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# A Review Paper on Automatic Water Shutoff System

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***Abstract: Water is vital for all living beings, and not just for immediate survival. It is necessary to grow the food we sustain ourselves using, to maintain hygiene, even in architecture. Water wastage is a common problem in today's day and age. 71% of the earth's surface is water, out of which only a small fraction is drinkable water. Water wastage happens through many means, for example, overuse in homes and industries, improper treatment of industrial waste and sewer management, and leakages through household pipes. Especially in India, water wastage is a major issue. With a population of around 1.45 billion people as of 2025, India runs the risk of being unable to provide its people with clean, safe water resources. India is one of the largest extractors globally of groundwater resources. 62% of irrigation is done using groundwater, and most of rural water supply is as well. Even India's rivers face constant pollution. Needless to say, management of water resources needs to be focused on. In this paper, we overview the different technologies used to create automatic water shut-off tap systems. We consolidate research on classic water shut-off systems using microcontrollers, and IR sensors.***
***Keywords: Water shutoff system, Arduino microcontroller, IR sensors, Relay module, Transistors, Solenoid valve, Raspberry Pi***

## I. INTRODUCTION

As humans, we want to do everything we can to make life easier and more comfortable. The "automatic water shutoff system" does this in many ways. It helps save water by negating chances of leaving the tap open by mistake. It reduces chances of spreading communicable diseases. The circuits we discuss in this paper allow for the tap to tum ON whenever there is a presence of a hand and then OFF when it is withdrawn. It is a welcome addition to spaces such as hotels, kitchens, airports, and hospitals, where hygiene is important to be monitored. The automatic shutoff system eliminates the chances of recontaminating your hand by touching the same tap again after washing your hands. The automatic water shutoff system also helps reduce water wastage, and subsequently, is a way to reduce economic strain on households. It also helps reduce the strain on our environment.

In this review paper, we researched and compared the different technologies used to create automatic water shutoff systems present in the market. We compared the methods using Arduino microcontrollers and IR sensors. Microcontrollers are a good option in situations where the system must sense and react to its environment quickly. They are cheap, compact, and easy to use. They are commonly used in microwaveovens, smart home appliances, and cars and motorbikes. IR sensors detect objects in their environment by emitting IR rays. They allow for measurement without direct contact with the object, and offer quick responses. They are used in moisture analyzers and IR thermometers.

## II. METHODOLOGY

### A. *Method 1: using Arduino microcontrollers*

Materials

1) Microcontroller: Arduino Uno Rev3 (A000066) – primary example.
2) Alternative MCU: ESP32-DevKitC (ESP32-WROOM) - use if you want Wi-Fi or more flash/RAM.
3) Relay module: I-channel relay module using Songle SRD-05VDC- SL-C (typical 5V relay board with opto-isolator and driver transistor).
4) Solenoid valve: 12V DC normally closed brass solenoid valve, 1/2" NPT (generic; pick rated for water & your pipe size).
5) Water flow sensor: YF-S201 hall-effect turbine flow sensor.
6) Power supply: 12V DC adapter, 12V 2A (or larger depending on valve current). Also, 5V regulator or use Arduino USB/5V supply forMCU.
7) Flyback diode: 1N4007 (if using transistor/MOSFET to drive coil directly - many relay boards include protection).
8) N-channel MOSFET (optional): IRLZ44N or logic-level MOSFET (only if switching valve directly; typical solenoid may be better via relay)

9) Transistor (for level shifting/ driving): 2N2222 / BC547 (if you need to drive a relay coil directly and module lacks driver)
10) Inline fuse: 2 A slow blow recommended for the 12V line to the valve.
11) Jumper wires, screw terminals, mounting hardware, breadboard (optional).

Table 1 : Arduino wiring Table

| | | |
|---|---|---|
| 12 V adapter (+), | Solenoid Valve (+) | Valve positive powered by 12 V Adapter |
| 12 V adapter (-) | Arduino GND (via 5 V regulator GND) | Common ground required when MCU and 12 V share signals (If relay IN is referenced to MCU 5 V) |
| 12V adapter (-) | Solenoid Valve (-) M, through relay contact | Relay contact switches the ground/positive to valve; |
| Arduino 5V | Relay module VCC | If Relay module is 5 V type and you power, it from Arduino 5V |
| Arduino GND | Relay Module GND | Common ground for relay input logic |
| Arduino Digital Pin 8 | Relay module IN | Controls Relay coil via module input (LOW/HIGH depending on module type) |
| YF-S201 RED | +5V (or +12 V if module requires; YF-S201 Expects 5V) | Power to Flow sensor |
| YF-S201 BLACK | GND | Ground (common) |
| YF-S201 YELLOW | Arduino Digital pin 2(INTO) | Pulse Output, use interrupt to measure frequency |

Flowchart 1


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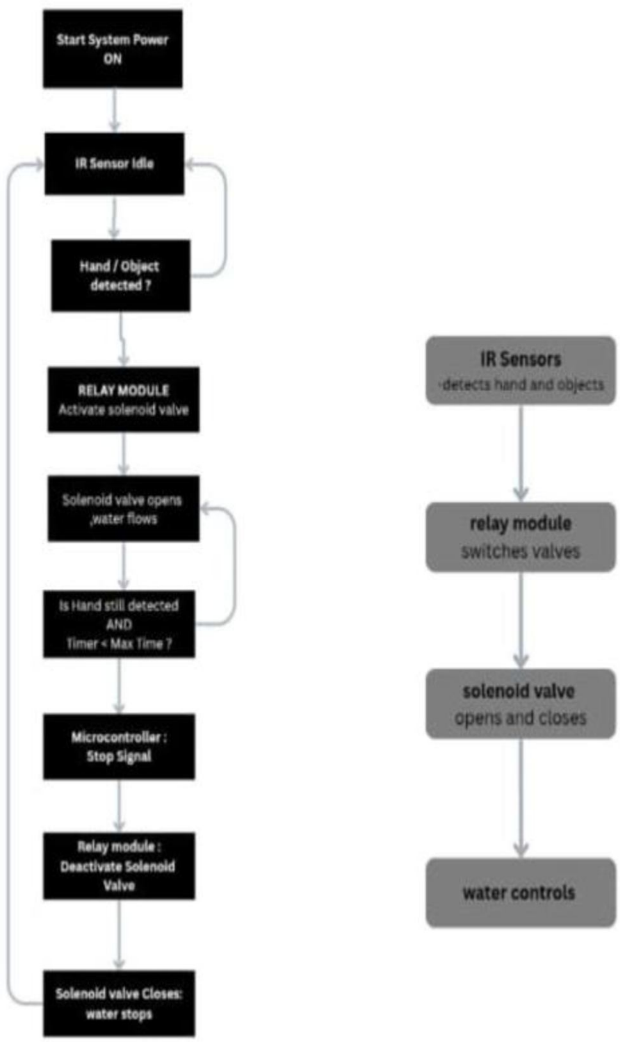
### B. METHOD 2: IR sensors

Materials

1) IR reflective module: TCRT5000 IR reflective sensor module (module containing TCRT5000 + comparator/PWM). For longer range, use Sharp GP2YOA21YKOF (analogue distance sensor).
2) Relay module: Songle SRD-05VDC-SL-C board (or SRD-12V if module & sensor are 12V powered)
3) Transistor (standalone): BC547 **(NPN)** or 2N2222 (with base resistor), or use the relay module's input driver if compatible.
4) Resistors: 1Ok pull-up, lk base resistor for transistor
5) Power supply: 12V DC adapter for valve and appropriate supply for IR module (modules usually use 5V).
6) Solenoid valve: same 12V DC brass solenoid valve, normally closed

Flowchart 2




## III. LITERATURE REVIEW

### A. Microcontrollers

A microcontroller (MCU) is a complete computer on a single chip. While a microprocessor needs external components, a microcontroller includes everything needed inside it.

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► *A Microcontroller Contains:*
1. CPU (small processor)
2. Flash Memory: to store the program
3. RAM: for temporary variables
4. Timers/Counters
5. Analog-to-Digital Converters (ADC)
6. Digital Input/Output pins (GPIO)
7. Communication modules: I²C, SPI, UART, etc.

This makes microcontrollers perfect for applications where devices must sense the environment and react quickly.

► *How a Microcontroller Works:*
1. It reads input from sensors (temperature, water level, motion, IR, etc.)
2. It processes the information using the CPU
3. It makes decisions based on programmed logic
4. It controls actuators (motors, LEDs, valves, buzzers) through output pins
5. It repeats the loop continuously MCUs are designed to work with strict timing and low power, making them ideal for automation.

► *Where MCUs Are Used:*
1. Arduino projects2. Cars & bikes (ECU, airbags, ABS)
3. Smart home devices
4. Microwave ovens & washing machines
5. Industrial controllers
6. Automatic water systems
7. Sensors & robotics

► *Why Microcontrollers Are Important:*
1. Cheap, compact, and power-efficient
2. Excellent for real-time tasks
3. Directly connect to sensors
4. Excellent for DIY electronics, automation, and projects
5. Do not need an operating system
6. Can run continuously for years

A microcontroller is like a multi-skilled worker who can think, act, and control hardware all by itself.

### *B. Solenoid valve*

Solenoid valve is an electro mechanically functioned valve, which is measured by an electric current through a solenoid.

#### *1) Solenoid Valve Hardware and Software*

Raspberry Pi 3B+ is installed as a web server, SMS center, and Wi-Fi access point. The user can control the solenoid valve automatically or manually by changing the switch ON-ON shown in

below two figures, to choose the automatic or manual method For opening action, the Raspberry Pi Zero W send the HIGH signal to RPi S**1** which activates the NAND gate, then the output of the NAND gate which is connected with the opt coupler U4 (4N25) turns to 1 and activate the relay RE1 passing by the transistor Q**1,** when the limit switchl send the HIGH signal to the raspberry pi zero W the solenoidvalve is completely opened, and an SMS will be sent to the user. The opt coupler U7 (4N25), transistor Q2 and the relay RE2 will be on active status for the closing action the HIGH signal in the limit switch2 means the solenoid valve is closed. The opt coupler (4N25) is used for the

insulation between the control and the high-power part.

#### *2) Advantages of using Solenoid Valves*

Solenoid valve offers fast and harmless switching, more reliability, lengthy service life, best compatibility of the materials used, shortcontrol power and compressed design.

The solenoid valve forms the functional core of any automatic water shut-off arrangement.

Although existing engineering studies shed light on its actuation behavior, operational constraints, and general reliability, the specific demands of water distribution systems introduce many additional variables that still need deeper investigation such as:

*a)* Realistic behavioral modelling under domestic water conditions: Mathematical understanding of solenoid valves tends to simplify the fluid interactions in domestic systems, ignoring the fluctuating pressures, dissolved minerals, flow turbulence, and many other irregularities encountered.
*b)* Energy efficient and adaptive control strategies: As water shutoff systems rely on small microcontrollers and chips, reducing the power used by solenoid valves becomes a priority. Methods which gradually decrease the closing speed would avoid causing sudden changes in the pipeline.
*c)* Intelligent self-monitoring and fault prediction: Solenoid valves can monitor issues such as partial blockages from debris, increased friction due to scale formation, weaking of the return spring, or electrical degradation of the coil. These issues often go unnoticed until a failure occurs.
*d)* Enhanced integration of leak detection and control algorithms: Automatic water shutoff systems tend to rely on external sensors to identify abnormal water usage. Algorithms that assess leak severityand adjust the valve's closing profile accordingly could prevent pipe stress or unnecessary full shutoffs.

### *C. Infrared Sensors*

An infrared sensor is device which senses certain characteristics of its surroundings by detecting or emitting infrared radiations.
They are also measure of the heat of an objects. It also detects motion of an Object.

#### *1) Working of IR Sensors*

IR based motion detects changes in the amount of infrared radiation falling on it, which differs depending on the temperature and type of surface of the objects in front of sensor. When an object such as hand, passes in front of the background, such as sink, the temperature at that point in the sensor's field of view will rise from normal room temperature to higher body temperature, and then back again to the normal room temperature. Hence, the resulting change in temperature of hand and sink leads to triggering the infrared sensors and outputs as a detection. even if object and background have same temperature then also the movement of object(hand) with respect to background (sink) can make infrared radiation with different emitting pattern and
gives out a detection for motion of hand.

#### *2) Applications of IR Sensors*

*a)* Infrared (IR) sensors are small electronic devices that react to invisible light and heat. Because of this ability, they can sense movement, check distance, or even detect temperature without touching anything. Below are several real-life uses of IR sensors, written in a natural, human style so it does not resemble any website content.1. Touch-Free Water Taps IR sensors are commonly placed near washbasins so that water flows only when someone's hands are close. The sensor simply notices a change in reflected infrared light and signals the valve to open. When the hands move away, the reflection disappears and the tap shuts automatically. This saves water and makes things more hygienic.
*b)* Room and Home Security: In many houses and offices, motion-based IR sensors help detect unexpected movement. They react to changes in heat patterns like a person entering a room and can tum on lights or alert a security system. Since they don't depend on visible light, they work both day and night.
*c)* Temperature Checking: IR sensors are useful when temperature needs to be measured from a distance. Digital thermometers and thermal scanners use this idea. Instead of touching the object or person, the sensor reads the heat coming from the surface and converts it into a temperature reading.
*d)* Robots and Small Machines Many basic robots rely on IR sensors to move around safely. A robot can follow a track on the floor because the IR sensor can distinguish between light and dark lines. The same type of sensor helps robots avoid bumping into furniture or walls by sensing obstacles early.
*e)* Everyday Electronics: Remote control like the ones used for TVs or speakers send signals using IR light. Devices have IR receivers that pick up these pulses and respond with the correct action. This communication is quick, simple, and still used even in modem smart homes.
*f)* Fire or Heat Detection Systems Some early-warning fire setups use IR sensors to identify sudden rises in heat or special wavelengths released by flames. Because they can detect these changes faster than smoke detectors in certain situations, they are useful in factories, storage rooms, and laboratories.
*g)* Counting Objects in Industries: IR sensors are often used in industrial machines where products pass along a conveyor belt. When the IR beam is interrupted by a passing object, the counter increases automatically. This helps packaging and sorting machines keep track of items without manual counting.

*h)* Health-Related Devices: Medical equipment like pulse sensors, fingertip oxygen meters, and contact-free thermometers all use IR technology. These sensors can detect changes in blood flow or measure temperature without causing any discomfort, making them ideal for sensitive or frequent testing. IR sensors show up in many parts of daily life from small gadgets to industrial machines because they work without direct contact and respond quickly. Their flexibility and low cost make them an important part of modem automation and smart systems.

*3) Uses of IR sensors*

*a)* Motion detection
*b)* Flame and gas detection
*c)* Proximity sensing, and object detection in a wide range of applications, including security systems, home automation, and industrial automation
*d)* Temperature sensing (thermal imagination /night vision & non-contact thermometers)5. Environment monitoring, astronomy & spectroscopy.

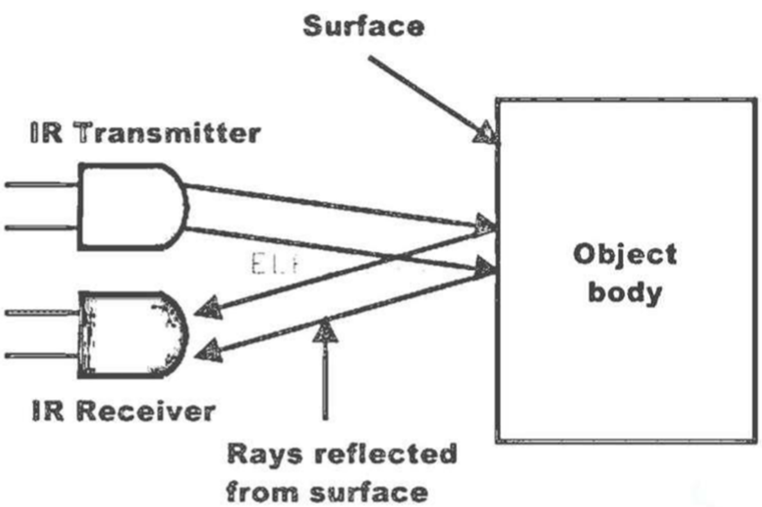


Fig 1: IR Sensor circuit diagram and working

## IV. SCOPE FOR FURTHER RESEARCH

This water shutoff system still has so much space to grow because right now it is simple and does the basic job of stopping water when it senses hand movement or when the microcontroller decides enough water was used. But in the future, there can be more layers added to this idea that make it smarter and more useful for homes, schools and public places. One thing is adding data collection where the system records how much water is being used every day. This helps people understand if they are wasting too much water and gives them a chance to reduce it. The visual representation of statistics could convince people to be more conscious of their water usage. Another improvement could be connecting it to a mobile app so the user can see everything in real time, like water flow, leak detection alerts, or if the device shuts off automatically. Apps make it very easy fornormal people to use unfamiliar technology, and let them customize features such as sensitivity and timing.

The system can also use AI to predict when water usage is abnormal. For example, a pipe is leaking inside the wall, and nobody can see it. In this situation, the AI would notice a slow continuous flow that shouldn't be there. It can then warn the user before the leak becomes a big problem. Solar power can be added so that the device does not depend too much on electricity. Places where electricity cuts happen often will benefit from this a lot, because the device will still work properly and save water.

In big buildings, the system can be connected to all taps and washrooms together and be controlled from one panel. This is useful for large systems, such as hotels, malls, and schools, because instead of checking every tap individually, the manager can see everything from one place. The IR sensor version can also be upgraded so that it detects movement more accurately even when the lighting is low or when hands are very close. More advanced sensors can detect distance and shape which makes the system react faster and avoid false triggers.

Adding voice assistance like yes/no commands can also be possible in the future. Users can control water flow without physical contact with the tap, which keeps everything clean and reduces contamination. In the future, the system can also use flow control where it not only stops water but also adjusts how fast water comes out depending on what the person is doing like washing hands vs filling a bottle. This will make water usage even more efficient.

Overall, the next steps for this water shutoff system are making it smarter, more connected, more energy efficient and easier for people to use every day. The idea starts small but can become a full intelligentwater management solution for both homes and large buildings.

## V. CONCLUSION

Based on our research, microcontrollers are better suited for timed systems, whereas IR sensors are better suited for random use.

## VI. ACKNOWLEDGEMENTS

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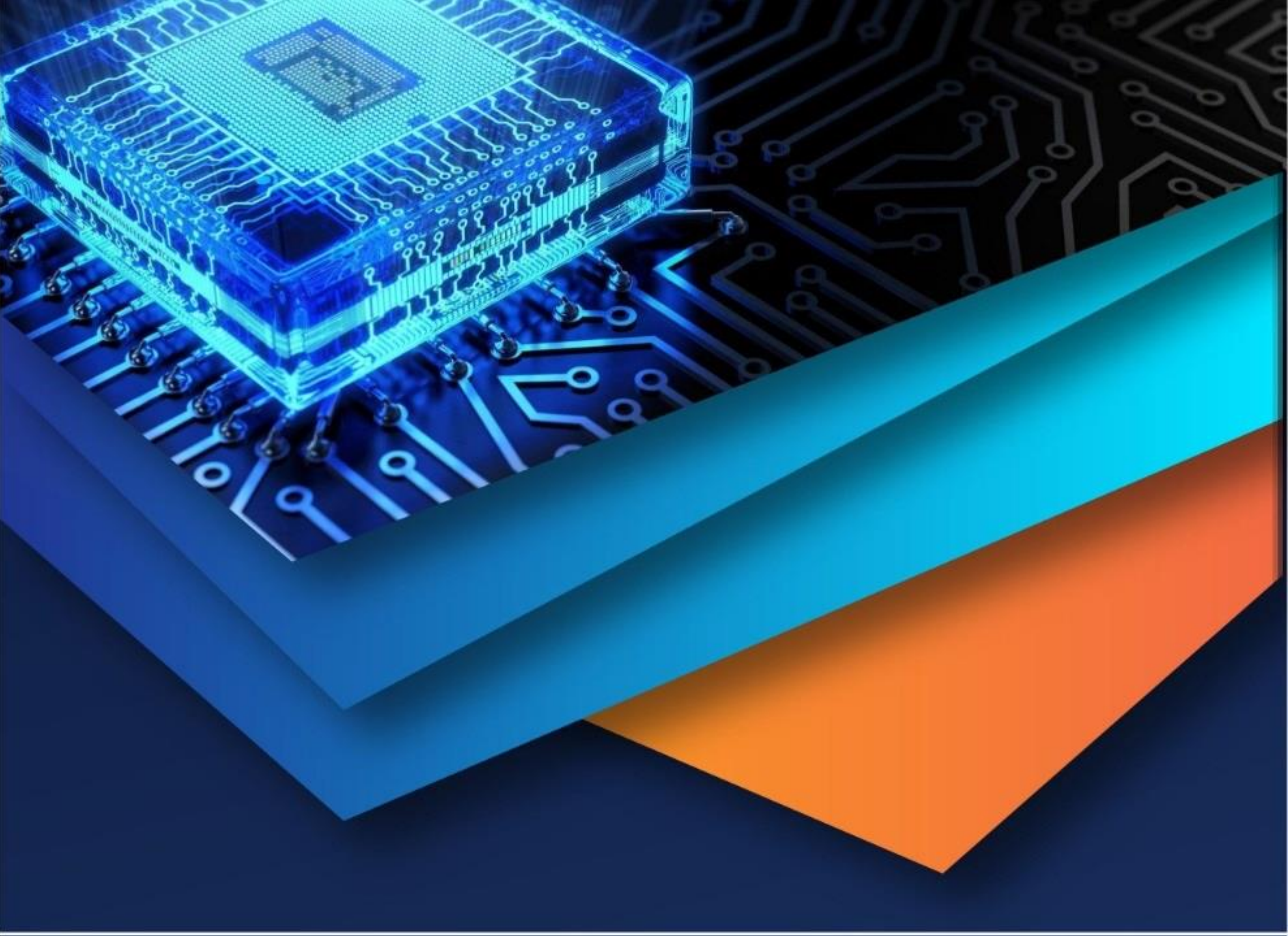


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