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Data Analytics using Array of Things

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Abstract: The AOT is a technology that aims at urban scale for development by doing various researches across many disciplines. The recent technology Array Of Things is something that exploit's Internet Of Things Technology which takes the advantages of IOT and use it for building instruments that helps in urban living projects. It also works on interactive networks, sensors that will be installed around various cities for collecting time to time data on the city's blocks, structures, and activities done for public use. We will be using a classification technique to predict and understand the data which can be generated further. Array of Things will be used as tracker for the city, tracking factors that influence in cities such as temperature, noise, climate and air quality. Array of Things is an urban-scale project that will enable the City, urban planners, residents, and researchers to monitor and examine the environment. Ultimately, the goal is to measure the details of city to provide data so that people of different skill set work together to make cities healthier and efficient.

Keywords: Array of things, Sensors, ZigBee, MongoDB, SQL, SVM, Data analytics, Smart City

I. INTRODUCTION

As, we know the world is growing rapidly various new emerging technologies are coming into existence. Amongst those, one is AOT which is basically known as Array of Things. It is an urban sensing project to collect real time data. The initiative was first taken by Chicago with the mission of developing smart city that will be healthier, efficient and livable. The usage of various sensors like temperature, water, smoke and noise will collect the data from various locations and that data will be transmitted to a secure database. After analysis of data collected, the AOT will be used to monitor the city's environment and activity.

Because the data will be published openly and without charge, it will also support the development of innovative applications, such as a mobile application that allows a resident to track the environment.

[1] 'Smart Cities' mission of the Government is an initiative to develop an urban eco-system which gives a decent quality of life to its citizens by making use of smart solutions.

When we think of smart cities, we think about smart transport, smart homes, smart education, smart governance, smart economy and smart management. These smart elements generate as well as consume lot of data. This paper tries to project a data centric view of Smart City, where the pulse of a city is viewed and monitored purely in terms of data. We can observe that the data is continuously being generated; it never sleeps!

II. MOTIVATION

Our city, Pune, the second largest city in the state of
Maharashtra, has been selected as one of the smart cities under Smart Cities Mission of the Indian Government, launched in year 2015 [1]. The motivation and mission behind this project is to build a smart city to improve the quality of health and living conditions better than what they were before and to give our next generation a new scope of living.

III. SMART CITY?

"Smart City" is something which we hear quite often now a days. A Smart City is an urban scale project which is being implemented in various cities of different countries aimed to improve the quality of life of its citizens. It has adopted technology to bring out the development in terms of social and economical living. Different definitions are given to Smart Cities and some of them are as follows:

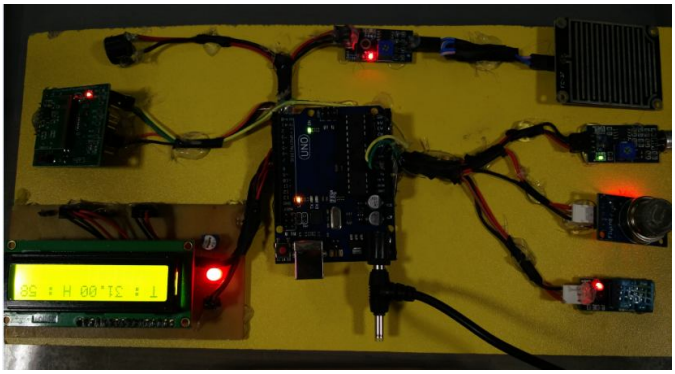
A. Definitions

1) Gartner [2] defines smart city as an urbanized area where multiple sectors cooperate to achieve sustainable outcomes. This is done through the analysis of contextual and real-time information..
2) The term Urban Computing used by the authors is synonymous to Smart City. The authors have defined urban computing as a multidisciplinary field where computer science meets conventional city needs.

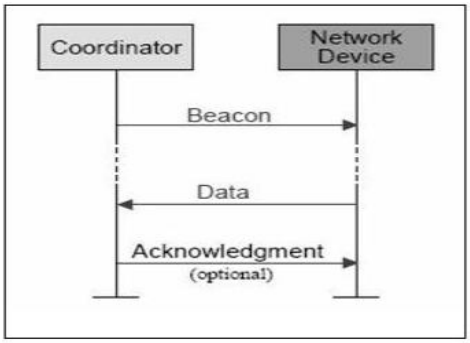
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IV. PROPOSED SYSTEM

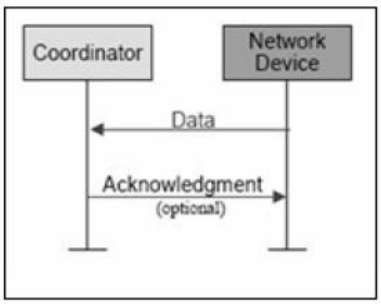
The proposed system architecture that we have proposed will give the data of objective type that is the data which is derived from the sensors. The data which is collected from the heterogeneous nodes will be used in order to obtain useful indications and generate a result which will be passed among the citizens for their governance through a webpage. The system which has been proposed is equipped with Atmega by interfacing distinctive sensors through Zigbee. The temperature, water, smoke and noise sensors are interfaced with Atmega for the distinctive display. The main role in the system is played by IEEE 802.15.4/ZIGBEE by focusing on network applications including the features of low power consumption, needed only for two major modes which are(TX/RX or Sleep), high density of nodes and simple implementations. ZIGBEE is used as a gateway for sending the signals from transmitter to receiver. The automation is done using Arduino which is used for efficient, comfortable and flexible user interface for controlling the electric appliances remotely.



The role of ZIGBEE in the system is focusing on applications including the feature of low power consumption, needed only for two major modes which are(TX/RX or Sleep), high density of nodes and simple implementations. ZIGBEE is used as a gateway for sending the signals through the LAN to the Internet. The data is transferred in packets. These have a maximum size of 128 bytes, allowing for a maximum payload of 104 bytes. ZIGBEE which are likely to be used should not require very high data rates. As proposed by the Authors in * ZIGBEE/IEEE 802.15.4 addresses three different traffic types.



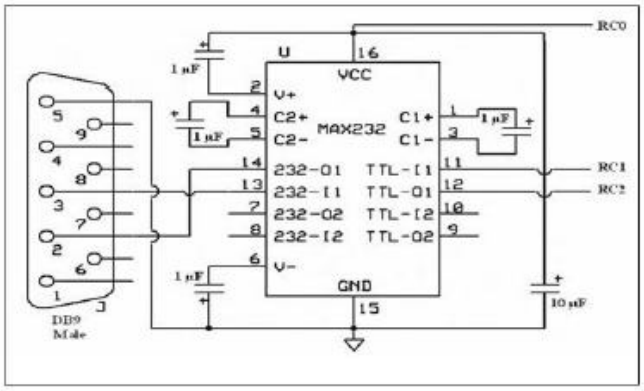
Beacon Network Communication



Non-Beacon Network Communication

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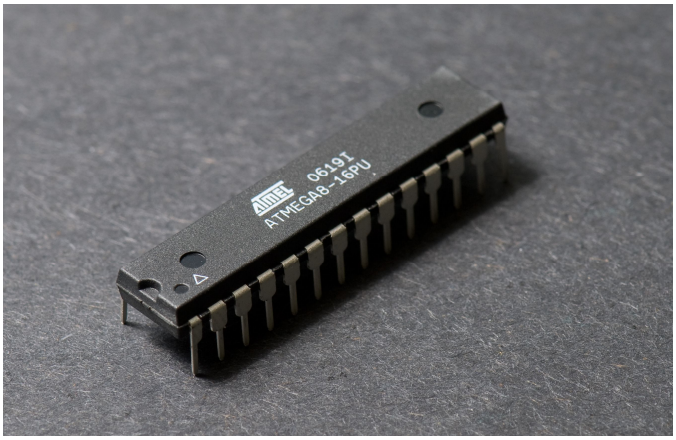
IEEE 802.15.4 MAC can accommodate all the types and the ZIGBEE transmitter and receiver must set transfer data to and from PIC and 89S52 successfully. As shown by the Author in *the ZIGBEE connection should have must MAX 232 connection so that it will send the analog signal to an analog digital convertor(ADC) inside the PIC.PIC will process and transfer to the base station using Zigbee.



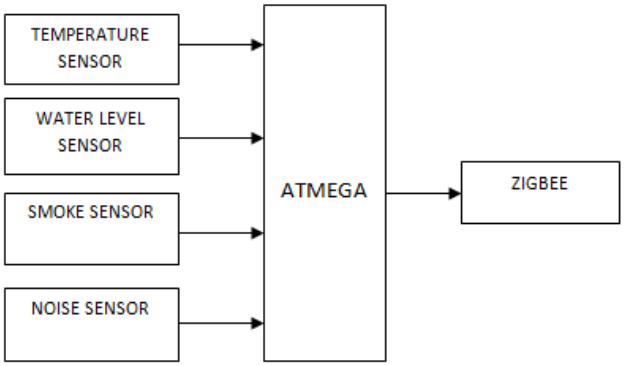
MAX 232 connection

A. Atmega

AVR is a family of microcontrollers developed by Atmel beginning in 1996.AVR was one of the first microcontroller families to use on-chip flash memory for program storage, as opposed to one-time programmable ROM, EPROM, or EEPROM used by other microcontrollers at the time.



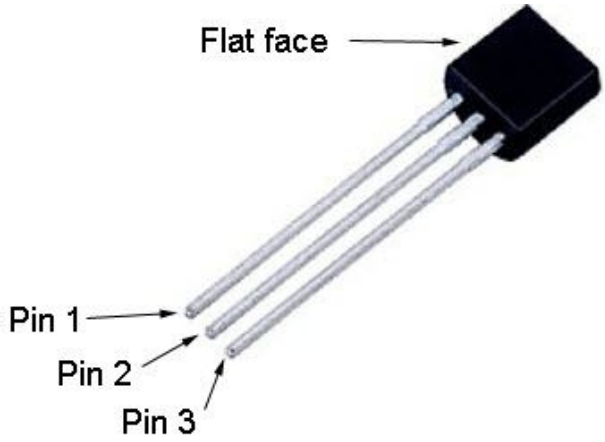
The system which has been proposed is equipped with Atmega by interfacing distinctive sensors and Arduino through zigbee. The temperature, water, smoke and noise sensors are interfaced with Atmega for the distinctive display. In this, four different sensors are used viz. temperature ,water, smoke and noise sensors.



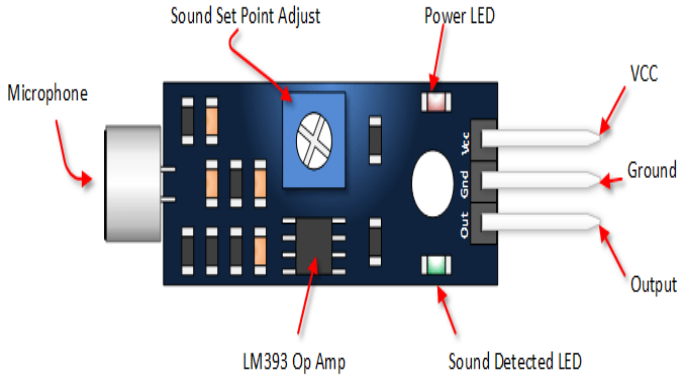
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B. Sensors

1) *Temperature Sensor:* The most preferable temperature sensor is the LM35 series which has most precision in build circuit temperature device with output voltage which is directly proportional to Degree Celsius temperature. This sensor has advantage over linear temperature sensors as there is no requirement of extracting large constant voltage from the output. LM 35 sensors are used because there is no need for external calibration. LM 35 draws 60 micro amperes from the supply because of which there will be less heating. These sensors can operate within -55 ^{o}C to 150 ^{o}C.



2) *Noise Sensor:* As we know, Sound sensors are used for detecting sound intensity .It is used in various application like switch, security and monitoring applications. It can be modulated according to the convenience of the usage. It has a in build microphone which forwards the input to amplifier peak detector and buffer. When the output is generated it process of the voltage which is being sent to the micro-controller and required processing is done.



3) *Gas Sensor/Smoke Sensor (MQ2):* The MQ2 grove gas sensor is a module which is used for sensing the smoke or any kind of gas leakage. These sensors have high sensitivity and fast response time because of which the measurement can be taken as soon as possible. The sensor's sensitivity can be adjusted with the help of potentiometer.



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4) Water Sensor v1.0: The water sensor is mainly for sensing the level of water and it is also a part of grove system. The water sensor with the help of conductivity it will check whether the sensor is damp, dry or totally emerged in water. This sensor will also work with digital input output pins of Arduino. The main advantages of it are it consumes low power and has high sensitivity.



V. IMPLEMENTATION

The implementation of our project initiated with the hardware part where we used four different sensors which are temperature ,water, noise and smoke. Initially we started with only one sensor which is temperature sensor and tested it individually by giving a specific range of values. When that sensor worked properly we made some more additions of other sensors, tested them too and finally combined all of them together.

The real time values from the sensors are transmitted through ZIGBEE and can be received using Putty just like a serial monitor in Arduino IDE. Putty basically acts as a bridge between client server communication. All the data values that are displayed serially are stored in a file.

This file is given to the database and based on the relevant dataset the output is predicted. In our project, we have used Support Vector Machine algorithm for classification and prediction. The benefit is that you can capture much more complex relationships between your data points without having to perform difficult transformations on your own. It is usually effective in cases where number of dimensions is greater than number of samples. Although, the SVM is bit slower in computation when compared to others but it leads to the approximately accurate solution and that is the reason we have preferred SVM. To implement, the SVM we have used JAVA as a programming language because it is platform independent and moreover it can be used to deal with business complex logic. In the backend, we have used the databases like SQL, MongoDB. The connectivity of the project is performed using both the databases but we have preferred MongoDB because it is used for unstructured data. And, the data here is generated in document format and you need not to build schema oriented structure. The data in MongoDB is sorted on the basis of timestamp. There are various factors on which MongoDB is preferred over SQL. The comparison is shown below in bargraph:

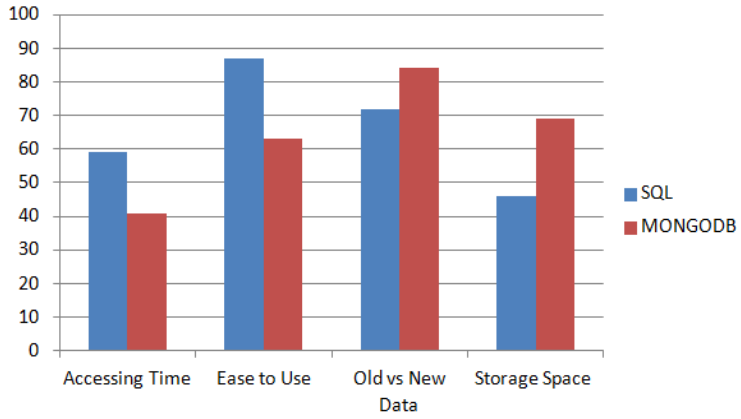
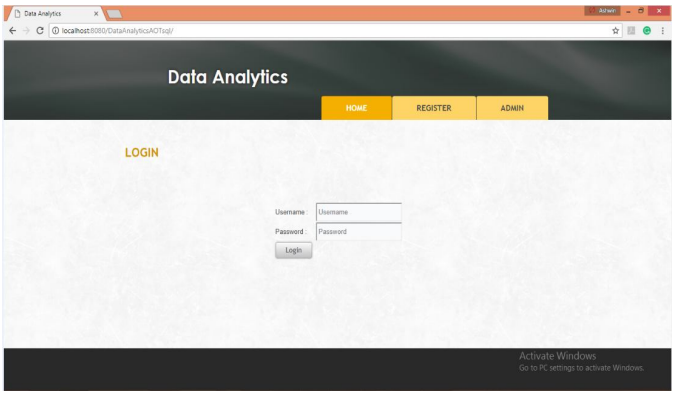


Fig Comparison Between SQL and MONGODB

The final results of prediction will be shown on the webpage which is created using Javascript as it helps in making the webpages more dynamic and interactive by implementing custom client side scripts. In our webpage, we have made two sides:-

1) Admin
2) Customer

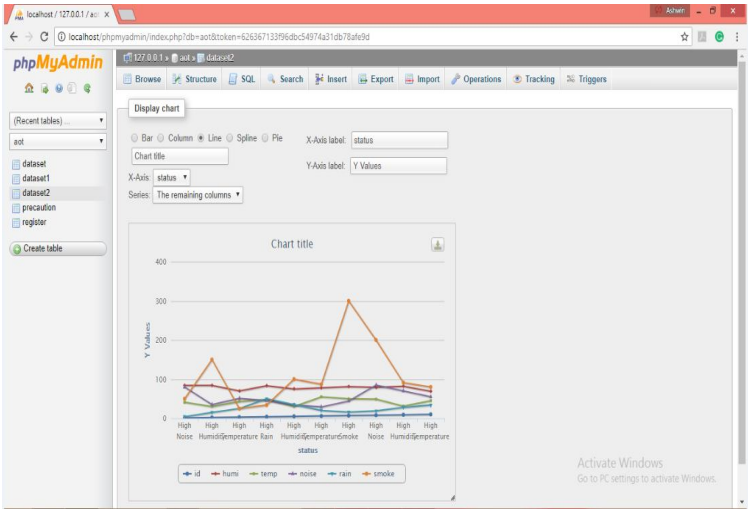
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The customer has the option to register himself/herself on the webpage . After registration, one id and password is generated and using that credentials user can login on webpage frequently. On the other hand, in admin side there is an added advantage of adding the various precautions related to each condition based on the data. The prediction is done on the basis of the data set and the relevant precautions regarding the weather and surrounding conditions is displayed on the customer side. Also, the comparison of new and old data is displayed through bar graph using which customer gets more clear picture of the weather conditions. The output is shown below:

VI. RESULTS

The above specified sensors which have been used for this project to connect with Arudino are working properly and sensing the values of different conditions. The values are being stored in the database and the data is being reviewed using a webpage which can be seen by the user using appliances. For example, When the temperature, humidity, rainfall, noise are being sensed then it will be compared with the dataset provided in the database and accordingly generates the output which will be in the graphical visualization. The following graph visualization is shown below for the previously generated results during implementation just for the understanding purpose:



VII. CONCLUSION

This paper, presents the modern techniques for making a city a smart city with the help of new established technology known as Array Of Things. With the help of this project the user can collaborate with the database to retrieve different kinds of data regarding the climatic conditions of different blocks of the city. The requested data by the user can be accessed with the help of the concerned webpage. The outline of the proposed system has been practically applied, actualized and the accuracy of working of the system has been monitored and verified.

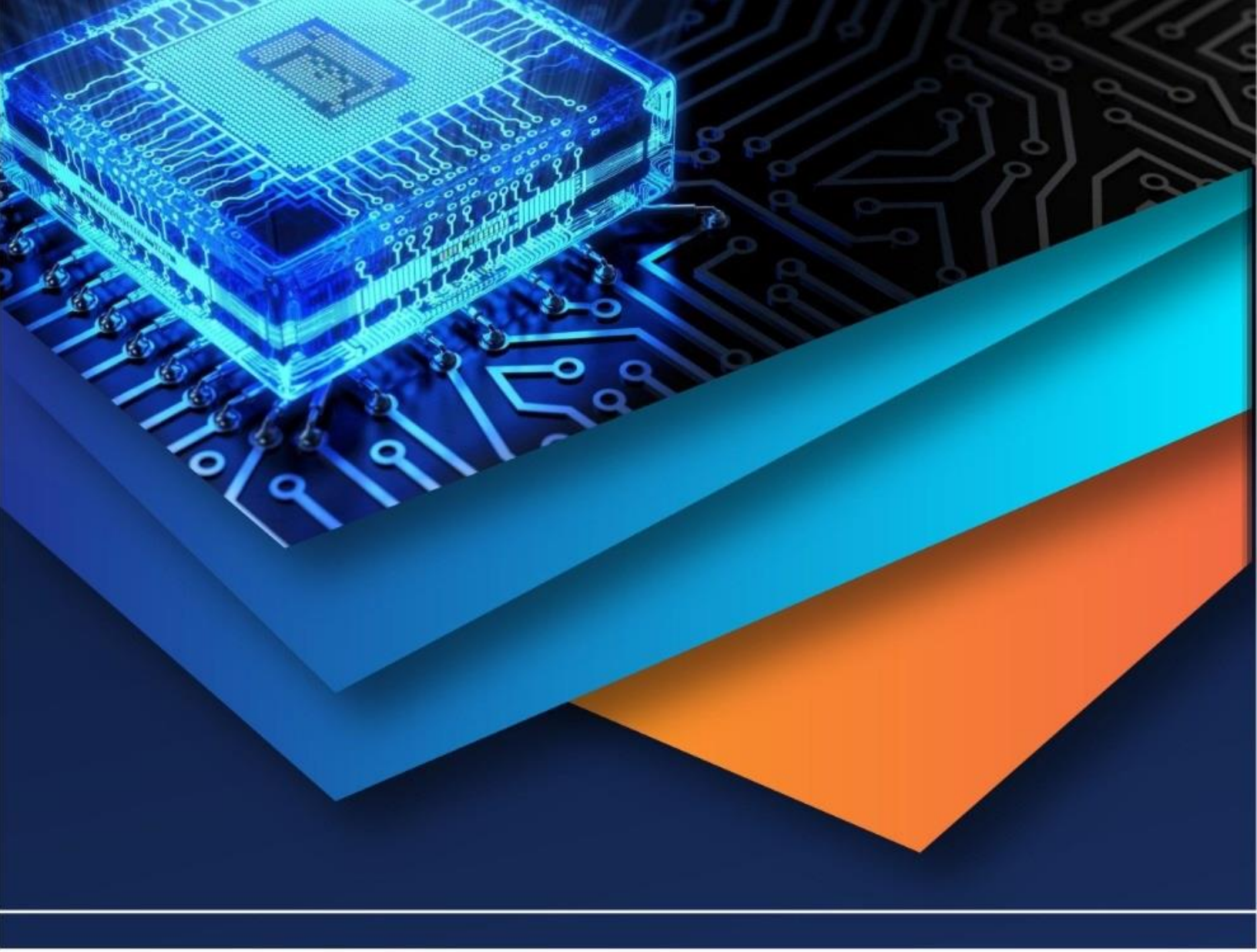
There is still room for future research regarding Array Of Things. One can expand the current benchmarks to an another extent to explore the performance and use of different sensors and the databases with more complex type of data retrieval methods.

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