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# IoT Based Automated Tomato Sorting Machine

Dr. P. Sivakumar[1], Gnanaprasad. J[2], Lokesh. C[3], Praveen.V[4]
[1]*Professor,* [2, 3, 4]*Student, ECE Department, GRT Institute of Engineering and Technology*

***Abstract:*** ***Sorting of Tomatoes is necessary as tomatoes are widely used and an important fruit in India hence they play a vital role in our day to day lives. Our goal is to provide better quality tomatoes to meet the market standards and for that we need fresh and ripe tomatoes instead of unripe tomatoes. In India, sorting of tomatoes is done by humans which is prone to human error. We need to minimize the error and for that a low cost Tomato Sorting Machine is proposed which differentiates between ripe and unripe tomatoes on the basis of their colour. To differentiate between ripe and unripe tomatoes two TCS3200 RGB Colour Sensors are used in the proposed system. The tomatoes are passed in a straight line on the incline to the characterization point. The distinguishing proof of the colour of tomatoes passed on should be possible by checking the recurrence investigation of the yield of the colour sensor. The arranging of tomatoes as ripe and unripe depends on the colour force caught by TCS3200 colour sensor. The general framework precision was 93.33%. The arranging execution was evaluated for 1500 tomatoes for every hour with 1 channel which can be expanded if at least 2 channels are utilized.***

***Keywords: TCS3200 RGB Colour Sensor, Tomato Sorting Machine, Ripe and Unripe;***

## I. INTRODUCTION

One of the most familiar fruits in our lives is Tomato. Tomato and its products are widely used in our day to day lives as they are a source of dietary lycopene and have a great bioavailability after cooking and processing. [1] The number of tomatoes grown globally in 2016 were approximately 177 million tones. Out of these all these tomatoes 160 million tonnes were ripe whereas 17 million tonnes were unripe. China is the largest producer of Tomatoes in the world and accounts for 31% of the total tomato production. India and United States follow China for the Second and the Third Position [2]. Agriculture contributed more than 14% of the GDP and 50% of the workforce in 2013, hence we can say that Agriculture is one of the most suitable field for research in India.

In India Tomato positions third, soon after Potato and Onion however it positions second internationally. There was an expansion in the generation of Tomatoes in India in 2017- 18 by 7.8% when contrasted with 2016-17, anyway there was a 20% expansion when contrasted with the previous 5 years. The major Tomato delivering states in India are Andhra Pradesh, Madhya Pradesh, Karnataka, Gujarat, Odisha, West Bengal, Chhattisgarh, Maharashtra, Bihar, Haryana, Uttar Pradesh, Telangana and Tamil Nadu. These states on the whole produce 91% of the tomatoes in India. The transplanting and Harvesting Period in India relies upon the district. The transplanting and harvesting seasons differ for areas belonging to different states

A few common defects in tomatoes are immaturity and ripening disorders which lead to small and discoloured tomatoes which are not suitable for consumption and doesn't attract the vendors for industrial use. Most of these defectsoccur because of abuse of pesticides and poisons while reaping and not putting away them appropriately. As tomatoes must be expended, we can't supply terrible tomatoes. Consequently the most significant procedure in bundling the tomatoes and after that their supply to the market is arranging as we simply need to send the great quality tomatoes[3]. Over the years development of technologies has been going on to sort the tomatoes on the basis of their colour, size, weight, maturity etc.

These days, more and more companies are giving importance to Industrial Automation for the process of sorting tomatoes as computer machinery and technology these days are fit for taking care of such monotonous errand rapidly and adequately without any error unlike humans which is prone to error as humans usually work for 7-8 hours per day. Working for more hours may lead to workers losing their focus, hence it becomes difficult for them to sort the tomatoes.[1] This problem can be solved by using the proposed system which works for 24 hours 7 days a week continuously. To sort the tomatoes our proposed system uses two TCS3200 colour sensors which are cost effective and identify the colour dependent on the recurrence examination of the yield. Our proposed system aims to develop a simple, efficient and affordable tomato sorting machine which helps us to get good quality ripe tomatoes without any human error. Further the exhibited paper talks about the current writing of tomato sorting machines in Section II. In Segment III, the design of the proposed framework alongside the equipment and programming utilized are examined in detail. In segment IV, execution of the proposed framework is talked about lastly in segment V, the outcomes alongside its cost investigation are displayed. Area VI finishes up the work with its future extension.

 

## II. LITERATURE SURVEY

Discussion about the existing Automated Tomato Sorting Machines along with their various algorithms, their broad issues and limitations is done in this section.

### A. *Broad Issues and Background*

Colour is the most significant component for precisely arranging and organization of tomato. As the buyers nowadays are getting increasingly more worried about their prosperity, they request great quality items. Henceforth mechanized evaluating of agricultural products is the top high need right now among the farmer affiliations since they need to supply these top notch tomatoes inside a brief timeframe. In this manner, the programmed assessment of tomatoes assumes a significant job in quality control for agricultural items , Zhang proposed a framework to consequently sort cherry tomato as indicated by development. An aggregate of nine highlights were extricated from each picture. Tomatoes were ordered into three distinct classes (unripe, half ready and ready). Pictures were put away in the RGB shading space. The Principle Component Analysis (PCA) result demonstrated that the proposed framework had the option to recognize ready tomatoes from develop and half-ready tomatoes. The machine had the option to precisely order 93.2% of tomato test. The utilization of colour sensor would have unquestionably decreased the handling time frame. A machine which sorts and arranges tomatoes and utilizes the three calculations to be specific (SVM),(MLP), and(LVQ) was created in [10]. In the paper, programmed control of tomato quality was investigated dependent on three distinct techniques: LVQ, MLP, and SVM. Pictures were first caught by a camera and after that noise reduction and differentiation improvement tasks are performed on them.

### B. *Automatic Tomato Sorting Machine Algorithms*

1) *Support Vector Machine (SVM):* A Support Vector Machine (SVM) classifier is characterized by an isolating hyper plane. In basic words, given marked training data set (directed learning), the calculation yields an ideal hyper plane which classifies new precedents.
2) *Multilayer Perceptron (MLP):* A class of feed forward ANN is known as a Multilayered Perceptron. A MLP comprises of at any rate three layers of hubs, in particular: an information layer, a concealed layer and a yield layer. Aside from the information hubs, every hub is a neurone that utilizes a nonlinear actuation work.
3) *Learning Vector Quantisation (LVQ):* Learning Vector Quantisation (LVQ), utilizes regulated learning and is an aggressive system henceforth is not the same as both Vector quantization (VQ) and Kohonen SelfOrganizing Maps (KSOM). In this procedure, the examples can be arranged and recognized from one another where each yield unit is represented to as a class. The system is given a lot of preparing designs whose characterization and an underlying appropriation of the yield class is known. Since it utilizes regulated learning, LVQ arranges a contribution by relegating it to a similar class as that of the yield unit.

### C. *Limitations*

The outcomes proposed that SVM has a superior execution contrasted with two elective techniques. The colour sensor could have been utilized rather than the camera to lessen the handling time frame.

## III. METHODOLOGY

The use structure of the proposed framework is depicted by Fig 1. At the first step the IR sensor is used to identify the motion of the tomato. In the second step colour sensors are used to detect the colour of the tomatoes in order to classify them as ripe or unripe. Finally the weight sensor is used to measure the weight of the tomatoes classified as ripe.

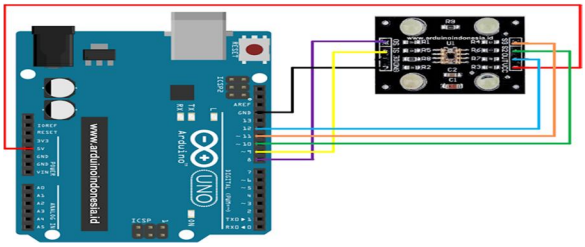

Fig1. TCS3200 Colour Sensor.

1) At a first step, the tomato is passed on from the initial position. It rolls down to a place where it is detected by the IR sensor. The IR sensor tells the microcontroller which is the Atmega328 that a tomato has passed on and hence it should pass on the signal to the colour sensor to detect the colour of the tomato.

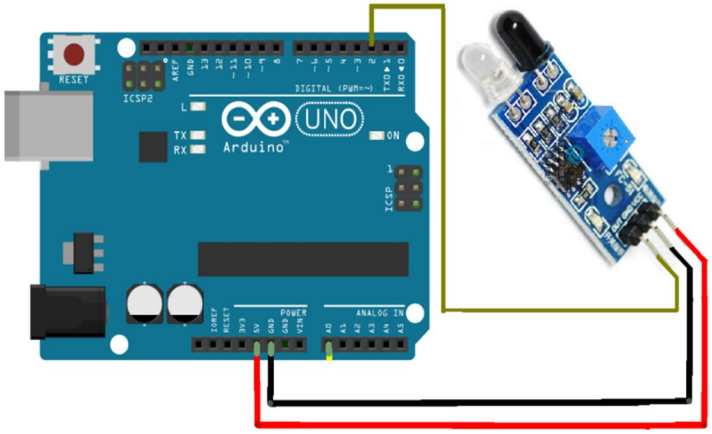

Fig 2. Working of the IR sensor.

2) After passing on from the IR sensor, the tomato rolls on and is stopped by a gate which is controlled by the servo motor. When the tomato stops the colour sensor detects the colour with the assistance of 8x8 cluster of photodiodes. The readings from these photodiodes are then dissected and a relating value is produced by the colour sensor which is passed on to the Arduino micro-controller to decide the colour based on the data set that was created during testing and trials.

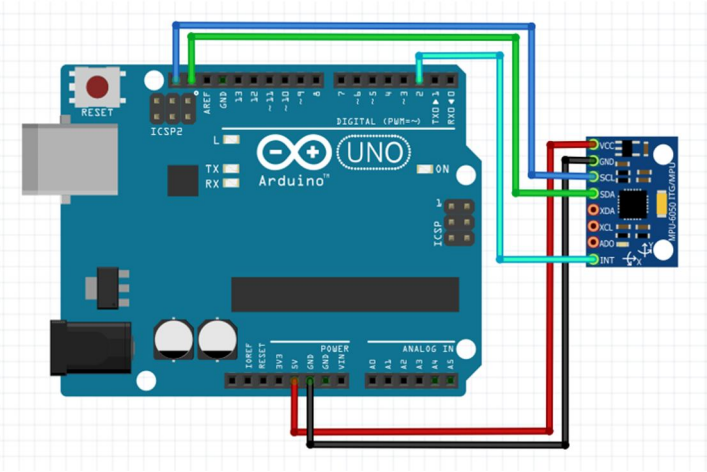

Fig 3. TCS3200 Colour Sensor connection setup.

Fig4. Colour Sensor

*3)* As soon as the colour of the object is decided the first servo motor opens the gate and the tomato passes on. In the next step, the microcontroller gives the signal to the second servo motor after deciding whether the tomato is ripe or unripe and on that basis it opens the gate to the ripe or unripe side and hence segregates the tomato.

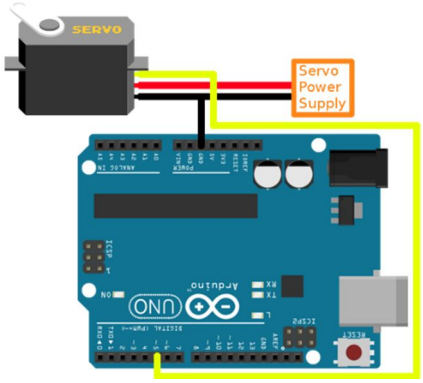


Fig5. Servo Motor.

*4)* Finally when the ripe tomato reaches the end, a weight sensor measures the weight of the tomato to calculate the quantity of ripe tomatoes.

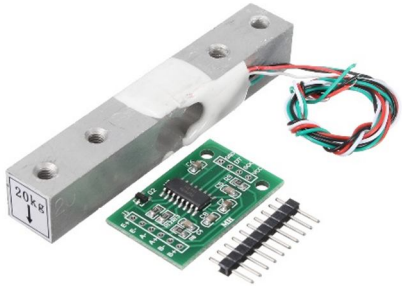


Fig6. Weight sensor.

*5)* The tomatoes are differentiated on 3 basis, Red is considered as ripe tomato Green is considered as unripe tomato Mix is considered as half ripe tomato.

Fig7. Unripe, Mix and Ripe Tomatoes

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## IV. RESULTS

The proposed system, sorts the ripe and unripe tomatoes so that human power is minimized and there is less scope for error.
The proposed system with 1 channel right now sorts 1 tomato in 2.5 seconds which sums up to approximately 1500 tomatoes per hour and 36000 tomatoes per day.

*1)* If the frequency for red light lies between the range of 70 to 120 then the tomato is considered as a Red and Ripe tomato
*2)* If the frequency for green light lies between 100 and 199 then the tomato is considered as a Green Tomato

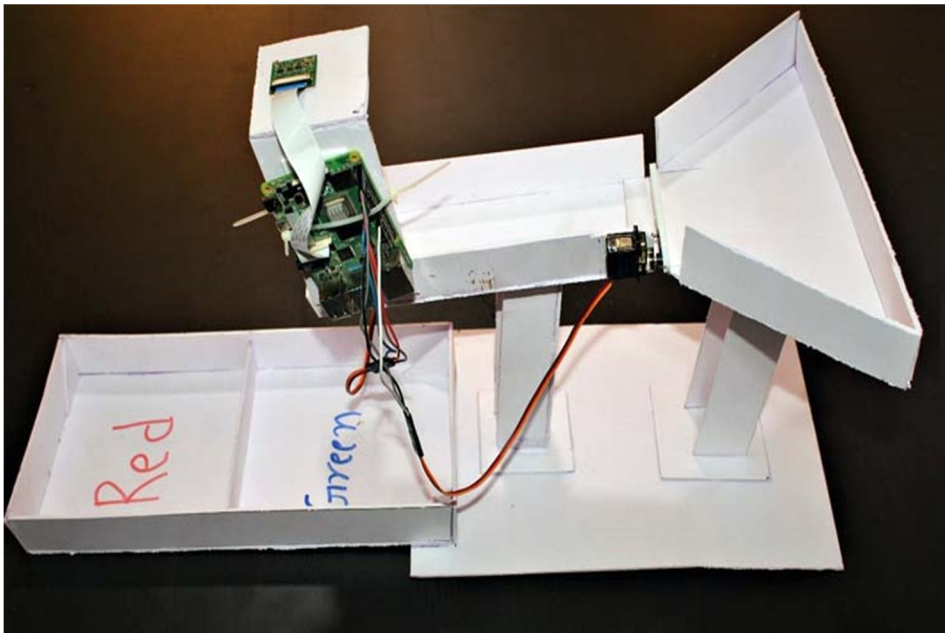
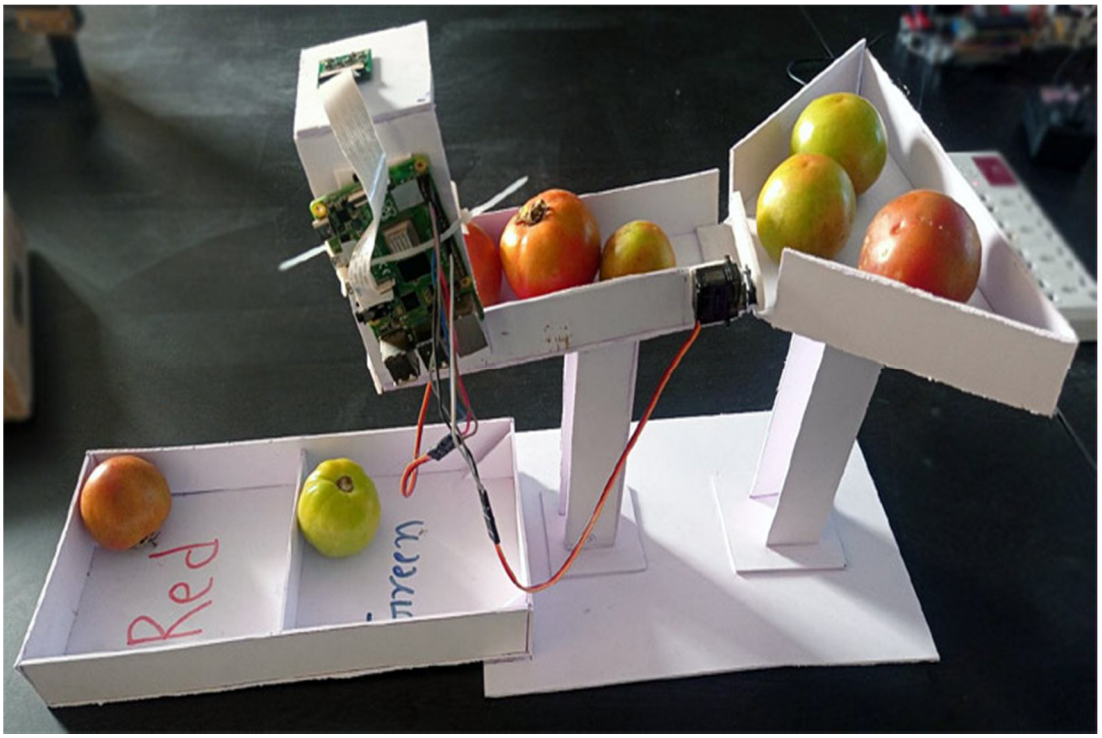
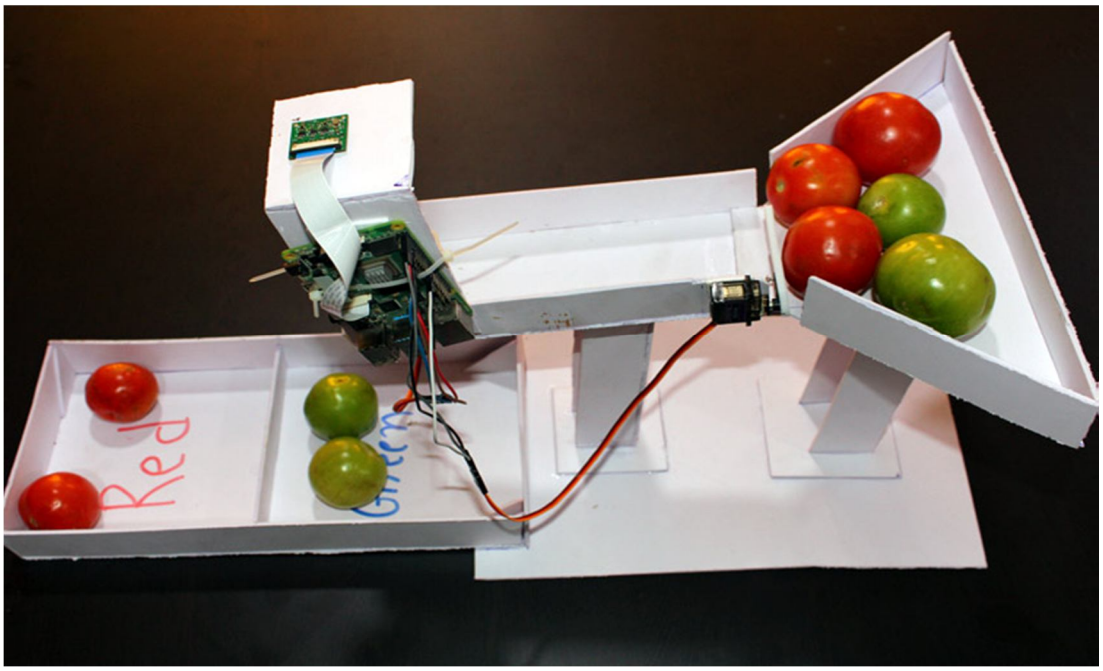



Fig8. Proposed Tomato Sorting Machine.

## V. OUTPUT IMAGES






## VI. CONCLUSION

For the design and development of the proposed system which is the Tomato Sorting Machine, TCS3200 colour sensors have been used. The machine consists of a conveyor system which is a ramp, the sorting unit, two TCS3200 RGB colour sensor, IR sensor, Servo motors, weight sensors and an Arduino Uno board. The colour of the tomato passed is detected by the TCS3200 colour sensors along with a PIC development board which is the Arduino Uno. Arduino Uno depends on the ATmega328 micro controller and controls the general procedure. The tomatoes go in a straight line on the incline to the arranging point. The distinguishing proof of the colour of tomatoes passed on should be possible by checking the recurrence examination of the yield of the colour sensor. The sorting of tomatoes as ripe and unripe is based on the colour intensity captured by TCS3200 colour sensor. After vigorous testing and considering all the factors involved the proposed system is working with 93.33% accuracy.

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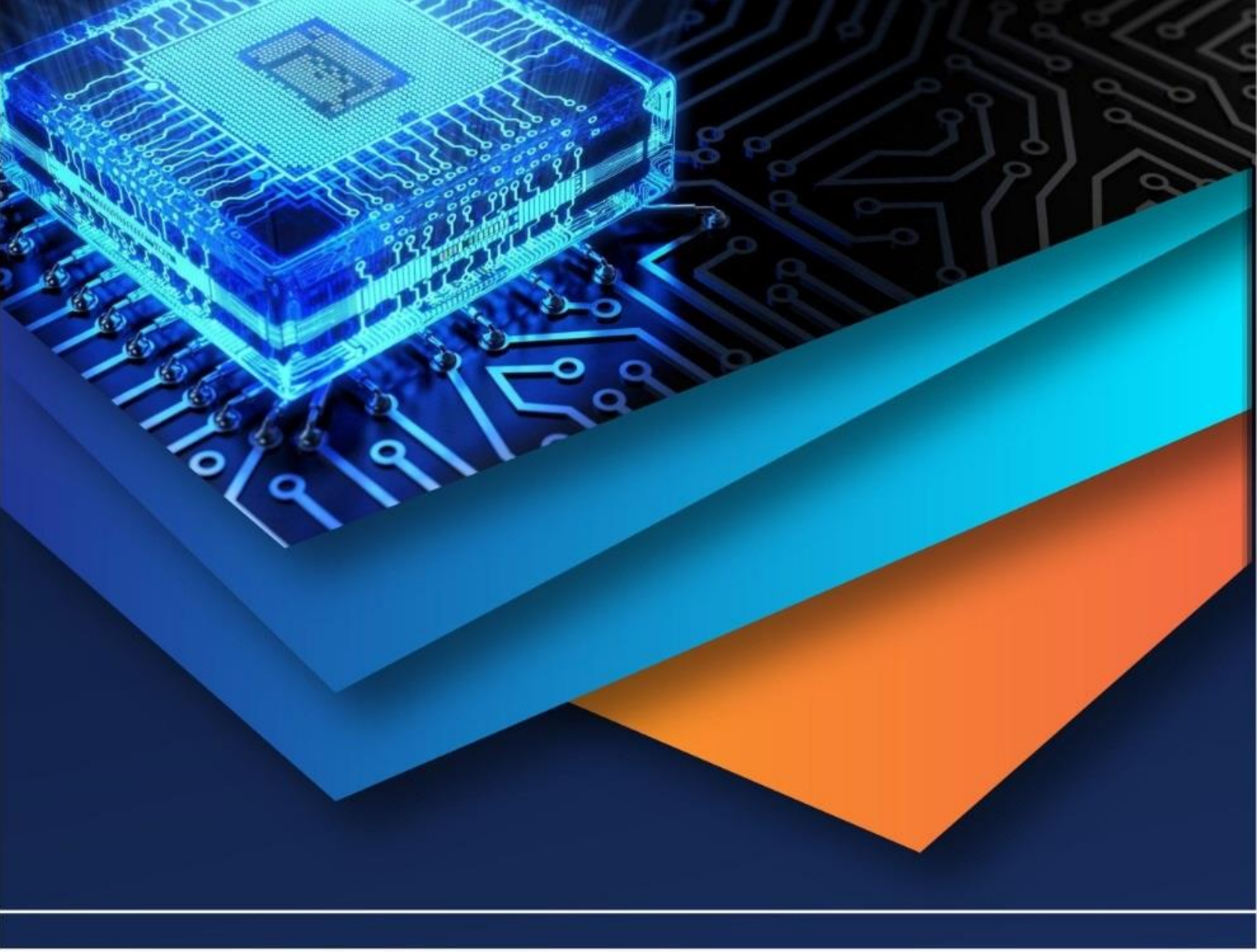

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