iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** V **Month of publication:** May 2020

DOI: http://doi.org/10.22214/ijraset.2020.5081

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

Smart Garb - A Wearable Safety Device for Women

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Abstract: ***Nowadays women harassment is increasing and women's safety is a big question mark. India is one of the most dangerous places for women to live in. Times of India reported the data by the National Crime Records Bureau unveiling that 93 women are being raped in India every day. This should be considered seriously in a developing country like India as it greatly affects women empowerment ultimately affecting the growth of the Indian economy. Most of all everyone should have the right to freedom. Clearly this is a bigger problem and there are many systems like SHE(Society Harnessing Equipment), VithU app, etc out there to solve it. But the main issue with these systems is that it requires victim intervention to trigger it. Not every time a victim can trigger the system and according to a study conducted on rape victims, 78% of victims reported that they were paralyzed during the assault and they even felt guilty for not being able to defend them. It is clearly obvious that those systems that require human intervention are not efficient. There are also very few systems that don't require any kind of human intervention, but the efficiency of those systems are not up to the mark. This paper suggests a model where zero victim effort is required to trigger the system. This model utilizes the power of IoT with a device that can detect physical assault on the user. The core of the device is a highly pressure-sensitive garb. The pressure data and other features are fed to a machine learning algorithm which makes predictions on it. If the prediction turns out to be true then the police and emergency contacts set by the user are immediately informed about the happenings along with the location and time. The location and alerting is done using an application connected to the system. So this model will require a location-enabled device with an active internet connection. This model can also be made to work without these. But as there is a need for communication, a GSM module is required which results in the increased size, cost of the device. And also to make the model learn and improve over time, all the relevant data are stored and fed back to the algorithm.***

Keywords: Women Safety, Smart devices, IoT.

I. INTRODUCTION

The Internet of Things (IoT) is becoming a major part of human life unknowingly. Giving machines the ability to communicate with each other and with humans is the Internet of Things. By making use of the internet, every machine can be controlled by anyone with the right access anywhere from the world.

IoT is continuously evolving and is greatly flexible to work with. It can also be used in any crucial situation provided that there exists a reliable internet connection.

With that in mind, this paper focuses on providing security for people facing physical sexual harassment. In many developing countries, the safety of its citizens has always been a question mark. People are facing harassment in their daily life and the worst of its kind is sexual harassment. We humans did many technological advancements and improvements to protect our species from other threats.

But what we failed to do is protect our species from our own species. The major reason for sexual violence is illiteracy, anger, sadism, power, dominance and etc. To protect people from this, there is clearly a need for a system that is capable of saving the victim as soon as possible at the time of violence. There are many systems proposed to solve this issue but unfortunately, most of them require human intervention to trigger it.

A system completely relying on the intervention of any kind from the victim is not efficient because not every time the victim can reach out to the trigger and in fact, in most cases, the victims are paralyzed. Some systems exist which are not completely dependent on an action to trigger it, but the accuracy of those systems is very low. With low accuracy, those systems can never be used in crucial situations like this. So there is a need for a system that should not be completely dependent on an action to trigger it and it should have high efficiency, accuracy and should be easy to use.

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II. LITERATURE SURVEY

The systems that are proposed for providing safety to an individual during the violence are categorized based on the methodologies that they use to overcome the issue. The most basic methodology is using a shock circuit which can be used to shock the attacker. The core objective of proposals under this category is to create a basic defense mechanism using which the victim can defend themselves from the attacker. A Self Defence Device [1] is proposed where the device is a shock circuit that can be activated with a valid fingerprint which can be then used to shock the attacker. On activation, the system also sends location-based alerts to the emergency contacts with the help of GSM and GPS.

Another proposal made under the same category suggests a wrist band [2] with an inbuilt shock circuit. When the display of the band is tapped twice, the system gets activated and the current flows through the two nodes present on the top of the wrist band. The system is also capable of sending location coordinates to the emergency contacts using the GPS module. The next methodology is using Audio and Video Recording.

The core objective of proposals that fall under these categories is to collect evidence of the violence. A Smart Ring [3] is suggested which is a Raspberry Pi system with a Raspberry Pi Camera. In case of any emergency, the victim is required to press a button on the ring which trips the camera to capture images.

The captured images are then stored in the server and the links to the images along with the location are sent to the emergency contacts set by the user. Another system is proposed which does the same but all the components are hooked inside a Smart Shoe [4]. A system named ProTecht [5] is proposed which also records the video and audio from the environment and alerts the trusted contacts. One thing unique in this system is that it is voice-enabled with the help of Google assistant. The whole system can be triggered with a single voice command. In addition to that, this system also has a shock circuit. The most common methodology that is popular in IoT is using sensors.

The proposals that fall under this category mainly focus on collecting data from one or more sensors and determine the safety of an individual with those. A Women Self Protecting system [6] is proposed which monitors the body of the individual using it with the help of various sensors. These sensors are also known as vital signs monitoring sensors which include temperature sensors, pulse rate sensors and motion sensors.

The data from these sensors are sent to a microcontroller which then processes it to determine the safety of the individual. In addition to this, there is also a manual switch that can be triggered in case of an emergency. Another proposal that falls under the same category is A Smart Intelligent System for Women and Child Security [7]. This system uses a pressure switch that can be set off by the victim in a panic situation. This proposal also uses a unique methodology known as geofencing to virtual lockdown a child in a geographical area. If the child is detected to be crossing the virtual boundary then the parents and emergency contacts get an alert about it.

The most advanced methodology of all is using machine learning. Learning and performing prediction is the core objective of the proposals that fall under this category. A Women Safety Device [8] is propounded which collects data on the temperature and pulse rate of the individual.

A logistic regression model is applied to the collected data to predict safety as a binary value (ie., Danger/ Safe). Based on the prediction value, the system will decide whether to alert emergency contacts or not. Another proposal using machine learning is a Smart Foot Device [9] which has an accelerometer placed in the footwear that sends the data to a mobile application. In case of danger, tapping the footwear with another leg will trigger the system to send alerts to the contacts registered. Here, supervised learning is applied to the data received from the accelerometer to predict whether it is a tap or a walk.

III. PROPOSED SYSTEM

The proposed system mainly focuses on eliminating the need for human intervention. This system consists of two units, a sensor unit, and a transceiver unit. The sensor unit consists of a collection of pressure sensors. The transceiver unit holds a communication-enabled microcontroller that transmits the data received to the connected application for processing. The application is responsible for performing logistic regression on the received data to predict if it's safe or unsafe. If the prediction turns out to be unsafe, then immediately emergency contacts and police are informed. The alert will hold the exact location coordinates of the victim and time of the assault which makes it easy to track. In addition to this, to make the model learn and evolve over time, all the relevant data with proper user feedback are stored and fed to the model.

The block diagram of the proposed system is shown below,

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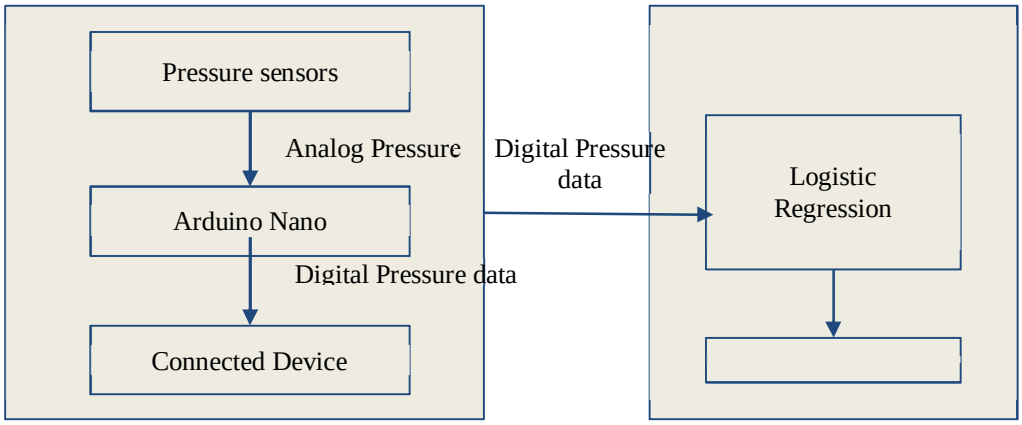


Fig:1 Block Diagram of the system

A brief about the components in the block diagram,

A. Pressure Sensor

There are a variety of pressure sensors capable of measuring accurate pressure readily available in the market. But those sensors lack flexibility. The pressure sensor used in this project is made by placing a flex and pressure resistive conductive sheet (Velostat) between two flexible conducting nodes. Now, this setup wholly acts as a sensor capable of measuring pressure, as the resistance of the Velostat decreases when pressure is applied on the surface allowing more current to flow through. The current flow can be measured as an analog value which then can be correlated as a pressure value. This sensor is more suitable for this project as,

1) It is flexible
2) It is water-resistant
3) Comfortable to wear

B. Arduino Nano

Arduino nano is a microcontroller with 22 IO pins out of which 8 are analog pins. The operating voltage is 5V which is also enough to drive the pressure sensors. It also supports communication protocols such as serial, I2C, and SPI which makes it handier to use.

C. Communication Module

A communication module will be needed to transfer the analog pressure data from nano to the application running on the connected device. The module can be WiFi or Bluetooth. But using WiFi makes the system more reliable because of the wide area of coverage.

D. GSM/GPS Modules

To make the system run independently without any need for another device and internet connection, GSM and GPS can be used. GSM is Global System for Mobile Communication which can be used for communicating alerts and GPS is Global Positioning System which can be used to get the location coordinates of the user in case of danger to make the alert.

IV. IMPLEMENTATION

This proposed system consists of two major modules,

1) Module-1: Sensor buildout using Velostat (Conductive Sheet)
2) Module-2: *Integration of machine learning algorithm*

A. Sensor buildout using Velostat (Conductive Sheet)

In this module, the Pressure sensor is made of two conducting nodes separated by flex and pressure resistive conductive sheet. When pressure is applied on the surface of the sensor, the resistance of the sheet decreases allowing more current to flow through. This current flow can be measured using the analog pins of the Nano. The measured data can then be correlated to get a standardized pressure value.

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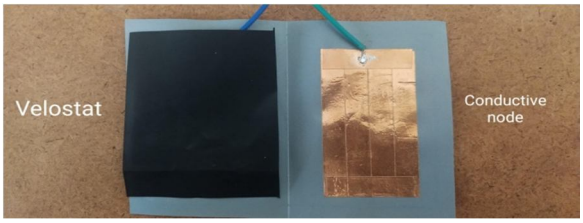


Fig:2 Inner view of the Sensor

B. Integration of machine learning algorithm

To increase the efficiency of the system and to make it more reliable, machine learning is used. It also makes the system dynamic and customized for users.

1) Algorithm (Logistic Regression): Logistic Regression is a machine learning model that uses a logistic or sigmoid function to fit an s-curve among the given data points. This algorithm takes a binary class as input labels and makes a probabilistic prediction on the given value (ie., 0 to 1). Unlike linear regression, the prediction value will not be exactly 0 or 1. Rather it will be a value somewhere between 0 and 1. If the value is much closer to 1, then it is considered as 1 and vice-versa.

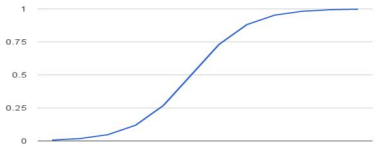


Fig 3: Sigmoid Function Curve

The sigmoid function for logistic regression is, $f(X) = 1 / (1 + e^{-X})$ where e is the base of the natural logarithm.

V. WORKING METHODOLOGY

The working methodology of the whole system is explained in detail

A. The stream of analog pressure data from the collection of pressure sensors is captured and converted to digital data within a range of 0-1023.

B. This continuous stream of converted digital data is then sent to the application running on the connected device.

C. The application performs logistic regression on the incoming data using a trained model.

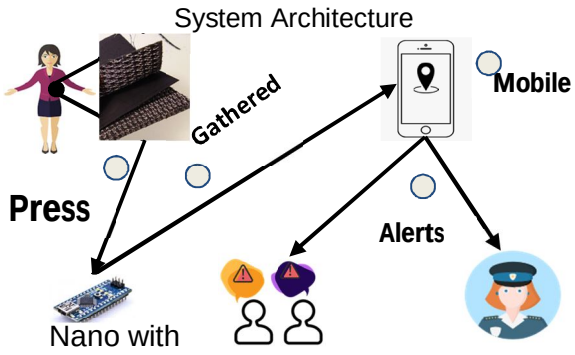


Fig 4: System Architecture

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D. If the prediction turns out to be unsafe, the time and location details are obtained from the device and sent as an SMS to the emergency contacts.

E. Else the prediction will continue on the next data until the user manually turns it down (optional).

VI. RESULT AND DISCUSSION

A breadboard version of the whole system is shown in the image below,

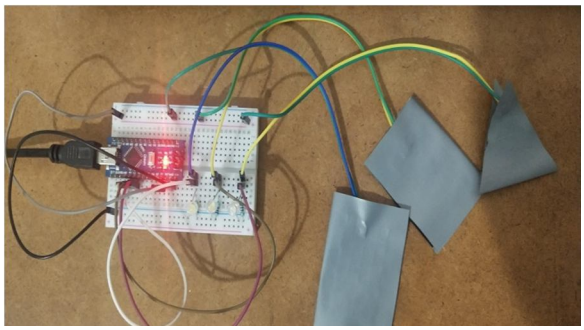


Fig 5: BreadBoard version of the System

Only the sensor and processing units are shown as the communication module is customizable. For the sake of simplicity and easy understanding, serial communication is used.

A snapshot of the application running on the connected device is shown below,

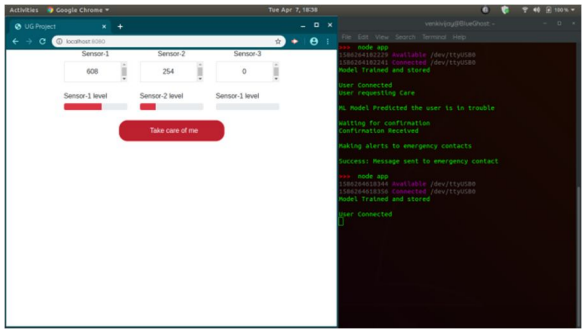


Fig 6: Typical User Interface

The machine learning model (Logistic Regression model) shows an accuracy of 96%. The confusion matrix shown below explains a lot of information. The false-negative prediction is what matters a lot and it seems to be 2. As the model is retrained on every user feedback, there is a higher possibility for the false-negative to become 0.

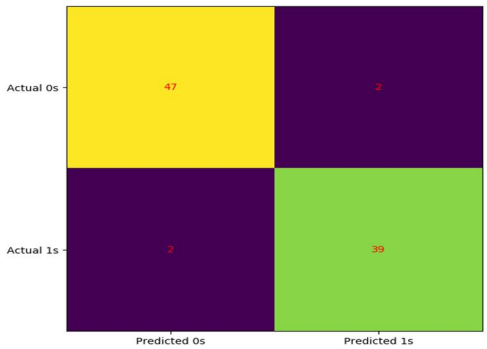


Fig 7: Confusion Matrix

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The ROC curve shows that the model is so close to perfect with a true-positive area of 0.96. Over-time when the model is retrained, this area will undoubtedly increase.

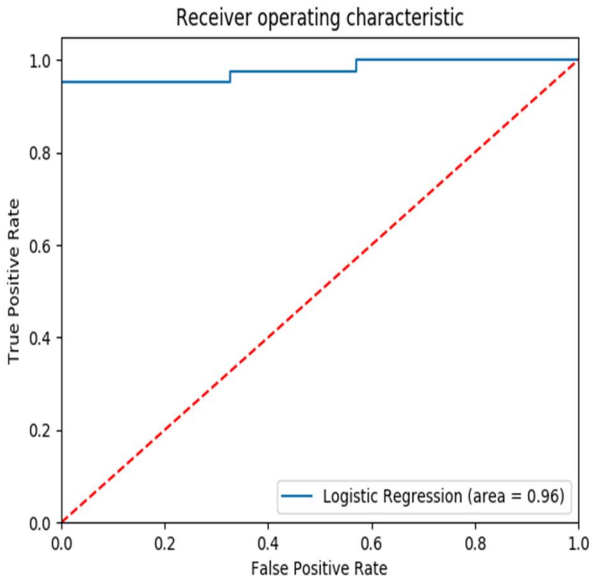


Fig 8: ROC (Receiver Operating Characteristic)

A snapshot of the SMS received by an emergency contact is attached below,

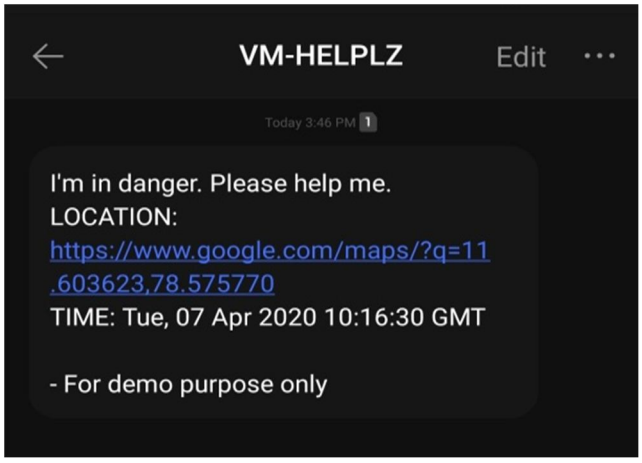


Fig 9: Typical Alert SMS

The SMS received contains the exact location of the user along with the exact time of the assault happening.

VII. CONCLUSION AND FUTURE WORKS

An individual's wellbeing is a major social issue that should be illuminated desperately by the exertion of all. We can't state that an individual is protected in India by observing the most recent couple of year wrongdoings, particularly in the national capital. Ladies, for the most part, feel alarmed while going alone outside to the home. The individual security has been the subject of significance for each Indian resident. So as to improve the condition in regards to everyone's security, this project has been introduced. This project as a whole shows full support to the safety of an individual in dangerous situations. The machine learning model is tweaked and tuned to perfection. A more optimized wearable version of the system can be developed as a future work. The solid wires can be replaced as more flexible and strong wires to make it more comfortable to wear. Instead of using a collection of sensors, a matrix of sensors can be developed to get more precise pressure values.

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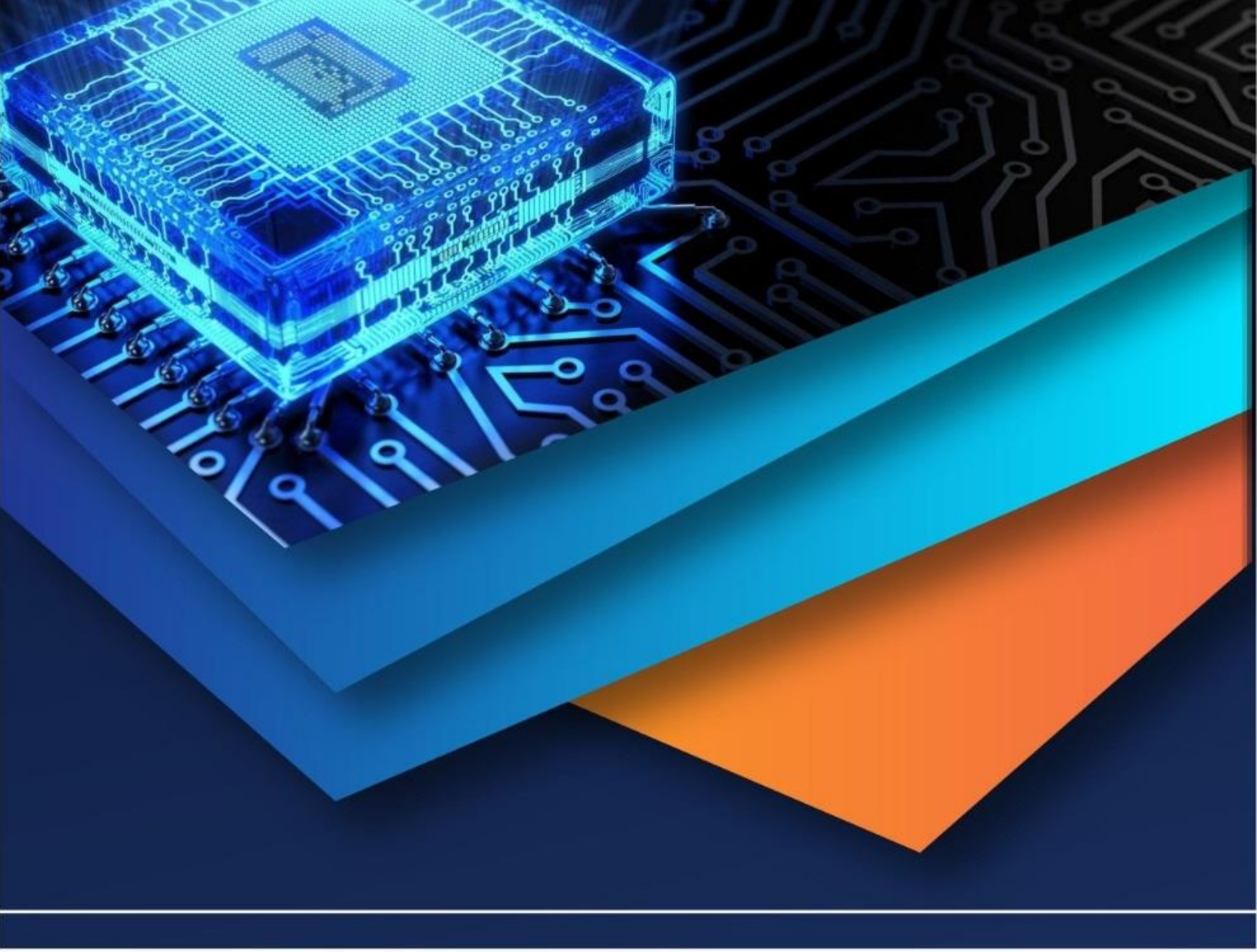
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