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Cloud Based Workplace Safety Inspection for Food Industry

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Abstract: The proposed conceptual framework for the design and use of a cloud based audiovisual recording and surveillance system for safety in the workplace. a video surveillance system has been put in place. The aim is to gain some insights into the benefits as well as the drawbacks connected to the use of video technology as a means to improve safety management in manufacturing companies. Demonstrate the effectiveness of video technology at supporting the identification of the risks connected to unsafe behaviours of the workforce and critical conditions of the working environment. Video surveillance provides several benefits as opposed to in person observations, such as non-biased and accurate accident data; in-depth analysis; observations possible not in real-time; observer not exposed to risks; undisturbed work activity; possibility of longer observation periods. The recorded videos can facilitate the identification of safe practices and the best risk management approaches as well as be used to improve training sessions. The accident frequency rate is higher in the food industry than other manufacturing industry. Hence, there is a need to implement further actions to prevent occupational accidents and improve health and safety at work in the food industry. To guide these actions, up-to-date information on accidents at work is needed. This study descriptively analyzed the circumstances, causes, and consequences of accidents at work in the food industry. The data were retrieved from the accident database. The results reveal that most of the injuries were minor, such as wounds and superficial injuries, resulting in 3 days of incapacity for work. The most accident-prone activities were handling objects, movement, and carrying loads by hand. Hands were the most exposed body parts. The most common causes of injury were related to movement and slipping, stumbling, and falling. Focusing on these factors to may support the food industry in preventing and reducing the number of accidents at work.
Keywords: Food industry, Safety, Surveillance, Cloud, Machine Learning.

I. INTRODUCTION

Cloud Software based video surveillance and security analytics systems, commonly called closed-circuit televisions (cctv), relate to the use of video cameras to monitor the activity of targets in a scene. Cameras are considered a fundamental commodity for setting up any surveillance infrastructure, but at the same time, 24×7 monitoring of hundreds or thousands of video feeds by operators doesn't serve the purpose of providing proactive surveillance and quick response to breaches.

Cloud software-based Video Content Analytics provides a certain level of reprieve by raising real-time alerts for a few standard breaches like left baggage, motion detection, etc., but the in-accuracy and false-positives far outweighed the potential benefits, to an extent that most of the operators disable these analytics to avoid the innumerable false alarms.

Video records are used for data collection, e.g., to quantify indicators of perceived risks, or for the assessment of workers' exposure to ergonomic risk factors. Proposed the use of video clips and questionnaires to assess safety at work.

Video surveillance systems monitored in real time may support emergencies management and allow timely detection of events that can cause harm to people. Cctv may be useful also to approach safety in a proactive manner, i.e. Not waiting for incidents to happen but trying to create conditions to prevent them. One possibility to minimize the chances of accidents occurring, as advocated by behavior-based safety (bbs) methods, is to reinforce safe practices and reduce the frequency of at-risk behaviors. In fact, video clips are a rich source to examine safety performance and provide many advantages with respect to live observation, such as lower interference with the observed situation, possibilities to make longer observation periods, store and review important situations. Videos may also be used for training purposes to show new workers how to safely perform their task prior to having to enter the actual work environment.

Video clips may be reviewed also by experienced workers to detect at-risk behaviors or practices, thus creating an opportunity to reflect on their behaviors and learn from their own mistakes.

Finally, the ‘‘observer effect” also referred to as the ‘‘Hawthorne effect”, caused by the presence of cameras may positively influence workers' behaviors. However, some possible drawbacks and implementation barriers also emerge.

The objective of this work is to provide some insights into the suitability of video technology to improve workers' safety in manufacturing companies. In an earlier paper a preliminary framework for the design and use of a video surveillance system to improve workplace safety was proposed by the authors. Following that previous research, a project of experimentation of a cctv for safety reasons in an Italian heat treatment company has been undertaken.

This work presents the project and critically analyses its main results. The remainder of the paper is organized as follows. Section 2 presents the conceptual framework. In sections 3 and 4 the experimentation case study is described and discussed.

II. REVIEW OF LITERATURE

[1]Cloud software-based Video Content Analytics (VCA) provides a certain level of reprieve by raising real-time alerts for a few standard breaches like left baggage, motion detection, etc., but the in-accuracy and false-positives far outweighed the potential benefits, to an extent that most of the operators disable these analytics to avoid the innumerable false alarms.

With the advent of Artificial Intelligence (AI) and machine learning software is being trained to detect, identify, and distinguish various objects in video by exposing them to many tagged examples. The aim of the surveillance applications is to detect, track and classify targets.

[4]The construction sites need to be monitored continuously to detect unsafe conditions and protect workers from potential injuries and fatal accidents. In current practices, construction-safety monitoring relies heavily on manual observation, which is labor intensive and error prone. Due to the complex environment of construction sites, it is extremely challenging for safety inspectors to continuously monitor and manually identify all incidents that may expose workers to safety risks.

The objective of study was to create and evaluate a low-cost automated safety monitoring system to assist in the construction-safety monitoring process.

Presents a framework for this safety monitoring system as a cloud-based real time on-site application. The system integrates Bluetooth low-energy (ble)-based location detection technology, building information model (bim)-based hazard identification, and a cloud-based communication platform.

[3]The work is divided into three major areas: the analysis of occupational risk implications at national and international level, the European priorities in terms of occupational risk and the existing cloud computing services. Since human resources are present within each organization, it is required a comprehensive and actual assessment of the processes in which they participate. Like in any daily activity, processes and people contribute to the emergence of risks. If each organization creates healthy and safe workplaces that means that it contributes to the sustainable development of the area in which it operates.

It can be said that occupational risk assessment and occupational health and safety is the foundation for optimal functioning of the enterprise, thus aiding in reaching the enterprise objectives. The combination of these key concepts, occupational risk and occupational health and safety with technological developments contribute to an innovative approach to risk.

Presents the literature review, European strategic directions and their implementation in occupational risk assessment in organizations, analysis of work accidents in compared to European Union and authors addressing occupational risk assessment using cloud computing by developing the associated architecture.

III. METHODOLOGY

In this work, a basic video surveillance system is proposed to improve safety management in manufacturing companies. The most important prerequisite to start this type of project is creating in the company a climate of trust and collaboration with the shared objective to increase safety level. It is necessary that both the employer and the workers show a genuine interest in the improvement of safety and fully understand the aim of the system. First, it is necessary to deal with confidentiality and regulatory constraints. Indeed, to be allowed to install and use the video surveillance system, written consent from all the workers and the unions must be obtained.

The workers should be adequately informed about the way the data will be collected and managed, and for what purpose they will be used. They should be aware that the objective of the CCTV is to record videos showing machinery, workers, and the working environment, thus allowing an analysis of the safety practices inside the company. They should also be reassured that the video collected will not be used to identify and punish those responsible for unsafe behaviours, but to identify unsafe behaviors and conditions to correct them and prevent injuries.

Indeed, since at-risk behaviours can be considered as precursors of future incidents, their timely detection and correction is critical for safety improvement.

For this protocol, an at-risk/unsafe behavior is defined as an action - such as a procedure, a task, or an activity – that does not conform to general regulations, principles, operation processes, or methods, and which is made in a way that could cause property damages or personal injury (e.g., A worker driving a forklift with an excessive speed or standing up. An at-risk/unsafe condition is a state characterizing an item, an equipment, a working tool, etc., with the potential to cause damage (e.g., A broken emergency button, the presence of oil on the ground floor, the lack of shelter).

Operating procedures are also necessary to make sure that all regulatory requirements are fulfilled, and safety data are systematically and accurately collected. To enhance the effectiveness of video reviews, a checklist to support video analysis should be prepared. The checklist should be used to collect a set of information about each observation: who is the observer, which camera filmed the video, during what timeframe, which safety relevant behaviors and conditions are observed. A space to note down the position of each scene of interest in the video recording should also be available to allow easy extraction of video clips that can be used for training purposes.

The checklist should consist of a list of behaviors and conditions critical for safety performance. The checklist could draw inspiration from standard checklists available in literature for safety behavioral observations but needs to be tailored by each company to include the risks specific for its context. Critical issues are grouped into five categories: working environment and materials; tools and equipment; body position and gesture; personal protective equipment; other examples of safe behaviors and conditions related to each item should be also provided in the checklist.

The testing phase is intended, on one side, to check that the identified safety relevant targets are in the field of view of the installed cameras. On the other side, it is necessary to decide the duration of the single observation, the type and frequency of sampling, and the number of cameras visualized on the screen during observations. These choices should be made compromising between the need to limit the amount of time, and thus the resources required to perform the observations, and to ensure an adequate detection of criticalities. After testing, the system can start its operation.

This phase includes activities such as: video acquisition, storage, and periodic deletion; video analysis to collect safety data, identify safe and at-risk behaviors and at-risk conditions; feedback and corrective measures implementation (training, procedure revision or technical measures); maintenance of the whole system. Video analysis should not take place only when an accident occurs, but on a regular basis to monitor how tasks are performed by different operators in different locations and at different times during the day or the week.

At worksite audit or inspection usually, the main aim includes ensuring that the basic responsibilities of employer such as providing a safe system of work at work site, safe plant and equipment is maintained, safe work environment is present in the job location. To ensure that the best industrial safety practices are incorporated at work sites and the deviations or gaps between the standard and the workplace practices is suitably identified. By measuring the key performance indicators which include leading and lagging indicators are suitably incorporated and regularly reviewed to ensure positive safety performance.

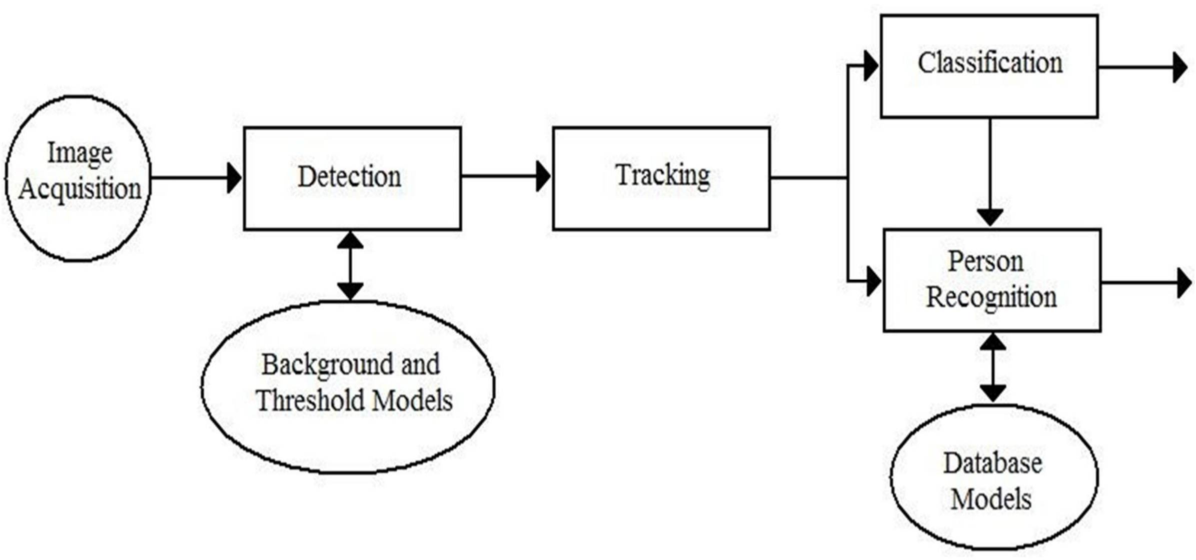

Fig 1: System Architecture

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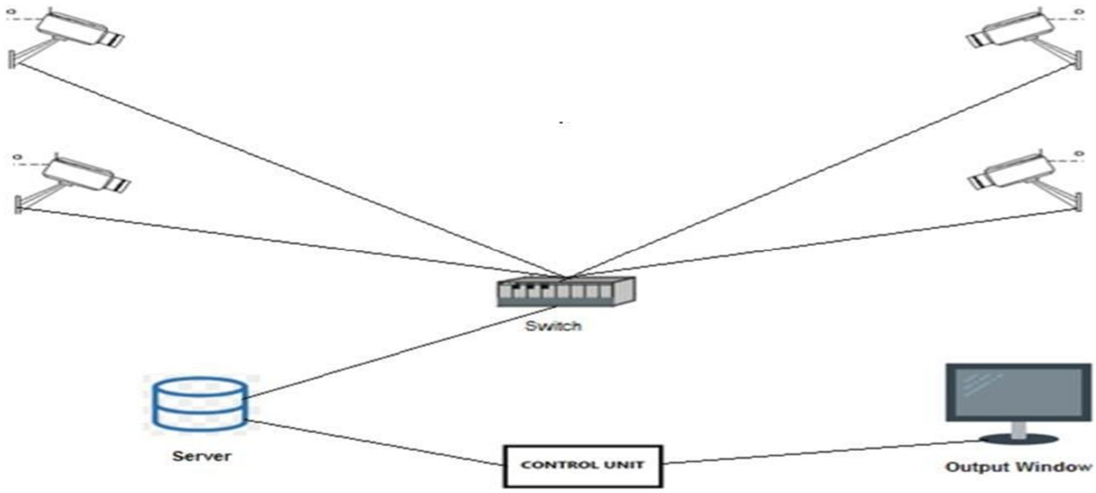

Fig 1.1: Block Diagram of the System

1) *AI in Video Content Analytics:* The objective of VCA software is to analyze the video stream, one frame at a time, and create a structured database of information out of the unstructured video data. The VCA engine accepts the raw video stream and converts it to a comprehensible format
2) *Face Detection, Recognition and Alert:* Accurate face detection and recognition are very critical to law enforcement agencies. It helps in identifying people of interest and is also helpful in post-incident investigations. Broadly, some of the benefits of Facial Recognition application are:

a) Automatic attendance
b) Automatic recognition of authorized individuals or re-identification of unknown people
c) Automatic alert for blacklisted/barred people or no-go zone breach
d) Customizable MIS reports (alerts / movements / area-access / area-usage)

3) *Object Tracking:* During post-incident analysis, object tracking facilitates tracking a vehicle in case of a hit-and-run or to track a person who may have left a suspicious package at the incident site.
4) *Video Forensics:* AI-based machine learning algorithms can help in other forensic activities such as:

a) Vehicle model detection
b) 3D face reconstruction
c) Video enhancement by Image Super-resolution
d) Video De-hazing and noise reduction
e) License Plate De-hazing

Challenges of AI vision Video-based anomaly detection in camera security systems is very challenging. There is several factors that make the real-life applications of computer vision very difficult to implement and scale: Lack of real-life data: There is a huge need for real-life data collection to train effective algorithms and build computer vision applications that perform well in real-world settings. Illumination: Managing variations of illumination is difficult because trained features are hard to extract from the videos. Pose and perspective: The camera angles that determine the surveillance area have a substantial impact on the performance of deep learning algorithms. This is because the appearance of objects or people may change depending on their distance from the camera. Heterogenous objects: Learning the movement of heterogeneous objects and entities in a scene can be difficult at times.

IV. WORKING PROCESS

The project, which was collaboratively developed and idea by the Human resource and safety department, started thanks to an agreement among the employer, the workers, and the unions. The objectives of the research project and the use of the data were clearly explained in the agreement. In particular, the agreement provided the workers with a written assurance that none of them was going to be punished or get a penalty because of the data collected by the video surveillance system. Fig-2 shows an overview of the research project timeline.

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Based on the protocol described in section 2, the first phase of the project was devoted to a thorough analysis of the company to map processes, tasks and procedures, and characteristics of the different types of equipment and their uses. Some of this information was provided by the record of the risk assessment and the quality manual, while other details were collected through on-site visits and interviews with workers, the operations manager, and the health and safety manager. The objective of this phase was to identify safety critical tasks and equipment as well as the areas of the factory with a higher level of risk. Among all the targets identified, the most critical were chosen to be monitored by video cameras.

Examples of those targets are walking paths, loading/unloading areas, workstations for manual handling, tanks, furnaces, boiler, oven, compressor and air handling areas, gas and hazardous, fuel storage areas, warehouse, and forklift paths. Fig.2 is an extract of the map of the factory which shows a production department (monitored by two cameras, #1 and #3) and an external area (monitored by camera #4). The circular sectors in the figure represent the fields of view of the cameras installed, while the circles identified by capital letters highlight the safety relevant targets in the area.

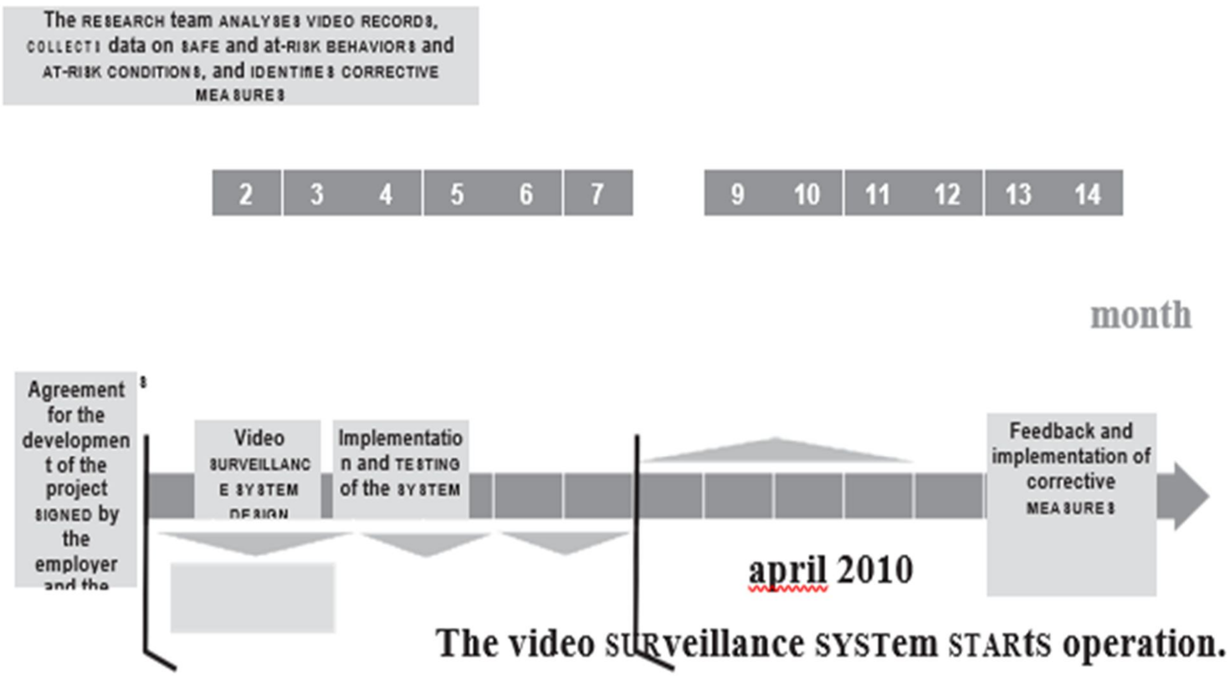

Fig.2: Timeline of the Research Project

After the installation of the system, each camera was tested to verify its correct positioning. Moreover, several tests were performed to define how to sample the video clips to analyze. The following parameters were considered: duration of a single observation (10 or 20 min); sampling frequency (1 observation per camera every 2, 4 or 8 days); type of sampling (random or selective); number of cameras visualized on the screen at the same time (1, 2 or 4 cameras).

Random sampling was employed to guarantee that the samples were representative of the whole working activity. Finally, visualizing on the screen only 1 video stream per time instead of 2 or 4 appeared preferable because, even though it takes more time, it reduces the mental load of the observer and, thus, limits loss of data. After the implementation and testing phases, the whole system was ready to start its operation. Furthermore, for each behavior, video clips showing both safe and at-risk practice were archived and then used to develop a training module. To avoid a possible deterioration of the organizational climate, regular meetings with the unionists were held to keep them informed on the development of the project, clarify their doubts, and solve any issue raised by the workers.

Checklist sheets were weekly reviewed to extract data regarding the number of safe and at-risk behaviors and at-risk conditions registered.

The checklists were reviewed also to identify and catalogue the behaviors and conditions recorded during the observations. Then, for each at-risk behavior or condition, the type of corrective measures to implement was identified in collaboration with the safety manager of the company.

V. CONCLUSION

A basic video surveillance system not monitored in real time with the aim to improve risk and safety management in a manufacturing company has been presented. The results show that video technology can foster a more proactive approach to safety management. It supports the identification of the risks connected to unsafe behaviors of the workforce and critical conditions of the working environment. The safe behaviors recorded by the system may be useful to identify the best risk management approaches and promote safe practices. Video clips can also be used to improve the effectiveness of training sessions.

An increase of safe behaviors has been recorded twice during the experimentation period. The first increase was at the beginning of the period, probably because of the 'observer effect" due to the presence of video cameras, while the second was at the end, after the feedback and the implementation of some corrective measures. One limitation of this research is that the analysis is based on one case study and generalization will be possible only after implementation in other companies. Furthermore, the ''voice of the operator" in terms of workers' opinions about the implemented system has not been directly investigated.

Artificial Intelligence is the next evolution in Video Analytics. Owing to the advent of high-performance GPU hardware, Deep learning-based AI techniques are being widely adopted by various VCA software OEMs. This improves the detection accuracy without increasing the hardware cost exponentially. For end-users, it greatly reduces the workload of security staff and brings significant benefits by detecting unusual incidents and solving a lot of video forensic problems.

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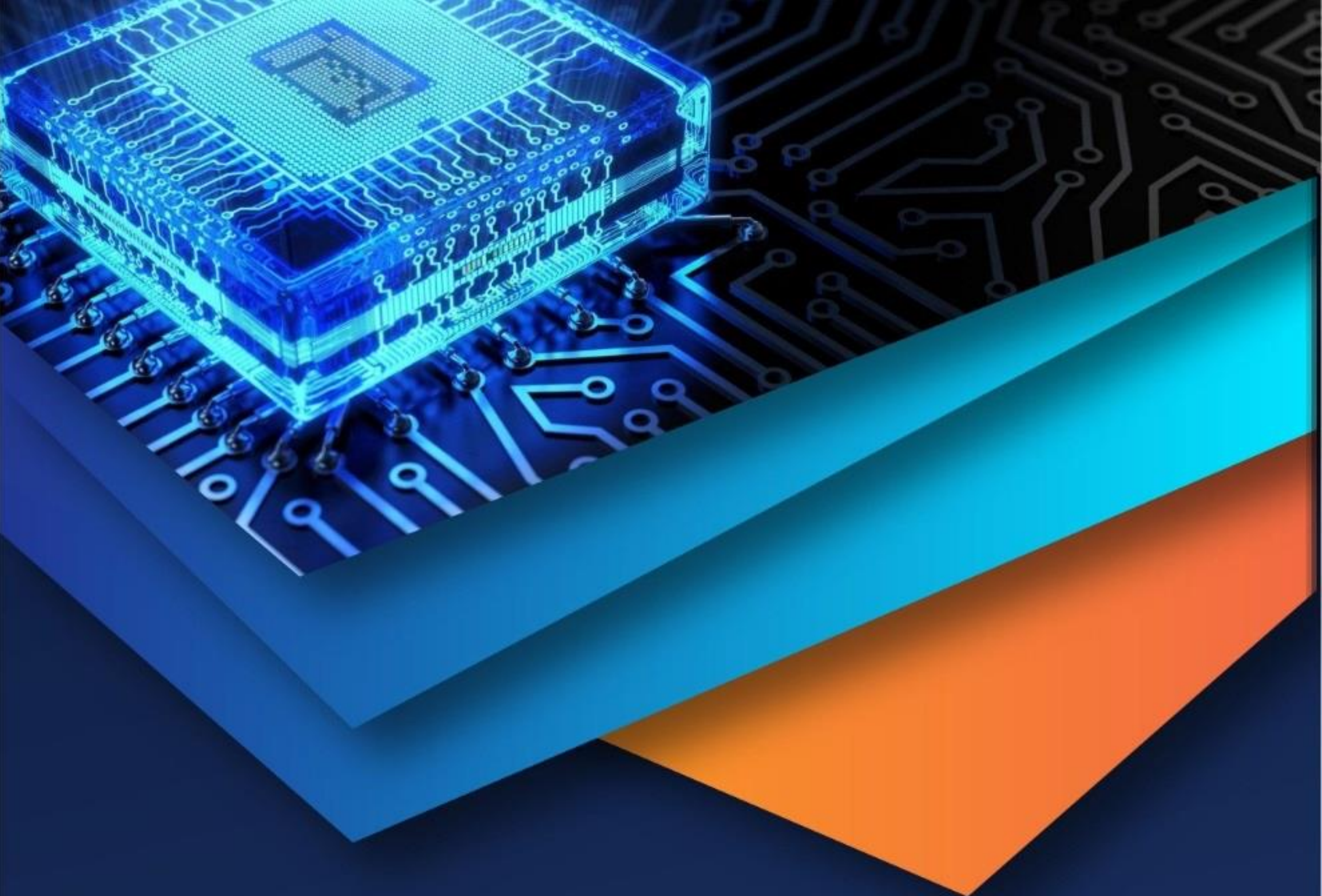

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