iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** III **Month of publication:** March 2019

DOI:

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: 6.887
Volume 7 Issue III, Mar 2019- Available at www.ijraset.com

Automation of Material Hanging Unit of a Cement Plant using ECS and PLC

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Abstract: ***Cement plays a significant role in any type of construction. Typical cement plant processes are quarrying, raw material handling, crushing, preheating, kiln phase, cooling, grinding and final packaging. The equipments used to carry out different processes are crusher, conveyors, kiln, coolers, bag filters, air sluice, rotary feeders etc. It is very difficult to control and monitor a plant involving 100s of motors manually. Thus it is high time to move towards automation of such a process plant. The project deals with automation of a particular department of a cement plant i.e., additive transport and reclaiming. Here the raw materials are reclaimed from a pile using a reclaimer. The material is then transported through belt conveyors and directed into silos. SCADA is used to monitor and control the department from a remote station. The supervisory control and data acquisition is communicated with the PLC for acquiring data from the field. The graphics for the material handling department is designed with the help of a supervisory system i.e., expert control system, which is a product of FLSmidth. The logics for the programmable logic controller are done in Siemens step7 platform. The hardware used is Siemens S7 400.***
Keywords: SCADA, PLC, ECS, DCS.

I.INTRODUCTION

Cement plants are huge systems that use lots of large and small equipments. The cement manufacturing process includes quarrying, raw material handling, crushing, pyro-processing, grinding and packing. There are number of equipments installed in all these units. Cement is basically a powdered material which develops a strong adhesive quality when combined with water. The two-main important raw materials required for the manufacturing of cement are limestone and clay. Limestone is obtained from quarrying and it is transported to the plant through heavy trucks. These substances are fed into the feed hopper and then crushed into fine particles. The crushing process is done in two stages. The first one is the impact type crushing used for raw crushing and the second one is hammer crushing. The crushed material or the meal feed must be made homogenous to form the raw meal. Then the raw meal must be converted into clinkers. Next, it passes to the pre-heater tower. Here, the raw meal is preheated by using the excess heat from the kiln. The raw meal is then collected in the cyclones in the tower that is heated by counter current gas flow. It is called the pyro-process. Calciner is a large hollow reactor where fuel is burned to maintain a temperature. It is the first stage where raw meal undergoes a chemical reaction to form clinkers.

Rotary kiln is a slowly rotating fire brick like steel cylinder. The clinker nodules fall into the clinker cooler. The crossbar cooler is used to cool down the clinker by the flow of cooling air. Next, the clinker is passed into the crusher. Gypsum is added to the clinker for the strength and hardening purposes. Ball mill is used for grinding the cement mixture. By the cascading effect, these steel balls crush and grind the mixture and pass it to the sepax separator. Cement silo is used for storage of the cement which is then packed in sacks and transported in trucks for various purposes. Supervision of all these units on site is very difficult and also less efficient. In order to reduce the cost, save time, increase efficiency and to reduce manpower, the cement manufacturers are moving towards automation technology.

FLSmidth is a leading company which provides machinery and services to the global cement industries for the past 125 years. This proposed system implements the control of the cement plant with the help of ECS. ECS is the SCADA developed by the FLSmidth. The Siemens PLC will communicate with ECS through communication ports. This automated system will help in reducing manpower, time and saves cost.

II.LITERATURE SURVEY

Vinod Kumar.E (2011) analyzed the importance of process automation. He stated that process automation is an important component of modern cement production. The versatility of the system in an exceedingly plant defines the potency of the plant operation and therefore the price leadership a cement producer can do within the market. ABB's Distributed Control System (DCS) has been widely used across all industry segments for many decades. ABB's philosophy during this field has been a path of continuous evolution protective existing customer's investments in addition as conveyance the newest IT technologies in

an exceedingly safe and secure manner to the industrial world. Its most successful latest 800xA DCS system may be a cluster of ancient industrial controls, open industrial field bus network topologies and the latest technology in the IT world. The software system engineering and image graphics is standardized by mistreatment cement method management libraries. In this paper, he discussed the above mentioned technologies and a cost efficient application of the same.

Ruchi Harchandani et al., (2014) developed a control system is for the kiln mill drive used in Cement Industry using PLC, and which can be interfaced using SCADA. Automation of manufacturing operations helps in increasing the production, improving the product quality, enhancing the safety of the operators as their role get transformed to supervisors and decreasing the cost of production. A Programmable Logic Controller (PLC) is nowadays key component for Industrial Automation. PLC helps in making the automation more flexible. SCADA systems became popular to arise the efficient monitoring and control of distributed remote equipment. Cement plants area unit one in all the biggest shoppers of energy. Their power prices account for regarding fifteen – twenty p.c of the entire cost. The large fans and motors used in the production process consume a major part of electrical energy. With the help of Variable Frequency Drives (VFDs) the energy consumption can be reduced from 90 kWHs/ton to 70 kWHs/ton of cement produced. VFDs offer much more flexibility in operating ranges like speed variation from 0 to 100 percent and a considerable reduction in maintenance costs

Sathish E et al., (2017) identified the importance of a centralized monitoring and control in order to ensure the belt conveyor operation safe and reliable. The main objective of the proposal is to monitor and detect the fault occurring in the coal conveyor using PLC. Faults like belt snap faults, oil level reduction fault, fire occurrence faults in the belt conveyor are not identified properly and thus belt conveyors are badly affected. In order to avoid this sort of significant conditions, he applied numerous forms of sensors within the operations exploitation PLC to produce correct protection for the belt conveyor in Thermal Power Plant. Manual control was more disadvantageous and is being the major reasons for frequent accidents. In order to reduce these accidents and for increasing further enhancements, automation was used. All parameters was processed, controlled, and managed in the coal conveyor with help of sensors and PLC.

Akash Samanta et al., (2012) found that the market demand of cement to be increasing continuously but most of those plants weren't up to the mark technologically. They were very inefficient, not so eco-friendly and had very low production speed. Keeping in mind the significance of these industries, an integrated solution of material handling department in cement industry was presented in this paper to meet the increasing production needs. This PLC or HMI based controls were not only cost-effective method but also improved the control system longevity and ultimately reduced the total cost of operation over the life of the system. The whole automation method was done victimization programmable logic controller (PLC) that has variety of distinctive blessings like speed, responsibility, less maintenance price and re-programmability. The whole system has been designed and tested mistreatment GE, FANUC PLC.

III. MATERIALS AND METHODS

A. Expert Control System (ECS)

Fig.1.ECS QCX

ECS is the supervisory control and data acquisition system developed by FLSmidth private limited as shown in Fig.1. Supervisory management and knowledge acquisition could be a system of code and hardware parts that enables industrial organizations to

1) Control plant processes locally or at remote locations
2) Monitor, gather, and process real-time data
3) Directly interact with field devices such as sensors, valves, pumps, motors, and more through human-machine interface (HMI) software
4) Record events into a log file

B. Simatic S7-400 PLC Software

The Siemens S7-400 universal controller saves an installation space and features a modular design. A wide vary of modules will be accustomed expand the system centrally or to form decentralized structures in keeping with the task at hand, and facilitates a cheap stock of spare parts. Simatic is known for continuity and quality. The Simatic Step 7 V5.5 is used as shown in Fig.2.

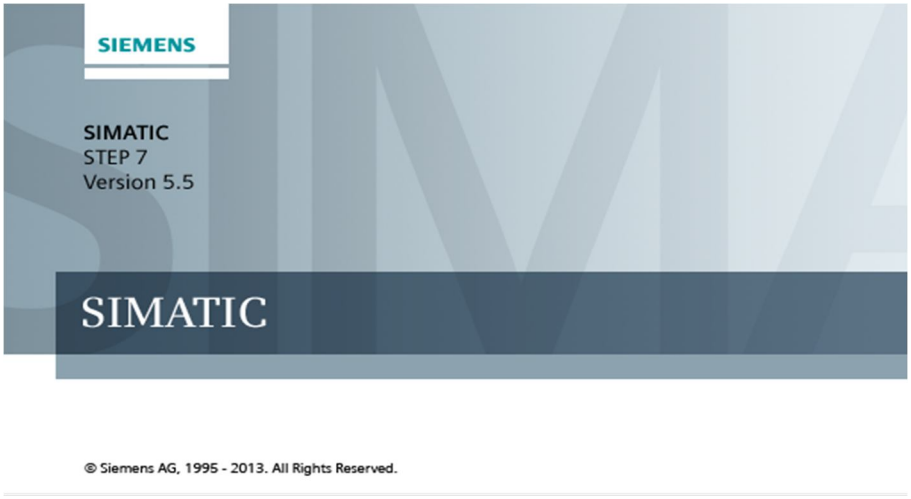


Fig..2. Simatic S7 Software

C. Simatic S7-400 PLC hardware

SIMATIC S7-400, rack UR2, central and distributed with 9 slots, 2 redundant PS can be plugged in was used as shown in Fig.3. The universal rack can act as both central and expansion rack. It has both Peripheral bus and the Communication bus. So all the plc modules including IOs, Function modules and communication processors are installed on this rack and communicate with each other.

Fig.3. Simatic S7 400 universal rack with 9 slots

D. ECS Design

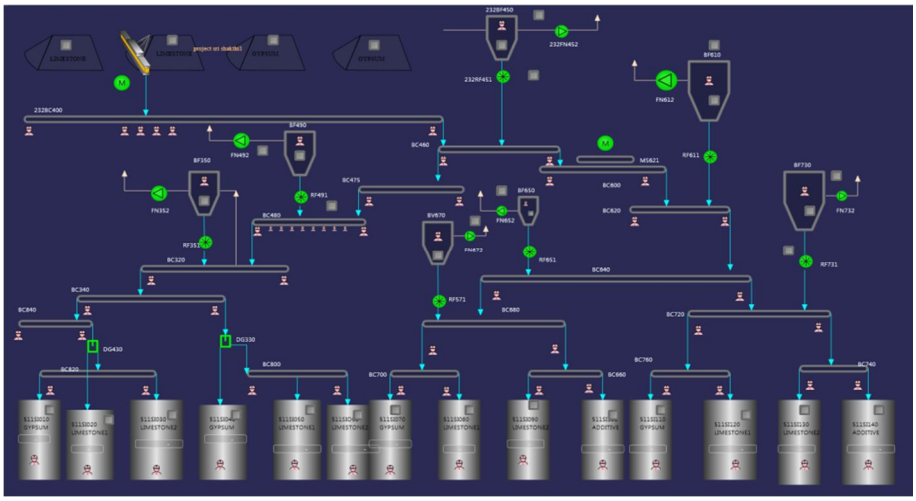


Fig.4. ECS design

The Expert Control System acts as the HMI for monitoring and controlling the process plant. The graphics for the material handling department was designed as shown in Fig.4.

E. PLC Programming

The PLC logics were developed in Simatic Step7 (S7) V5.5 Siemens Software. The programming can be done in any of the three logics. They are statement list (STL), ladder logic (LAD) and function block diagram.

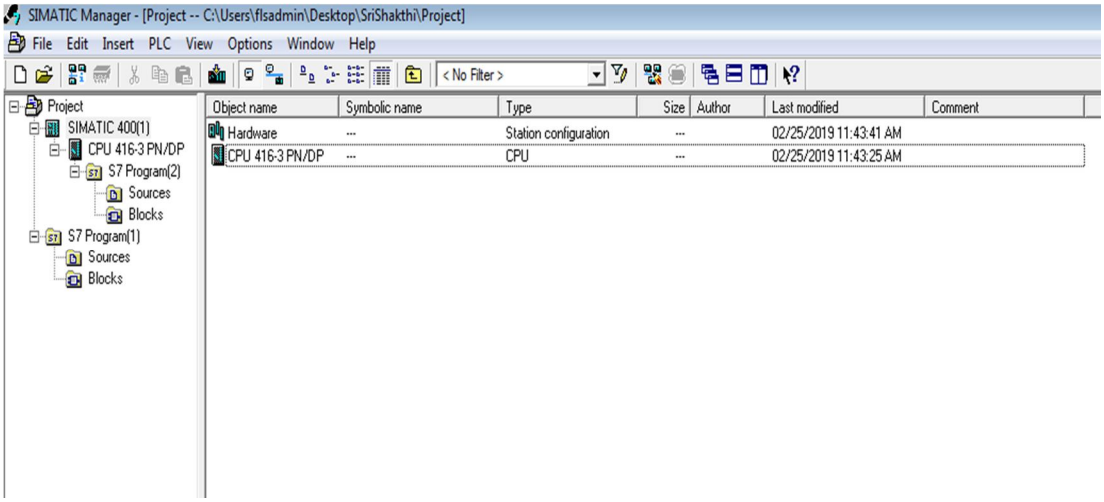
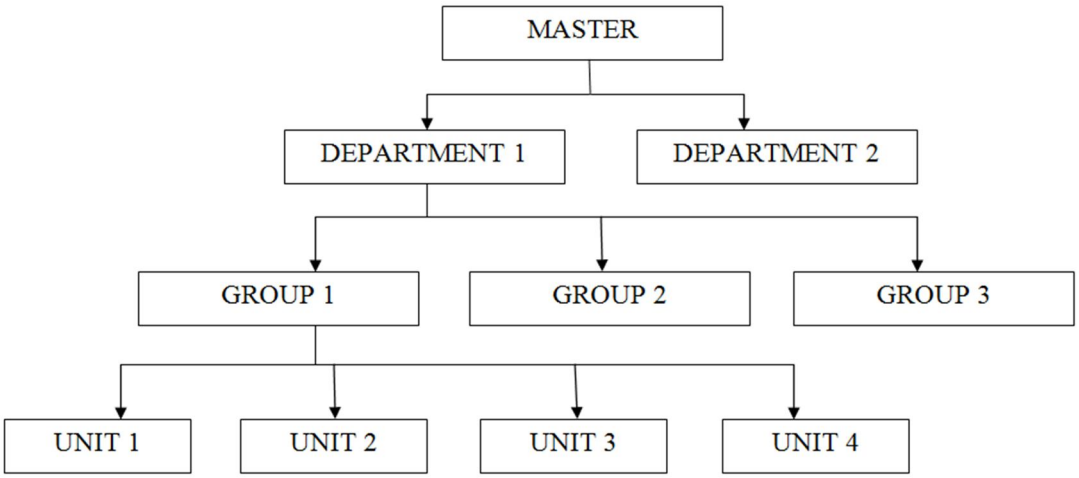


Fig.5.Hardware configuration

The operate diagram (FBD) may be a graphical language for programmable logic controller style which will describe the operate between input variables and output variables. A operate is delineated as a collection of elementary blocks. Likewise in the program, we have used function blocks for various equipments. The blocks used are Motor block, Gate block, Alarm block, Analog block, Select block and Interlock block. The Acesys library functions are included in the program. All these blocks are found in the Simatic S7 Siemens library. A new project was created in the Simatic S7 plc platform. Initially the hardware component is configured in the project. The Plc Simatic 400 station is added in the hardware section of the project. In the hardware the Rack UR2 with 9 slots and the CPU 416-3 are added. The hardware section as shown in fig.5.contains all the versions of the plc and the users have to pick the desired version of the hardware that is used in their project.

f) Interfacing of ECS and PLC: A master is the solution of the entire cement plant. A cement plant has a lot of departments that are separated based on the action that it is doing. A group is within a department. All the equipments that are associated with each other are grouped together and called as a group. All the equipment in the group is called a unit.



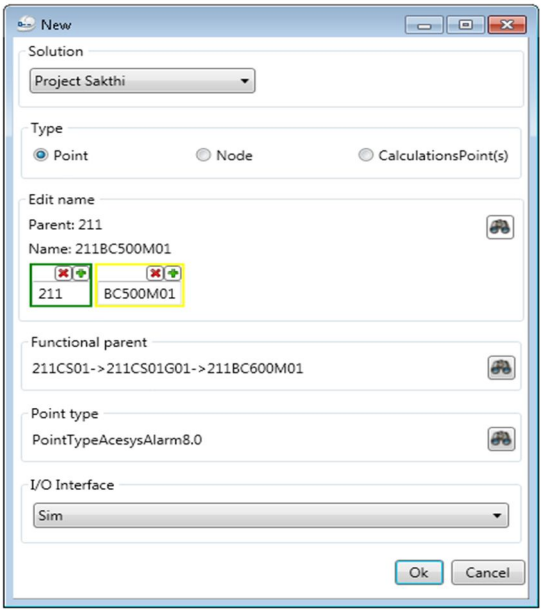


Fig.6.Grouping in ECS

These groups as shown in Fig.6.are defined in ECS in the point editor section. Here we can define the parent of a particular unit. This is done in the properties section of the point editor. This helps ECS recognize the units and their hierarchy. By this way the ECS is able to communicate through PLC and identify individual units with the help of their tags. While creating points, the address of the particular unit and their data word is also specified in the point editor section. Interfacing is the final step of the project. This needs to be tested using simulation. The simulation blocks are included in the programming in order to enable the simulation tab in the faceplates of all the equipments. This helps in simulating the project undertaken.

IV.RESULTS

In order to run the software, the program needs to be downloaded in to the hardware. The download option is available in the plc simatic S7 platform. The simulation needs to be turned on in the S7. Then we have to run the software. The ECS shows the running condition of the equipments. If there is any error in the equipments in the field, then an alarm will be generated. This is highlighted in the ECS.

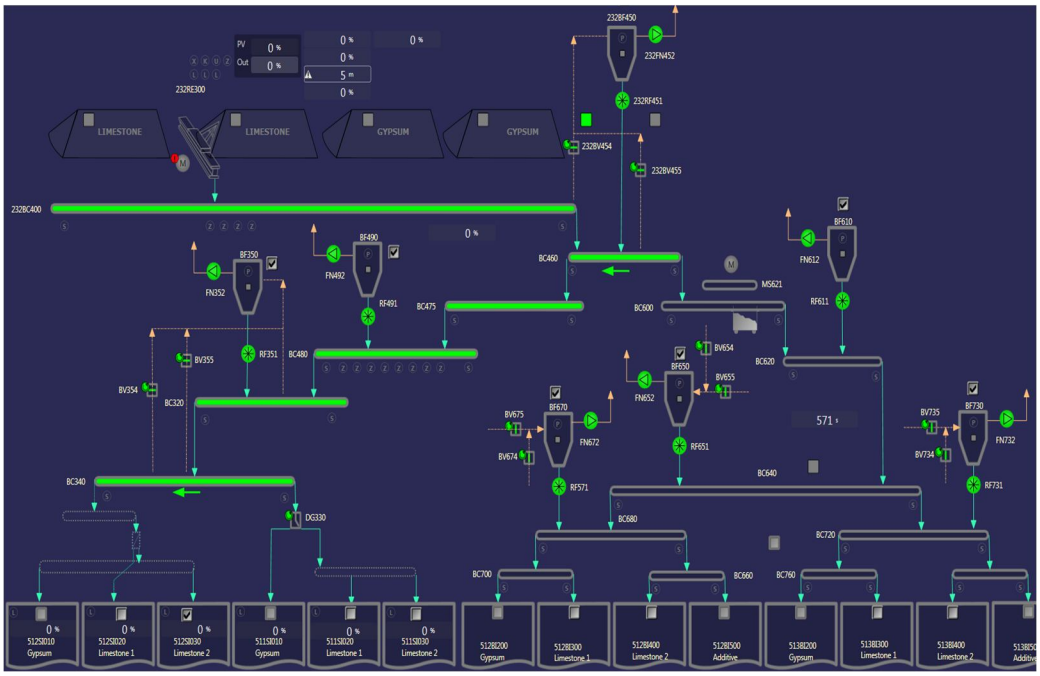


Fig.7. ECS

The developed ECS as shown in Fig.7.is simulated while running it online. The groups are started from the panel bar using their respective faceplates. All the groups have equipments that will be started sequentially according to the interlocks added in the equipments in the programming of PLC.

V.CONCLUSIONS

The Automated System developed can be used for the various other purposes apart from Cement Industry. Following are a number of the areas wherever this automation system is used. Automated manufacturing refers to the application of automation to produce things in the factory way. Most of the benefits of the automation technology have its influence within the manufacture processes. Industrial automation deals with the optimization of energy-efficient drive system by precise measurement and control technologies. Nowadays energy efficiency in industrial processes is becoming more and more relevant. Semiconductor firms like Infineon Technologies are providing 8-bit microcontroller applications for instance found in motor controls, general purpose pumps, fans, and ebikes to reduce energy consumption and thus increase efficiency. One of Infineon`s 8-bit product found in industrial automation is that the XC800 family.

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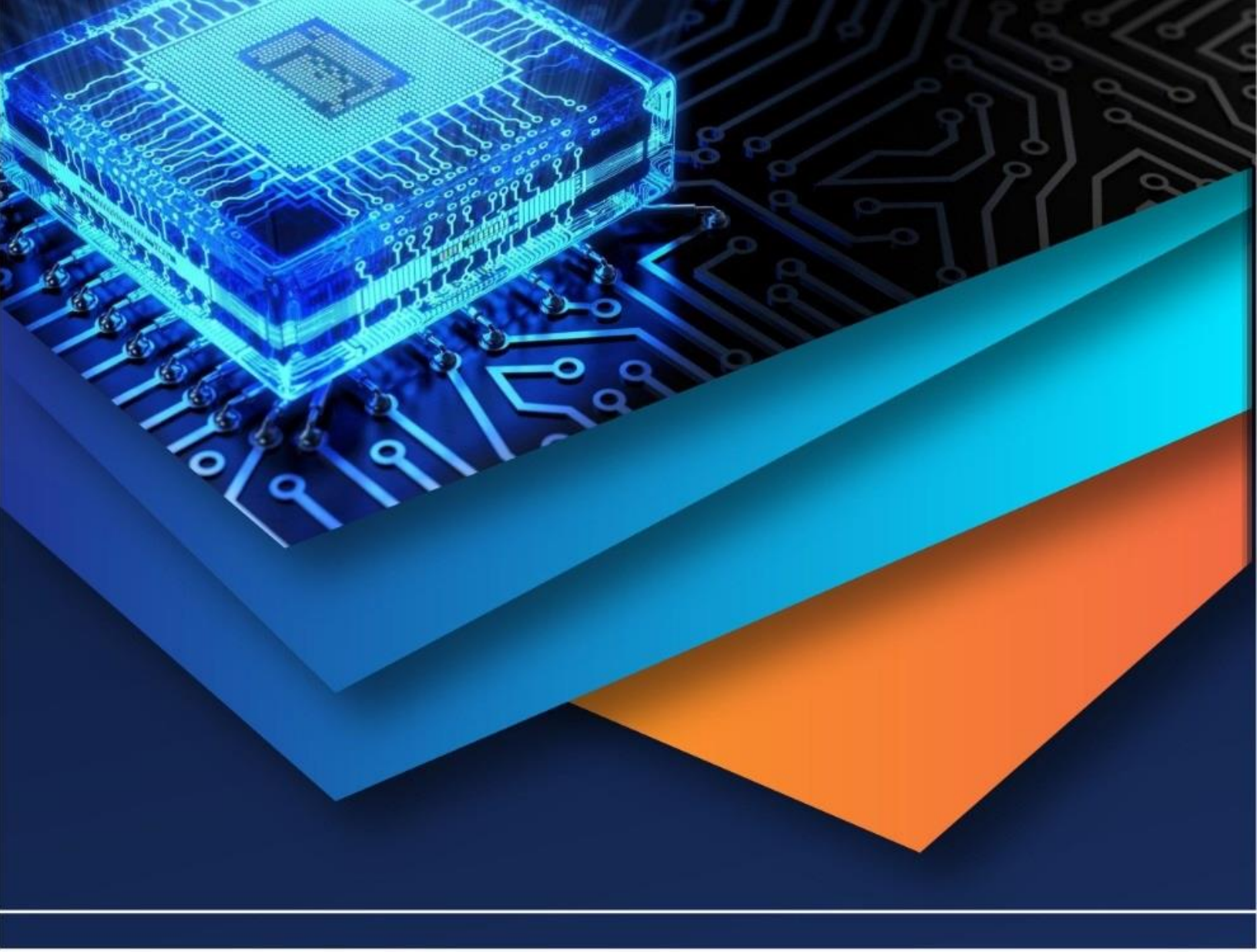

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