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IOT Based Smart Electric Vehicle

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Abstract: This project introduces a smart electric vehicle (EV) system designed to make transportation cleaner, safer, and more efficient. It combines two ways of charging the vehicle using solar power and the traditional electric grid so that it can always stay powered, even if one source is unavailable. At the heart of the system is an advanced Battery Management System (BMS) that keeps the battery healthy by monitoring its charge levels, balancing power across cells, and preventing damage.
To ensure safety, the vehicle also has a thermal monitoring system that keeps track of temperature in real-time. If it senses any risk of overheating, it can take preventive action. All this data battery health, charging status, and temperature is sent to the cloud using IoT (Internet of Things) technology, so it can be monitored remotely from anywhere. This smart setup helps in maintaining the vehicle, predicting issues before they happen, and ensuring the system runs efficiently.
By combining clean energy, smart monitoring, and automation, this project aims to support eco-friendly transportation while improving safety and Performance.
Index Terms: Solar and grid charging , Thermal monitoring system, temperature sensor , current sensor, battery monitoring , IOT, fan cooling, Smart EV.

I. INTRODUCTION

With the growing need for cleaner ways to get around, electric vehicles (EVs) are becoming more popular. They're better for the environment and help cut down on pollution and fuel use. But regular EVs still have some problems like needing a long time to charge, limited distance they can travel, battery issues, and not being able to track how the vehicle is doing in real time.That's where this smart EV system comes in. This project is all about making electric vehicles smarter and more reliable by adding modern tech. The system uses two ways to charge solar power and grid electricity so the vehicle can keep going no matter the weather. If there's sunlight, the car can charge from solar panels either on the vehicle or at a solar station. If there's no sun, like at night or on rainy days, it automatically switches to regular electricity from the grid.

It also includes a smart Battery Management System (BMS), which basically keeps an eye on the battery's health. It checks things like how much charge is left, the battery temperature, and whether it's being overused. This helps the battery last longer and keeps it working safely.

To avoid overheating, the system has a thermal monitor that keeps track of how hot the battery and motor are. If they get too hot, it alerts the user or turns on cooling systems by itself.And here's the best part everything is connected through IoT . This means you can check your car's status anytime, anywhere using a mobile app or website. You can see whether it's charging, how the battery is doing, if it's too hot, and even choose between solar or grid power.

In short, this smart EV system makes your electric vehicle safer, more energy-efficient, and easier to manage. It's like giving your car a brain and a voice—so it can look after itself and keep you informed.

II. RELATED WORK

As electric vehicles (EVs) become more common, people have been looking for better and more eco-friendly ways to charge them. Two popular methods are solar charging and grid charging—and combining both is showing a lot of promise.

A. Solar Charging

Many researchers and companies have tried using solar panels to charge EVs. In some cases, these panels are placed right on the car's roof to collect sunlight during the day. While this doesn't give a full charge, it can help power small systems or slightly extend how far the car can go.

There are also solar-powered charging stations where vehicles can park and charge using electricity made from sunlight. These are especially helpful in sunny areas and can reduce the need to use traditional electricity. Examples include solar carports or special solar EV hubs where cars charge during the day from stored solar energy.

B. Grid Charging:

The most common way to charge an EV today is by plugging it into the electric grid. It's simple and reliable, and it works at any time—day or night. Over time, grid charging has gotten faster and more efficient. Some systems even charge during off-peak hours when electricity is cheaper. However, the main drawback is that most of the grid electricity still comes from fossil fuels, which isn't as clean as solar power.

C. Combining Solar and Grid Charging

More recently, projects have started mixing both methods. In these hybrid systems, the vehicle charges from solar energy when it's available (like on sunny days), and switches to grid power when solar isn't enough (like at night or during cloudy weather). This gives the best of both worlds—clean energy when possible, and continuous charging when needed. Some advanced systems even store extra solar energy in batteries so it can be used later. A few can even send power back to the grid, making the whole system smarter and more efficient. While a lot of great work has been done in this area, most solutions are either complex or expensive. This project builds on those ideas to create a simple, cost-effective, and smart system that combines solar and grid charging—designed to be easy to use and track with real-time updates.

Electric vehicles (EVs) run on powerful batteries, and keeping those batteries healthy, safe, and long-lasting is really important. That's why a lot of research has gone into developing Battery Management Systems (BMS) and thermal monitoring solutions. These two technologies work together to make sure the EV battery stays in good shape and doesn't overheat or get damaged.

D. Battery Management Systems (BMS)

Think of the BMS as the battery's personal caretaker. Its job is to constantly check things like how much charge is left, the voltage levels, and how much power is going in and out. Over the years, experts have worked on improving BMS to be smarter and more reliable.Some systems make sure all the battery cells charge evenly so that one part doesn't wear out faster than the others. Others track the overall health of the battery and help prevent issues like overcharging or draining the battery too much, which can shorten its life. The latest BMS designs can even predict when a battery might start to fail—and take steps to avoid it.

E. Thermal Monitoring Systems

Batteries and motors can get hot, especially during long drives or fast charging. If that heat isn't controlled, it can lead to serious problems. That's where thermal monitoring comes in Many EVs today are equipped with sensors that keep an eye on temperatures inside the battery and motor. If the system detects that things are heating up too much, it can send alerts, slow down charging, or turn on cooling systems like fans or liquid coolers. Some systems even shut things down automatically if temperatures reach a dangerous level.

F. Working Together

In newer and smarter EVs, the BMS and thermal monitoring systems are connected. They work together so the car can make better decisions—like reducing power or turning on cooling if the battery starts to heat up. Some vehicles also let you see this information on a screen or app, so you always know how your battery is doing. While a lot of progress has been made, most of these smart features are still found in high-end or expensive EVs. The goal of this project is to bring these important technologies together into one smart, affordable system that offers real-time monitoring, safety, and better battery performance—something that everyday users can benefit from.

III. BLOCK DIAGRAM

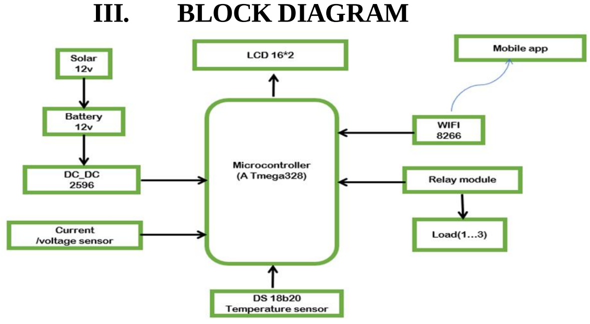

Fig A : Block diagram SEV

IV. COMPONENTS

1) *Arduino Uno*

Arduino is a prototype platform based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed and a ready-made software called Arduino IDE which is used to write and upload the computer code to the physical board.

The key features are: Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.

*You can control your board functions by sending a set of instructions to the microcontroller on the board via Arduino IDE

*Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. You can simply use a USB cable.

*Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.

Finally, Arduino provides a standard form factor that breaks the functions of the microcontroller into a more accessible package.

2) *Bluetooth Module*

In a smart electric vehicle, Bluetooth is like a wireless handshake between your EV and your smartphone. It helps you stay connected to your vehicle without needing any cables and gives you handy info right on your phone.

Check What's Going On Inside the EV Through a mobile app, you can instantly see useful info like:*How much battery is left *Whether the EV is charging from solar or grid power *If anything is getting too hot*Alerts if something's not rightAll this happens in real time, without needing to open the car or plug anything in.

3) *Current Sensor*

The current sensor measures the current flowing into and out of the battery, essential for tracking the battery's load and discharge rates. Sensors like the ACS712 current sensor are commonly used for this purpose, as they can provide both AC and DC current measurements.

4) *Temperature Sensor*

The temperature sensor continu- ously monitors the battery's thermal status, detecting any rise in temperature that could impact battery health and safety. A common choice for this type of application is the LM35 tem- perature sensor, which outputs a voltage directly proportional to the temperature. But in this application we are using DS 18b20 When the temperature exceeds a pre-set threshold, the sensor sends a signal to the Arduino, prompting it to activate the cooling fan.

5) *Solar Panel*

Imagine being able to charge your electric vehicle using just sunlight. That's exactly what solar panels allow you to do. They take energy from the sun and turn it into electricity that can charge your EV's battery—clean, quiet, and free once the system is installed. Solar panels are usually placed on the roof of a building, a carport, or even directly on the EV's roof. When sunlight hits these panels, they generate electricity. That electricity flows into a charger (and sometimes through a battery storage system), and then into your EV.So instead of depending only on the electric grid (which often uses coal or other non-renewable sources), your car is being powered by the sun—a natural, renewable energy source.

6) *Relay Module*

Imagine a relay as a tiny automatic switch inside your electric vehicle that knows when to turn things on or off — like a super-smart helper working behind the scenes.In a smart EV, especially one that has thermal monitoring and a Battery Management System (BMS), this little device plays a big role in keeping everything safe and running smoothly. If the car starts getting too hot maybe the battery or motor is warming up too much the thermal monitoring system notices it.Then the relay jumps into action: It can turn on a cooling fan or system to cool things down.Or, if it gets too serious, it can cut off charging or power to stop things from getting worse.

7) *Battery*

The battery is the primary component that stores and supplies energy to the system and other devices connected to it. In electric vehicles or renewable energy setups, the battery's performance, health, and longevity are crucial. The BTMS focuses on keeping the

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battery within optimal operational limits by managing temperature, voltage, and current conditions. The battery type used (such as lithium- ion) typically requires careful temperature regulation and monitoring of charge/discharge cycles to prevent degradation and ensure safety.

8) Cooling Fan

The cooling fan helps regulate the battery temperature by circulating air around the battery pack. The Arduino controls the fan's operation based on data from the temperature sensor. When the battery temperature exceeds the safe threshold, the Arduino signals the fan to turn on, helping cool down the battery. By maintaining adequate airflow, the fan prevents hotspots and reduces the risk of overheating, which could impact battery efficiency and shorten its lifespan

9) LCD Display

The LCD display allows real-time monitoring of data such as temperature, voltage, and current readings. Typically, a 16x2 screen is used, providing clear visual feedback on the battery's status. The Arduino updates the display in real-time, showing data that enables operators to assess battery conditions quickly

10) Chassis

This is used to implement all the component of EV or support the assembly of vehicle .This is backbone of electric vehicle.

V. SIMULATION AND HARDWARE PROTOTYPE ANALYSIS

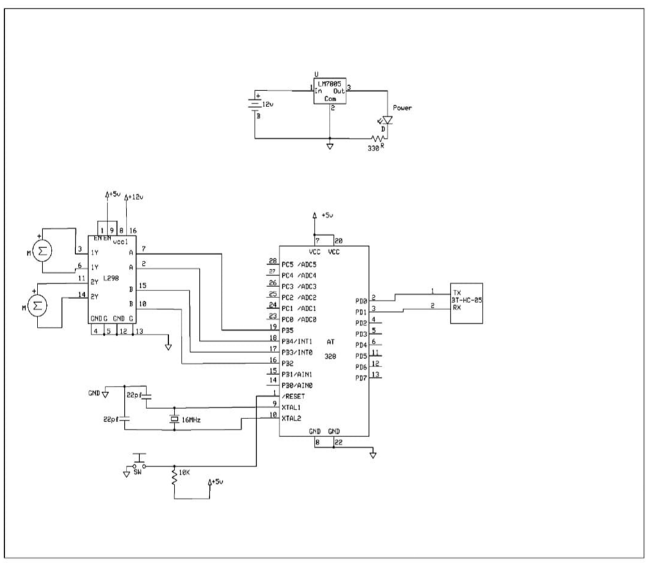

Fig B : Circuit Diagram

An electric vehicle (EV) operates using an electric motor powered by a rechargeable battery pack. The battery can be charged through two primary sources: external charging and solar energy. In external charging, the EV is connected to a power outlet or charging station, where the onboard charger converts incoming AC or DC electricity into the appropriate form for battery storage. This method provides a fast and reliable way to fully charge the battery. In addition to grid-based charging, the EV is equipped with integrated solar panels—typically mounted on the roof or body—that capture sunlight and convert it into electrical energy using photovoltaic (PV) cells. This solar energy is then managed by a solar charge controller and fed into the battery, supplementing the main charge. Although solar charging alone is usually not sufficient to fully charge the vehicle, it helps extend the driving range, power auxiliary systems, and reduce reliance on the grid, especially in sunny environments. Together, these two charging methods enhance the vehicle's flexibility, energy efficiency, and sustainability.

We have also connected the current sensor, voltage sensor, temperature sensor for the monitoring of the vehicle. If the voltage, current, or temperature of the battery or vehicle increases till the limit then these current, voltage and temperature sensor will sense this increased limit and pass this signal of increased values of the parameters to the Arduino uno which is used as the controller in the system will receive this signal and will display this signal on LCD and also on the mobile app through wifi esp. This monitoring will increase the safety of the vehicle by informing this to the owner of the vehicle.

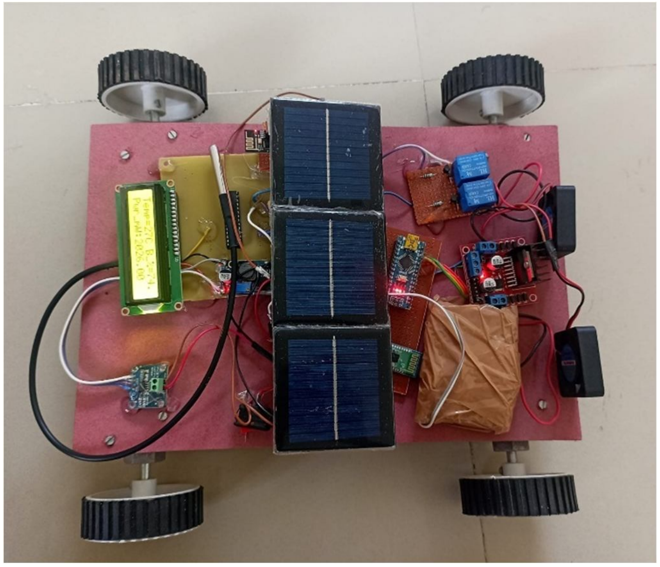

Fig C : Electric vehicle Prototype

Above figure shows the hardware prototype of Iot based smart electric vehicle which is operated via Bluetooth module .
In this hardware we are used solar and grid power to charge the battery and BMS is used to monitor the current, voltage, temperature and battery percentage to keep the vehicle operator up to date . we are used a LCD display of 16*2 for real time monitoring of electric vehicle paramerters . also we are used thermal monitoring system to monitor the vehicle circuit and battery temperature to avoid the unexpected fire and accidents which can cause the death of vehicle operator.
All the data of vehicle we are saving on thinkspeak app site for the future purpose or fault detection.
In this project for thermal manegment we are giving three alarms at three different temperature range for first 35 first alarm starts for operator indication, at 40 temp first fan will start for cooling purpose and at 45 temp second fan will start to cool down the circuit and battery temperature which is going cause the fire hazards in vehicle.

VI. RESULT ANALYSIS

Initialization of the EV is shown in Fig. D. The process of starting the system when the EV State and other values are displayed on the display. There will be no warning on the notice site when the Arduino Uno is powered on, but it will be displayed on the LCD display.

Fig D : LCD Display Output

An overview of the battery management system for electric vehicles where each data element has its own significance, such as battery information. After the system has been installed and connected to the battery and solar panel, the battery's charge percentage will be displayed on the LCD display for the entire system. The actual voltage supply of the vehicle can be determined by connecting the voltage sensor to the battery. The voltage sensor synchronizes the voltage in each battery cell and measures the transmission voltage. The actual current of the battery can be measured. The current sensor measures the current flow and balances the current in each battery cell. when the temperature sensor was connected to the battery. This temperature sensor monitors the temperature continuously and performs the function of thermal management. This system will inform the user and display the nearby location on the LCD display.

A. IOT interface for Vehicle Parameter Monitoring

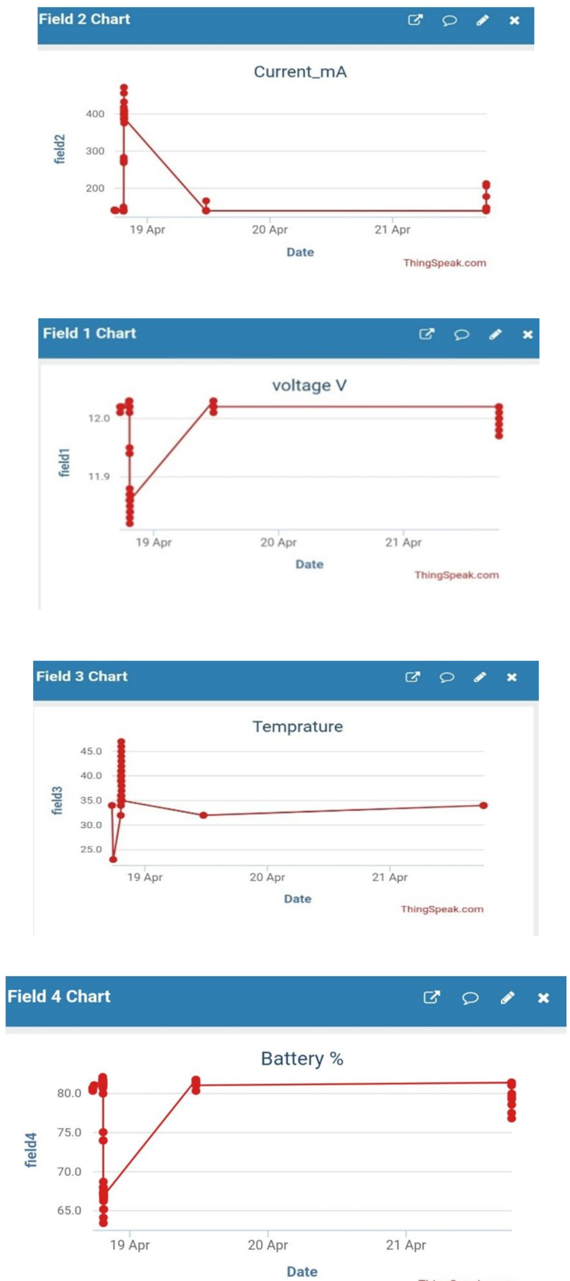

Fig E : vehicle parameter on mobile application

The proposed system can monitor the battery condition stated in the proposed model using an Android smartphoneshown in Fig. 9. User can monitor the charge, voltage, current, nearest charging station in a graphical user interface with graph view.

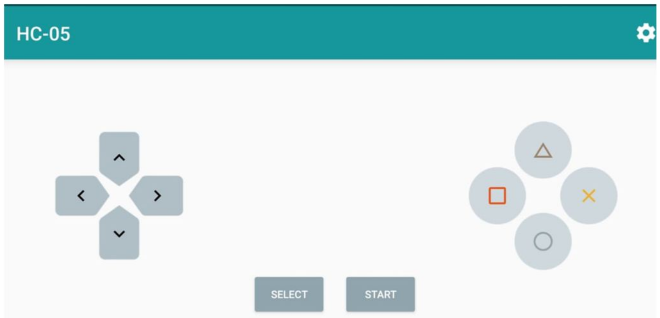

Fig F : Vehicle control

VII. CONCLUSION

This research emphasizes the potential of a Smart Electric Vehicle (SEV) system as a viable and scalable solution to many of the limitations faced by conventional electric vehicles. Through the integration of solar-assisted charging, an optimized Battery Management System (BMS), real-time thermal monitoring, and a mobile communication interface, the SEV offers a multifaceted approach to improving battery efficiency, extending driving range, and enhancing safety.The incorporation of solar power significantly reduces dependency on grid-based charging, while smart BMS ensures efficient power management and prolongs battery life. Real-time monitoring and alert systems offer an added layer of security by detecting thermal irregularities early and enabling preventive actions. Moreover, the mobile interface bridges the communication gap between the system and the user, promoting better interaction and control.As electric vehicles continue to evolve as a cornerstone of sustainable mobility, systems like the one proposed in this paper can lay the foundation for next-generation transportation. The SEV system not only meets current performance demands but also sets the stage for future enhancements including AI-driven energy optimization and smart grid compatibility. Therefore, this project contributes to the ongoing transformation of electric vehicle technology towards greater reliability, sustainability, and user-centric innovation.

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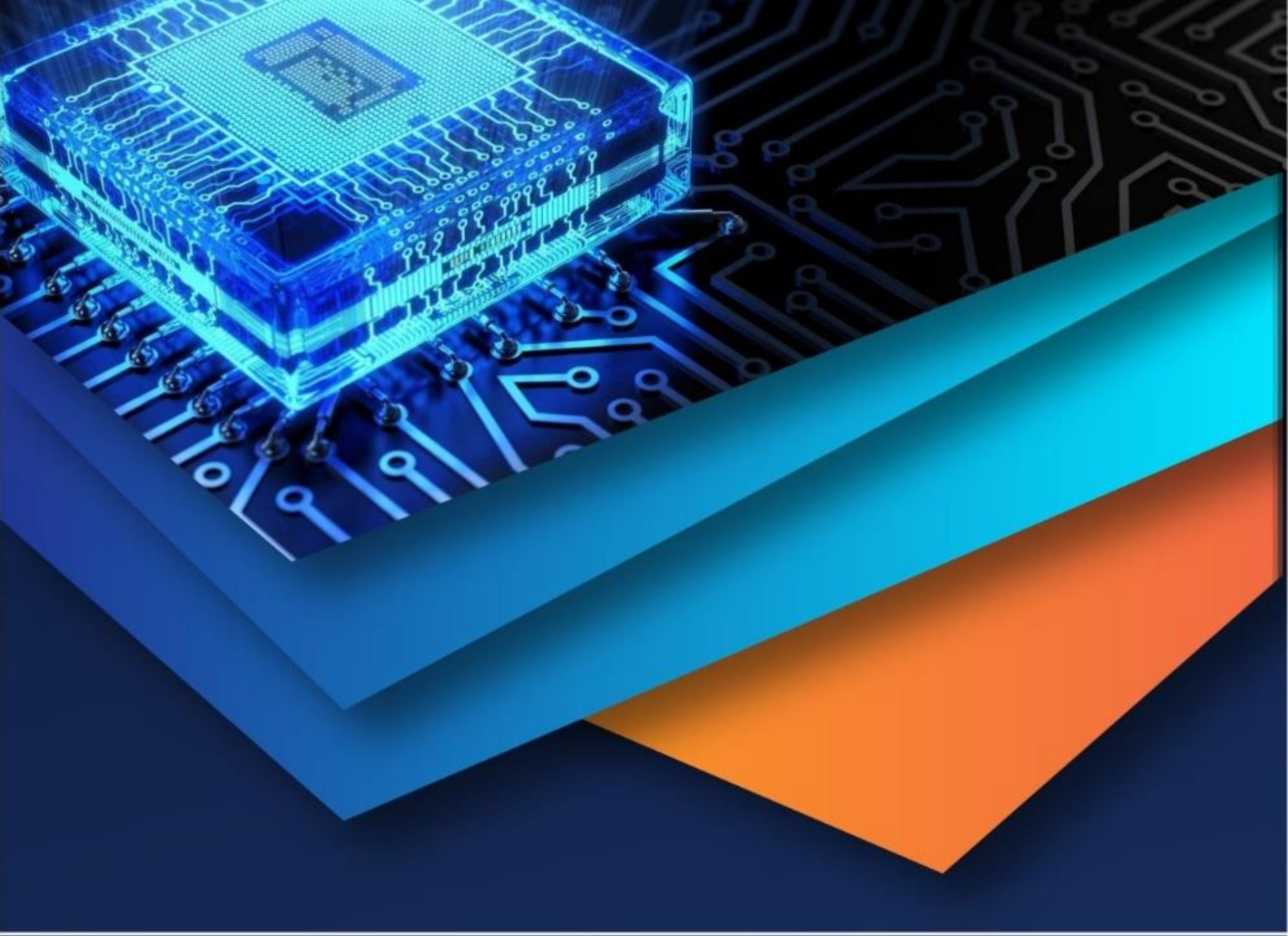

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