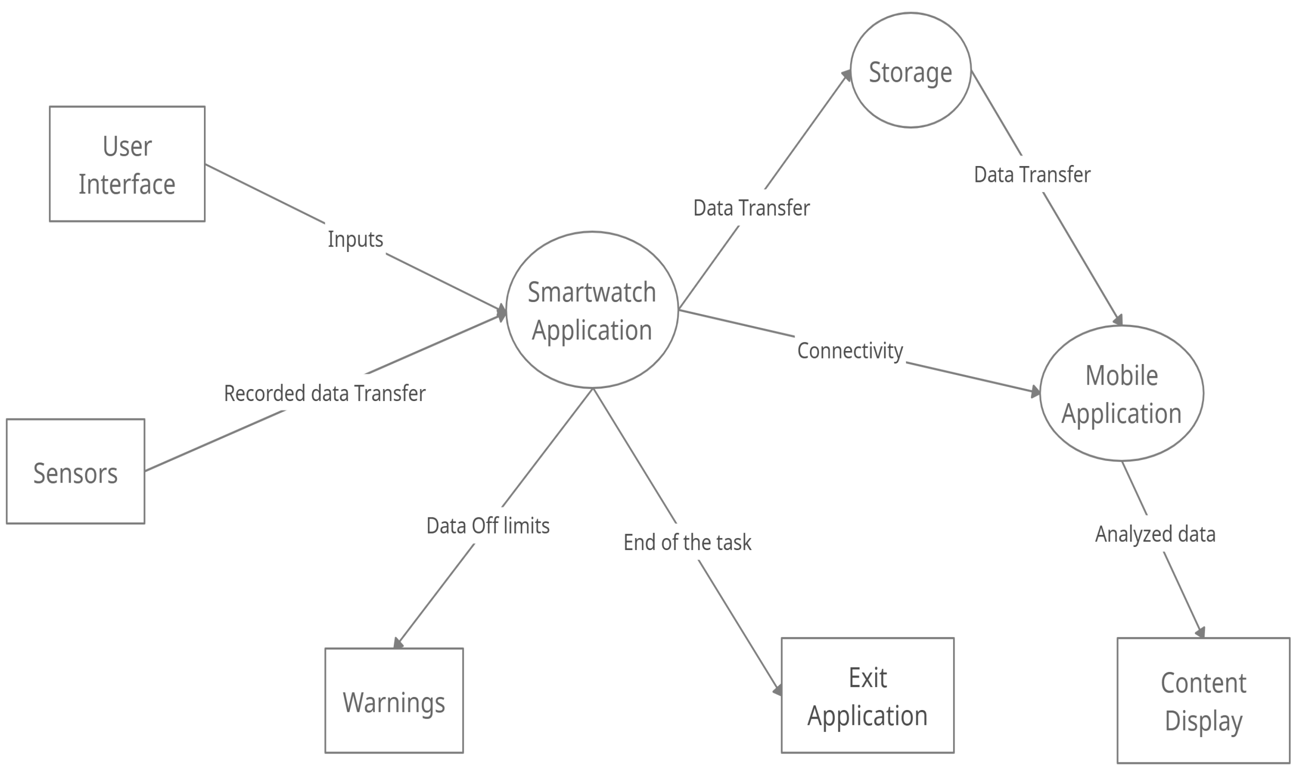

Fig 4: DFD Level – 2

IV. RELATED WORK

The smartwatch interface has many designs and ways of collecting data from sensors. The system must have a high fidelity and functionality prototype at par with the design and integration of the components. The data read from sensors must go through a series of examinations in comparison with the threshold value. The study ignites with knowledge of the threshold values calculated by a survey done on various group ages facing stress as one of the health issues. An entirely ideal system can only be developed with careful consideration of the user interface. The functionality provision should be effective and user-friendly. Regarding the integration of storage, wearable device, and mobile application.

This strategy aims to create intelligent wearables that function as partners in helping people manage stress in daily life. By focusing on how technological skills may be developed to create partnerships that take into account the person, the situation, and the right kind of assistance, the method makes a contribution to the growing field of smart wearables. As a result, by introducing new technologically enabled pathways for the treatment and care of stress, this study also advances healthcare. In addition to discussing the significance of these findings for smart wearables and stress management in general, the paper shows how their experiences managing their stress influenced our design approach. It also says that the accuracy is less and future work is required to accomplish the objective.[3]

In this work [2], we suggest a real-time method for identifying mental stress while performing various cognitive activities. Processing of GSR, RR Interval, and BT data collected by a commercial smartwatch is categorized as stress. Clinical psychological tests are used to validate the suggested unobtrusive method. In order to remove noise and movement artifacts from the data collected by the smartwatch, it is filtered and interpolated. In order to find a correlation with the stress situation, 27 features relating to GSR, RR, and BT are calculated. As a statistical test or measurement of the interdependence between the characteristics vector and the self-reported stress condition (i.e., stress/relaxation), the Mutual Information (M.I. Though each feature is retrieved, M.I. quantifies the "quantity of knowledge" acquired regarding the stress state. To train a K-NN classifier, 10 features with the greatest M.I. are chosen. To determine whether an individual is stressed or not, the authors trained various classification models using 10-fold cross-validation.

Another study examines which third-party developers have access to the sensors that the smartwatches currently on the market have. Additionally, the accuracy of stress detection utilizing various sensor combinations is being researched. Additionally, it investigated the relationship between window size and recognition rates as well as how detection rates differed between study participants. The publicly accessible WESAD dataset serves as the foundation for all of the studies. The findings demonstrate that an EDA signal is not required for user-independent stress detection, and commercial smartwatches can be used to detect stress when the utilized window length is sufficient.

The next study manifests mental and physical suffering all these emotions help us to prevent, analyze and monitor this complex challenge. WESAD is a new research based on a machine learning repository conducted by the University of California. Three different effective states—neutral, stressed, and amused—make up the WESAD data. Data from the wearable device is incorporated or chest-worn gadget. The paper shows that this data is processed using DL Processing. Further, noise is a common occurrence and it is dealt with using a filtering procedure. It made use of a deep convolutional neural network model. In addition, it claims that when compared to laboratory measurements and outcomes, procedures used to identify stress in daily life are far less accurate. [4]

V. METHODOLOGY AND EXPERIMENT

The project is deployed on both wear and mobile devices. When the project is built and run, in the smartwatch, the application starts reading and displaying heart rate at each sensorEvent or for each second. This heart rate is sent to the Firebase real-time cloud database for further usage in the project. When stress is detected by the implemented method, the next activity displaying a warning screen is shown on the watch display with a normal vibration for 5 milliseconds to inform the user that stress is detected.

In the Firebase real-time cloud storage, the data is stored each time there is a change in sensorEvent in the watch application. Each heart rate is stored along with the time it is recorded where time is a long integer value and heart rate is an int value. A new child is produced with its name as the date of the day when the application is run on a new day.

In the mobile application, a list of the dates, using the child values under the project key is shown to the user, each date representing that when clicked, on a specific date, that day's data is represented as a graph.

If the smartwatch app is run after a long gap on the same day, the gap between that time is a completely straight line btw the end value of the previous run and the start heart rate of the new run.

The peaks (with respect to the scale presented on the Y-axis), represent the highest heart rate at that time.

VI. RESULTS

The results are, that the threshold heart rate which was set to detect stress was accomplished. The threshold value being 120bpm is set according to various medical studies. The person wearing the watch will witness the display of stress or any such warning messages when their heart rate crosses the threshold value.

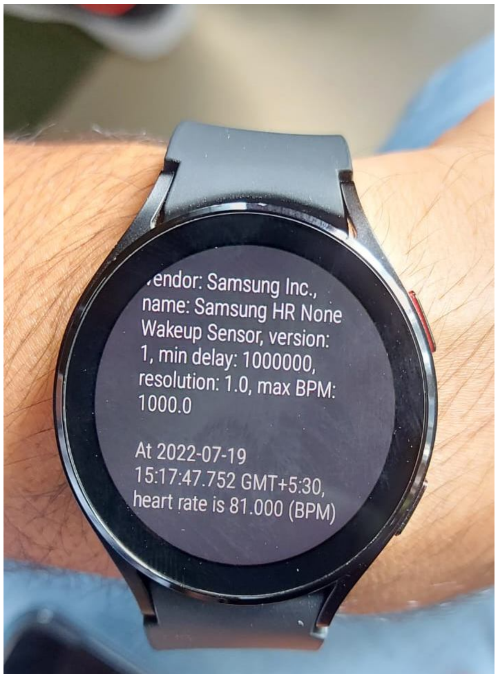

Fig 5: Smartwatch Application Interface

Fig 5 is the start page of the smartwatch application where it displays general information as the smartwatch vendor, the minimum delay between sensor events, etc. The main focus of this activity is to display the heart rate to the user at each second or when there is a change in heart rate. This heart rate is sent to the firebase real-time cloud storage.

Fig 6: Warning message

Fig 6 shows a warning message on the smartwatch application when the user starts the timer which triggers the sensors to collect the heartbeat data at that particular time and display appropriate warning messages as shown in Fig 6.

The Smartwatch application displays such a screen when the sensor data collected in real-time passes over the threshold value set prior to data analysis. So, in the above Fig 6 “Stress Detected” is displayed to the user due to their heart rate exceeding the value set to trigger such a warning.

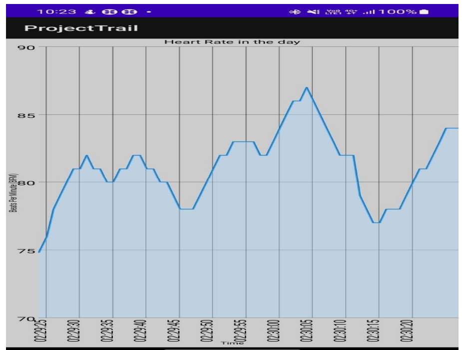

Fig 7: Mobile Application interface (Graph)

The graph can enhance the user usage of the application deployed. It is displayed using the data stored in cloud storage i.e., Firebase. All the real-time data collected from sensors are being stored in Firebase storage, using this the details on the graph are presented.

Below Fig 8 is the Firebase Connectivity module which represents the data being collected from sensors in real-time. All the sensor data collected is stored in the Firebase database. This storage helps in the easy transfer of information to the applications deployed. The data is stored in real-time when the applications of the project are connected to the internet. This helps in the exact transfer of the information for the mobile application to be presented as a graph.

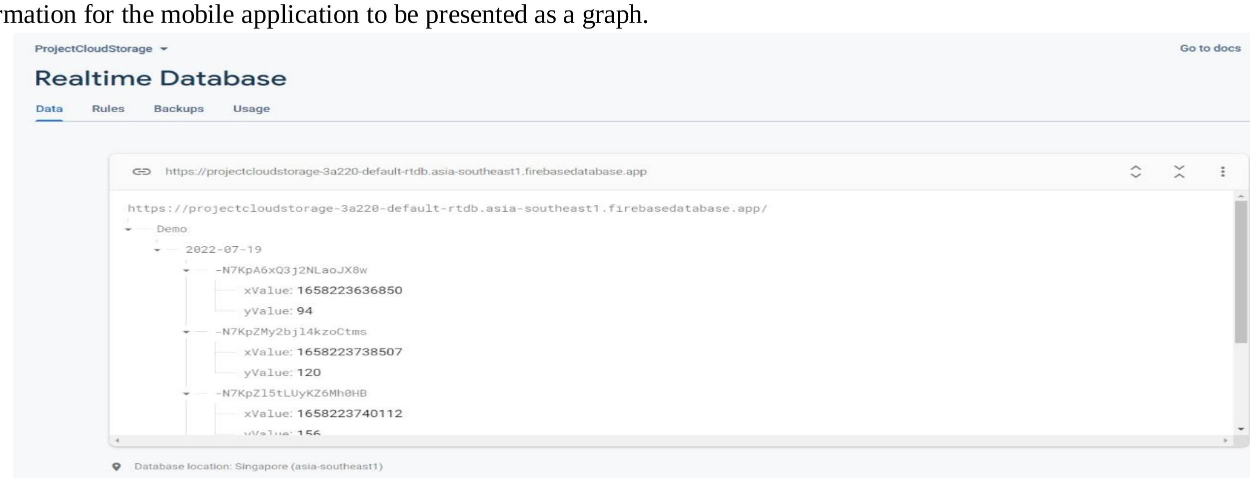

Fig 8: Firebase Connectivity

VII. CONCLUSION

The main problem discussed is the increase in stress levels undergone by people of various age groups. The objective of the project is to help the user with necessary warnings when they are stressed during a task performed. Thus, the solution to the problem, we implemented a smartwatch prototype that will detect stress and also help in managing a specified work according to the user’s choice. These recorded data are displayed using a mobile application where the data is transmitted using cloud computing.

The primary focus of our project is to help users understand their regular activities and times when they undergo stress while doing a job. The recorded data can also be used for medical purposes by showing the data to a doctor and taking measurable actions on their health. This also helps the user to understand their health condition based on their heart rate and be safe around so that there will be fewer chances of any health-related diseases.

The project can also help in the development of major smartwatch applications and methods in different modes like a workout, walking, etc., and help them to get more accurate information regarding their stress while doing a particular job.

Thus, we conclude on a note that the project helps society in ways so that it helps users with their heart-related, stress decreasing and also in the development of applications and technology.

VIII. FUTURE WORK

The project needs to be enhanced with a user interface; more detailed information should be displayed on the mobile application with better user interaction as the application only presents line graph data or the recorded heart rate values.

As we know the stress detected is not accurate enough when compared to laboratory values. The project needs optimization of the methods used to detect stress or use more recent algorithms which produce results with minimum variations.

IX. ACKNOWLEDGMENT

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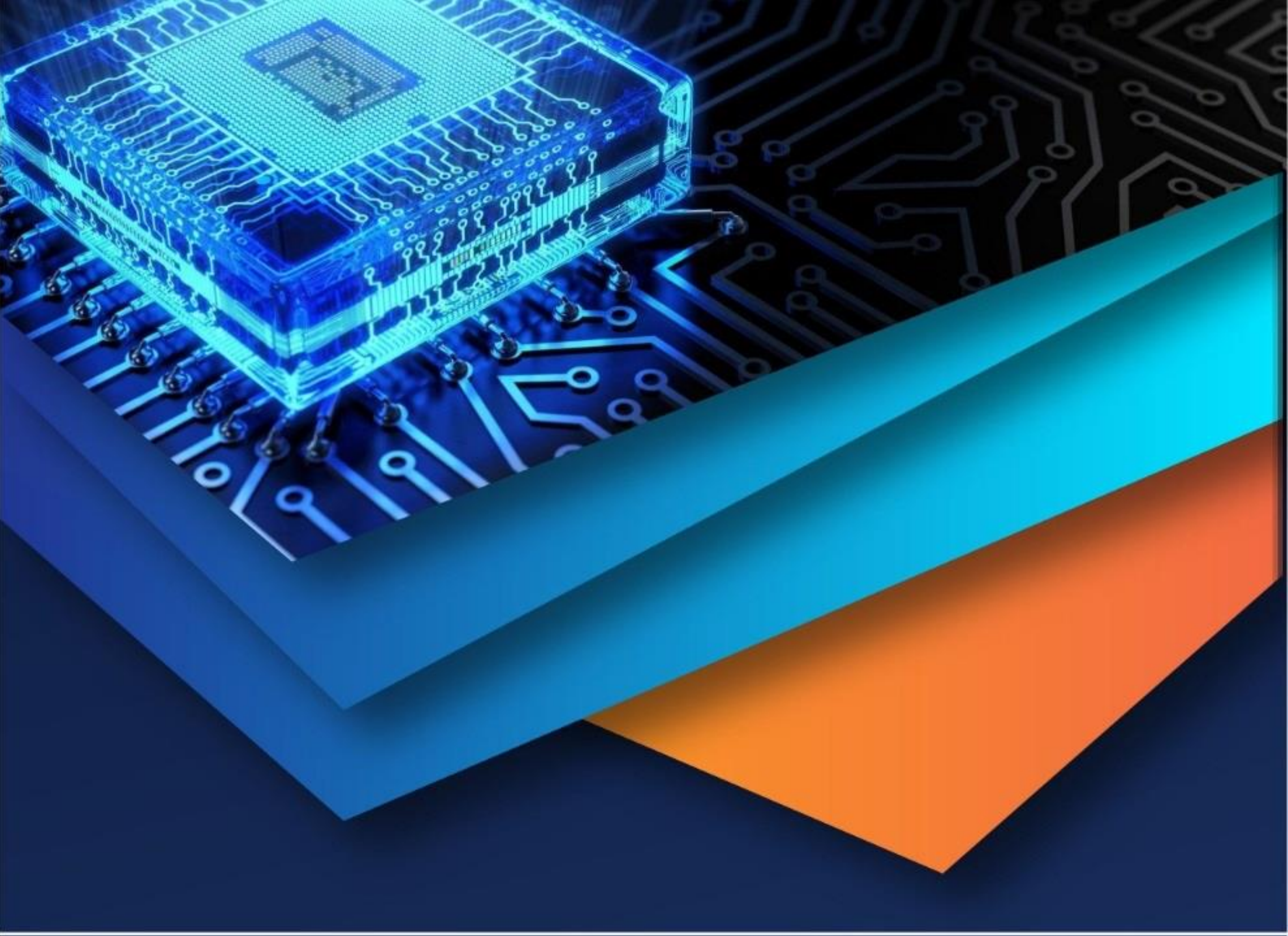

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