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Street Pothole and Speed breaker detection with Theft Prevention Techniques: A Survey

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Abstract: ***Potholes are very harmful road surface conditions that prevent a safe, secure and reliable transportation and movement of people, goods and services. Road surface obstacles such as potholes affect the safety and comfort of most road users and commuters. Bad road networks hamper the smooth movement of goods and services and contribute to the poor growth and development of the economy whiles good road networks provides access to markets and enable fast and smooth transportation of goods and services from producers to consumers. Early detection and maintenance of potholes helps to create a conducive and reliable road network that facilitates the smooth movement of people, goods and services. Transportation Plays a Big Part of our daily Lives. Every year, People are Increasingly using vehicle Especially Two-wheeler Motorcycle their Common mode of Transportation. The increases of Motorcycle users, Motorcycle theft also rampant over the year. This paper contains a survey on various potholes and speed breaker detection techniques with theft protection techniques.***
Keywords: Street pothole, Speed breaker, machine learning, GSM, Theft prevention system, Micro-controller.

I. INTRODUCTION

Traffic congestion and accidents are mainly due to pathetic condition of road. The most common form of distress on such roads are potholes, which can compromise safety, and result in vehicle damage. Repairing the roads on regular bases will ensure the drivers safety and helps reduction in vehicle damage. There are many methods existing for pothole detection which use sophisticated equipment and algorithms. Due to the huge data computation such processes are slow and power consuming. The world is advancing towards an autonomous environment at a great pace and it has become a need of an hour, especially during the current pandemic situation. The pandemic has hindered the functioning of many sectors, one of them being Road development and maintenance. Creating a safe working environment for workers is a major concern of road maintenance during such difficult times. This can be achieved to some extent with the help of an autonomous system that will aim at reducing human dependency. Nowadays rate of vehicle theft is very high all through the world and the situation are even worse in developing country. Therefore, protection of vehicles with an intelligent, reliable, effective and economical system is very important. The existing technologies for vehicle security have a number of limitations including high false alarm rate, easy deactivation and high cost.

This paper looks at recent work on using machine learning, deep learning, computer vision methods used in pothole and speed breaker detection and alarming to the drivers. Section 2 looks at how various anti – theft techniques used. Finally, Section 3 concludes our research by outlining many interesting facts and previous works.

II. ANALYSIS TASK: TECHNIQUES USED IN POTHOLE & SPEEDBREAKER DETECTION

A. Deep Learning Approach to Detect Potholes in Real-Time using Smartphone [1].

It uses mobile application for pothole detection with the help of camera, accelerometer, gyroscope and location which is available in all the smartphones. It does not use any hardware parts which reduces the hardware cost. It uses a deep learning object detection algorithm: Single Shot Multi-Box Detector (SSD) looks for potholes using a mobile camera in the background. As soon as an unregistered pothole is detected by SSD, coordinates of the pothole are updated to the database in real-time. It uses accelerometer and gyroscope readings that are continuously taken and assessed by a Deep Feed Forward Neural Network model to detect unregistered potholes. This dual mechanism of camera- based as well as accelerometer-gyroscope based detection not only cross validates detections but also provides stable results even if one mechanism fails. The pothole co- ordinates are rendered on the map user interface that can be accessed in the same application. This system with map/navigation feature as front end and two-fold deep learning pothole detection algorithm in backend is an efficient way for real-time pothole detection.

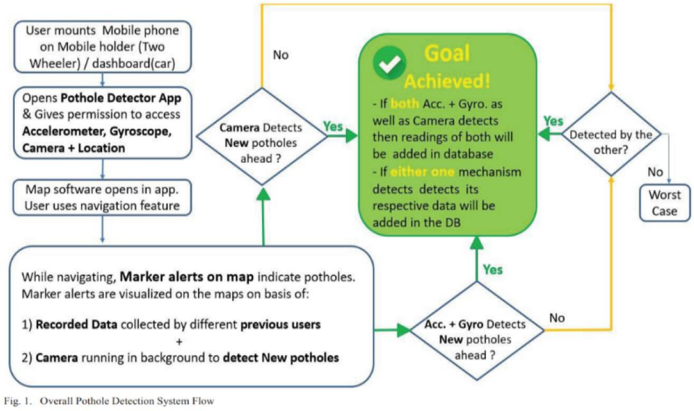


Fig. 1. Overall Pothole Detection System Flow

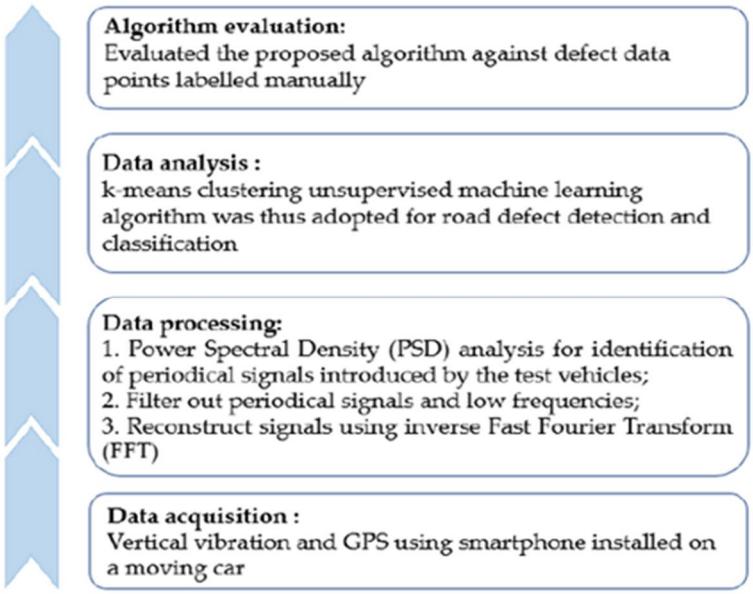
[5]

Two-fold cross verification mechanism i.e., Camera Based as well as Accelerometer and Gyroscope Based. No use of any external hardware sensor as both accelerometer and camera are present in almost all smartphones. Not restricted to certain areas as once the model is trained, the trained model can be used to detect potholes anywhere. Provide Real-Time updates to users. System improves over time.

B. Real Time Pothole Detection Using Android Smartphones with Accelerometers. [2]

First the data from the accelerometer sensors were collected on an urban road with various potholes. The device is based on the microcontroller MSP430F1611 and Analog Devices 3-axis accelerometerADXL335.It then uses the simplest event detection algorithm Z-THRESH tested on the acquired data set. It is similar to the z-peak algorithm used in Pothole Patrol. The features that classify the measurements are the values exceeding specific thresholds that identify the type of the potholes, e.g., a large pothole or a cluster of potholes. The algorithm assumes that the information about the Z-axis position of the accelerometer is known. Next, a slightly more advanced algorithm was Z-DIFF used that was also tested on the acquired data set. Contrary to Z- THRESH a search for two consecutive measurements with difference between their values above specific threshold level was performed. Thus, the algorithm detected fast changes in vertical acceleration data. The algorithm requires the determination of the Z-axis position similarly to the previous approach. After the analysis of the related work, the authors decided to implement some of the techniques that were used for post processing. One of the techniques, which looked promising for implementation on a resource-constrained device, was using standard deviation of vertical axis acceleration. Next using visual data analysis tools and searching for specific data patterns authors found that there exist certain events characterized by specific measurement tuples. All three-axis data in this tuple was with values near to the 0. Empirical analysis of these data sets led to two preliminary conclusions: a) such data tuples could be acquired when vehicle was in temporary free fall, for example, entering or exiting the pothole; b) such data tuples could be analysed without information about the exact Z-axis position of the accelerometer.

Marking of the ground truth for the selected test track using the Walking GPS approach. Test drive session on selected test track with 4 different smart-phones as data acquisition devices. Processing of collected data using selected event detection algorithms. Statistical analysis of algorithm performance in context of previously marked ground truth and the existing RoadMic methodology. The authors performed this task using methodology similar to the previous pothole detection related activities where the events detected in ≤15m radius from any ground truth item are classified as true hits. A ground truth item is classified as true positive if during 10 test drive laps at least 4 events in different laps are detected within ≤15m radius. Note, that all the detected events, which are not true hits, are false positives - events, which do not have any proximate ground truth points. Autonomous defect detection without the involvement of human inspection relies on emerging machine learning algorithms. Broadly speaking, a machine learning algorithm can be classified as either supervised or unsupervised. A supervised machine learning algorithm generally requires a significant amount of labelled data for training. The labelled data must present various types and characteristics of defect, so that the trained algorithms can be generalised to recognise similar defects. In contrast, an unsupervised machine learning algorithm does not require pre-knowledge about defects. Based on the characteristics of the defects contained in the dataset, the algorithm can automatically classify them into a predefined number of categories. In the application scenario of this work, collection and manual labelling of defects can be very time consuming and costly. An unsupervised machine learning k-means algorithm was adopted, as this is one of the most well-developed and widely accessible clustering algorithms.



[3]

C. A Modern Pothole Detection Technique using Deep Learning[4].

Proposed a system to detect potholes in real-time in images/videos captured by a camera mounted on the vehicle and to give an alert to the driver about the pothole on road in front of the vehicle. Further the system will detect the location of the pothole and upload the same on map (reflected in android app developed by us) so that other users who have no camera mounted on their vehicle can get alert about the pothole using the app only. In this system, they used famous and complex CNN architectures like Inception v1 (GoogLeNet), inception v2 and finally select inception v2 in our system in the experiment data, the system shows extremely good results. Setting up a laptop and camera on a vehicle. Region-based. Detecting potholes in real-time using the system in videos captured by the camera. Matching the captured data with real data of the road. TensorFlow's object detection API is a very powerful tool that can quickly enable anyone to build and deploy a powerful image recognition system. It provides many pre-trained models (trained on different datasets) which can be used to build customized classifiers/detector/recognizer after fine-tuning. Selected model named "F-RCNN inception v2". Transfer Learning makes use of knowledge gained while solving one problem and apply it to a different but related problem. With this technique, we can save a lot of time. In this technique below first, we select any pre-trained model (In which all the parameters are trained), then perform fine tuning. Fetch the new dataset to fine-tune the pre-trained CNN. If the new dataset is similar to the original dataset (with which the model has been trained), the same weights can be used for extracting the features from the new dataset. In this case, the dataset is very different from the original dataset. Fast R-CNN takes an input image and then with the help of CNN & max pooling layers, a convolutional feature map is extracted from the image. The ROI pooling layer performs a very important task here. We know that fully connected layers can accept only certain sizes, So ROI pooling layers converts the output of the CNN into certain fixed sizes. When we put Fast RCNN with the RPN (Region proposal network), it becomes Faster R-CNN. So, basically, the difference between Fast R-CNN and Faster R-CNN is the Region proposal. In Fast R-CNN, there is an external selective search whereas in Faster R-CNN RPN is combined with the Architecture. The pothole dataset consisting of more than 1500 images. This dataset has been compiled at the Electrical and Electronic Department, Stellenbosch University in 2015. The entire dataset consists of two different sets, one was considered to be simple and the other more complex. The pothole detection task was found to be much easier if only the region in the images that contained the road was cropped and then used in detection but it takes more time to crop 1500 images. We perform labelling in all images. In the task, we create a CSV file containing images name, path, image dimension and coordinate of the pothole in the image. After pre-processing the data, we created a system for the detection of potholes in video/images so that the driver can get an early alert about the pothole on the road. For the system, we have used inception v2 architecture and perform fine-tuning. We fixed the earlier layers of inception v2 network (consisting of 22 layers excluding pooling layers) and re-train only the later layers. For the training, a special configuration file has been created. After training, the testing process has been done and some extra code has been written to capture video and to detect pothole in the video as well as in image.

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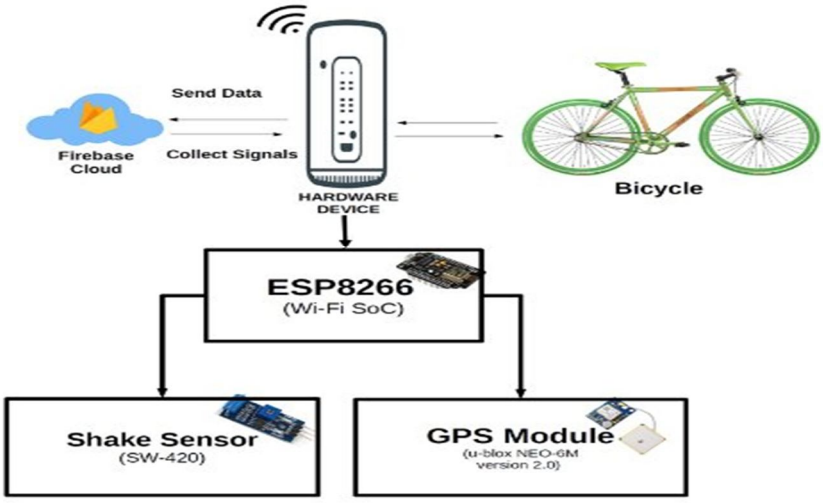
III. ANALYSIS TASK: TECHNIQUES USED IN THEFT PREVENTION

A. An Anti-Theft System for Two Wheelers[12]

The system is a combination of a device and an android app. The device is small and can be attached under the bicycle seat so that the thieves do not notice it. The user can search for a secure parking slot using the app. The secure location can be added by the users using GPS module. The NodeMCU checks the values of the vibration sensor and the GPS module continuously. If the NodeMCU gets any suspicious value from either the sensor or the module, it instantly updates the value to the cloud storage.

The user can access these data or get notified of the status via the app which readily collects information from the cloud all the time. After the user gets notified of any suspicious activities, the user can rush into the place where the bicycle is parked and check whether the bicycle is safe or not. Even if the user is late to find out what has happened and the bicycle is already stolen, the user can track it by checking the location of the bicycle via the app using the GPS module. GPS module Constantly Send the Coordinates of location of bicycle.



[13]

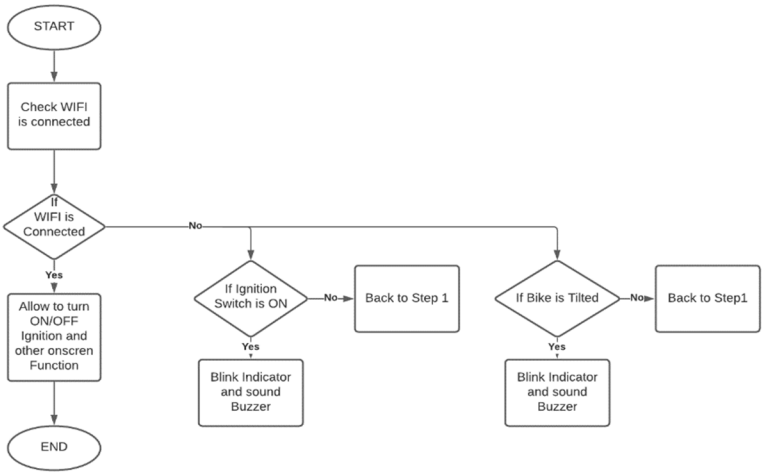
It needed a processor for processing the sensors data. NodeMCU has been chosen for this purpose as the processor. There are several reasons for this choice over Arduino Uno or Mega or raspberry pi as the processor of our project. One reason is the dimensions which makes it easily portable and hide able under any bicycle saddle or even into some bicycle seat posts. Another reason is, it has an inbuilt Wi-Fi interface with complete TCP: IP stack that would already consume almost all capabilities of the AT mega (one TCP/IP packet can exceed 1500 bytes long). So, we did not need to add an extra Wi-Fi module to send the data of other modules and sensors to the real-time database system. We considered two vibration sensors, 801S and SW-420 based on the availability into the local market. Both of the sensors have the LM393 as their main chip. The operating voltage of both of them is 3.3V to 5V and both having signal output instructions with analog and TTL-level signal output and digital switching output (0 and 1). Both even have adjustable sensitivity (fine-tuning) and non-directional vibration detection range with mounting holes. The first thing to concern about This device was the size of the device. SW-420 and the 801S have almost the same dimensions. Since, SW-420 and 801S shares the same specification and they both are available in the market, we have chosen the SW-420 as vibration sensor for DiChokro based on the price. The price of 801S (BDT. 550) is five times more expensive than the price of the SW-420. GPS based location tracking is an important feature of DiChokro. It shows the user the current location of the bicycle via app. GPS module can remain standby until an activation event occurs such as the shaking or vibration of the bicycle or users can track the bicycle always if they want Basically, Neo 6M takes the GPS coordinates and gives to the processor (NodeMCU). NEO-6M uses the latest technology from Ublox to give the best possible positioning information and includes a larger built-in 25 x 25mm active GPS antenna with a UART TTL socket. A battery is also included so that one can obtain a GPS lock faster. The battery is to back up the power and EEPROM for storing configuration settings. Adafruit Ultimate Breakout (AUB) is far way better than the Ublox Neo 6M, with the -165 dBm tracking sensitivity and 10hz of position update rate (which is twice the update rate of Ublox Neo 6M). However, the price of AUB is nearly BDT 3300, which is more than 3 times the price of Ublox Neo 6M. The other reason for not using this module was the availability of this product.

B. Theft Preventing for motorcycles[14]

In this Paper, the security of each & everything is the vital role and the security of two-wheeler or bike is one of the important parts. We have designed for the security of the two-wheeler ESP8266 microcontroller, which has a prefabricated Arduino board with inbuilt Wi-Fi module. This Wi-Fi module can be accessed through the HTML web page or Android app from the mobile phone. This web page or Android app controls the ignition of the two-wheeler, head light & side indicators of two-wheeler.

We are using GSM and GPS technology. Two-Wheeler position is obtained by GPS module this data is given to microcontroller hardware which sends messages to user mobile phones through GSM module.

System alerting owner by SMS to user whenever theft attempt, allowing user to control vehicle remotely by SMS also provide engine immobility and alarm. Hardware is implemented to prevent theft from stealing vehicles and fuel. About an attempted theft attempt, the owner is alerted by SMS allowing the user to control the system remotely. The proposed design uses Global Positioning system (GPS) and Global system mobile communication (GSM). System constantly watches a moving Vehicle through GPS and sends data when demanded. For a theft attempt, we have to send SMS to the microcontroller, then the microcontroller issues the control signals to stop the engine motor. Then we have to reset the password and restart the vehicle.



[15]

To start the two-wheeler, we have to open the web-page or the android app. Now, owner has to check the Wi-Fi connection, if it is on than press ON switch on the web page for ignition & than Switch on the two-wheeler with the key. Now, start other options available on the web page or android app if required. Now, if the owner is not in the range of the Wi-Fi & someone tries theft the two-wheeler, then tilt sensor will be activated & buzzer will start. If owner has parked the bike/two-wheeler in the dense parking & wants to search it, then owner just have to be in the range of WI-FI & press search my bike button on the webpage or android app, which will start the indicators of the bike/ two-wheeler & owner will easily get position of the vehicle.

IV. CONCLUSION

Needless to say, the importance of proper roads in the country. There are huge number of accidents taking place every year and one of the most important reason is poor roads. Thus, there have been many techniques which have been developed to detect the potholes on the road and thus alerting the driver. Not only the potholes but speed breaker in the middle of the road, many a times gets unnoticed causing sudden obstruction, so we have worked and collected a number of research papers and collectively combining the different ideas all together in a one. Coming to the anti-theft techniques, we gathered data and results, this study concludes that the Motorcycle Theft Prevention and Recovery Security System is a very helpful and effective measure to prevent motorcycle theft. The alarm system feature is very useful for Stealing motorcycles. In cases of motorcycles that are completely taken, this study helps in the recovery through the use of Global Positioning System (GPS) technology that locates the location of the vehicle. The communication of the user and the motorcycle were made possible through the use of the Global System for Mobile (GSM). The medium of communication depends on the cellular network coverage. Under some circumstances, there are delays on delivering and receiving of text SMS. Over all, the output results of the system meet the proposed output and functionality of the study.

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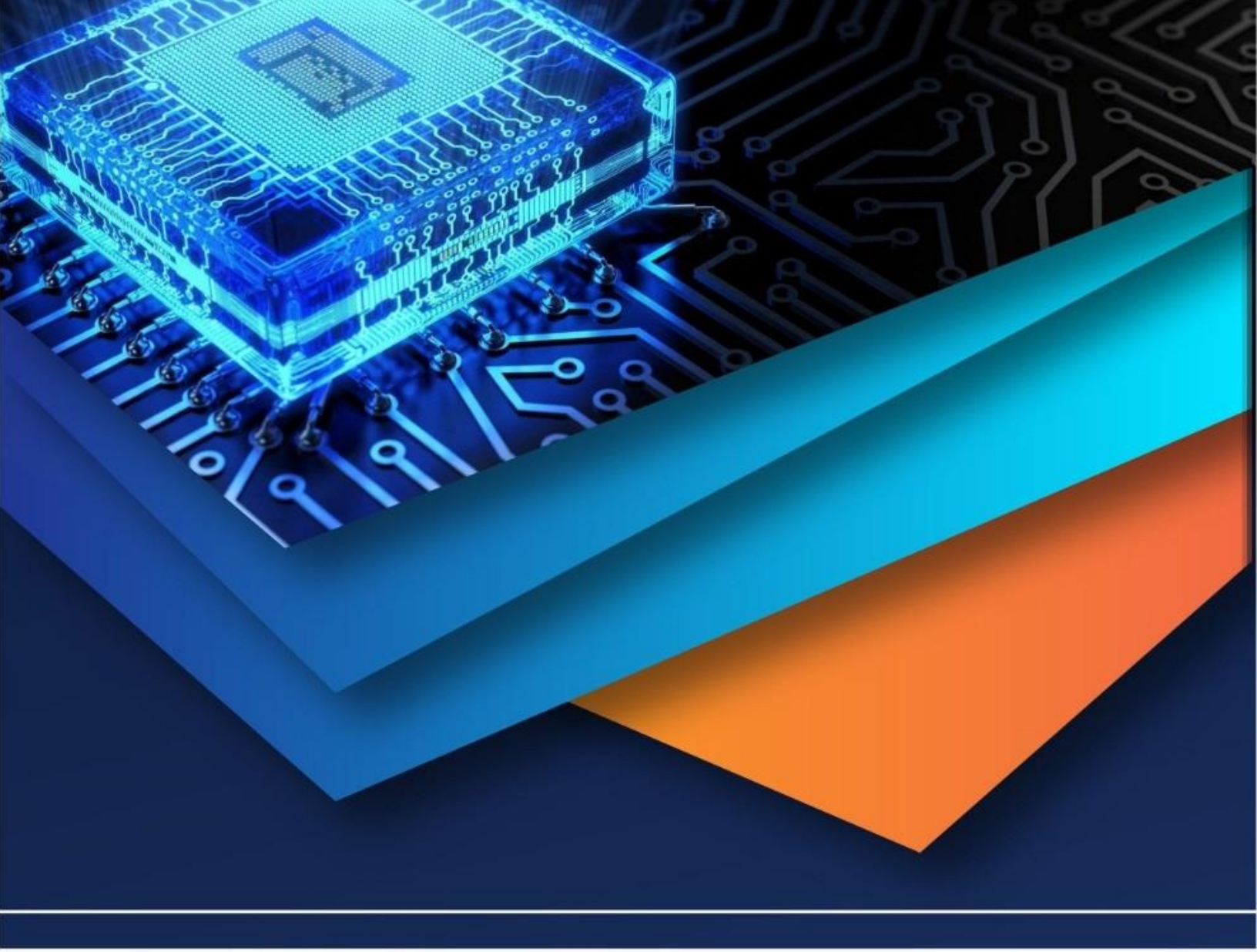

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