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An Application of IoT to revolutionize Agro Sector

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Abstract: In this paper, an IoT based automated water irrigation system is proposed. This system is used to increase the production rate of agriculture based on the internet of things (IoT) and cloud computing. Sensor technology has been developed and various kinds of sensor such as humidity, temperature, soil moisture sensor, and pH sensors are used to collect information about the condition of the soil. By using the advanced technologies, the farmers get benefitted for better production in agriculture.
Keywords: Sprinkling, Smart Sensor Pouch, MSP 430, RS 485 Port, IoT, Cloud Computing

I. INTRODUCTION

India is an agro based country and maximum part of the country depends on the agricultural production. So, it's a big challenge to supply enough food to huge population which is nearly about 130 crores. The traditional method of cultivation has been used by the farmers, but to meet the huge requirements we must concentrate on the yield growth. In most part of our country, agriculture is mostly dependent on rainwater for irrigation purposes.

It also depends on the soil conditions such as presence of nitrogen, potassium and phosphorous and on climatic factors also such as temperature, precipitation, etc. The agricultural sector required almost 80-85% of freshwater resources across the country. And this percentage is increasing with the population growth and the demand rate.

So, the new efficient technology for proper utilization of water resources for irrigation purposes and to prevent misuse of water is required. Non-scientific use of ground water (GW) in different purposes like cultivations, industries, household and commercial rises a serious problem in our country, India as well as worldwide. Some places of India are facing drought every year and whole population of that area got affected very seriously [7].

To get rid from this crisis, Indian Government takes initiatives for conservation of water. Hence, use of ground water in scientific way plays an important role to maintain an ecological balance in the environment [8]. Better management of land is also needed along with the improved fertilizing technology for better yield.

In this regard, an IoT based automated water irrigation system is proposed in this paper to increase production rate of agriculture. It can be widely used in smart farming to increase the production of abundant crops. This IoT systems is based on the internet of things and cloud computing. It consists of different kind of sensors such as Ph, Moisture, Rainfall, Temperature and Humidity. These sensors help to obtain the information from the field and then it is sent to the cloud for analyzing purpose. The manual irrigation system can be completely replaced by the automatic irrigation system. This proposed system includes the water supply management, investigation of crops, weighing and counting fruits. Water irrigation system is installed as a part of automatic plant irrigators systems in the field through wireless technologies. This technology is used to enhance the productivity level without the involvement of manpower. By using the advanced technologies, the farmers get benefitted for better production in agriculture. These innovative projects hopefully fulfill all the required requirements of our unique start up India programs launched by Government of India.

A. Traditional Agriculture

According to the survey, it has been observed that agriculture contributes 27% to GDP and provides employment to the Indian population [1].

Agriculture is the backbone of our economy. Agriculture uses almost 85% of available freshwater resources worldwide but this rate is becoming huge day by day due to population growth. Therefore, it is an urgent need to develop effective methods based on technology for sustainable use of water for irrigation purposes, soil conditions and climatic factors. After considering all the factors related to efficient cultivation several methods are developed to boost up the agricultural growth to overcome the problems of traditional cultivation.

New innovative IoT products are used to overcome these difficulties and help to increase the quality, quantity, sustainability, and cost effectiveness of agricultural production.

II. PROPOSED SYSTEM DESIGN

This proposed IoT System is totally supported by smart sensors and it follows the strict thumb rule of International standard 0-5V scaling. The Micro miniature composite sensor array is to be placed at different areas of land and total signal conditioning, sampling and data generation is taken care of by these unique modules. Sigma -Delta conversation technique is used in this system and it is trouble free round the clock Quality Check at random manner when executed and gave satisfactory result.

The system has been designed with the best Industry Standard Texas Instruments Chips to operate the full DSP based signal which is required to send into the cloud. It is best for control and governance to optimization of data to memory transfer, data acquisition, port availability in every sub sections. In the design, there is a provision for exchanging and execution of various tasks by separate Master and Slaving Cards of complementary nature.

Furthermore, full length graphics generation, logging, routine data sheets scrolling facility with PHP web-based servers is under use which perfectly admin the whole process and through auto time gaped continuous scanning making available the reading at one hand and actuating the Drives in the other hand. Therefore, fail safe uses of the System in Open Land has been made possible.

Auto scanning mode should be made active in the system after giving the power supply. Then the individual channel testing will be started automatically which can even be experienced by observing the respective status of the Indicators.

The GSM Module will get packet of data only after passing through the checking engaged status of the registers. The averaging option has also been incorporated in the system for better management of data and its reproduction. There is a set of 5 isolated channels which are decided down into two blocks. So, the pumping and sprinkling operation of water should be done very efficiently. Microsoft, Google, IBM, Amazon or any other Server could be the best match for this proposed system with ease of interfacing. The PCBs used in this proposed system are of multilayer type where PTH techniques are followed. The chips and all other passive components are of SMD type for providing the best accuracy and ease of maintenance.

A. IoT in Agriculture

The Internet of Things is a way to established connectivity between electronic systems with the physical or virtual computers. It has an ability to transfer information over a wireless network without human-to-human or user-to-computer interaction. The proposed system analyzed the data obtained from the multiple sensors and processed in the server to evaluate those by using cloud computing techniques. The data sensed for different parameters by the different sensor from crop field are humidity, temperature, precipitation, pH quality, etc. These data are processed and stored by IoT systems and then these data values are utilized for proper irrigation purposes. Therefore, the proposed system helps to make appropriate decision for better production.

This IoT technology can be run in any kind of devices like desktop, laptop and in any kind of android smart phones. The IoT network used in the proposed system consists of 4 layers and they are as shown in Fig. 1.

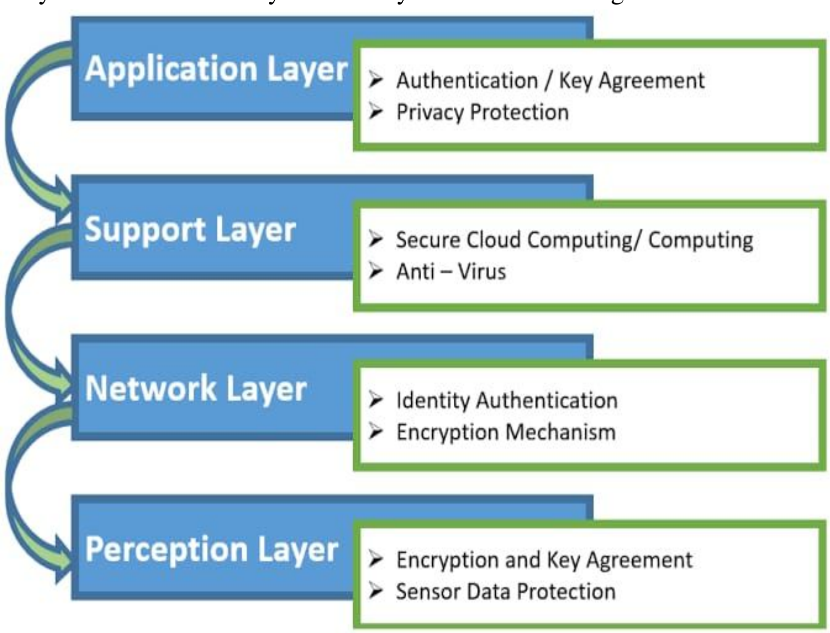

Fig. 1. Different Layers of IoT Network

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1) *Application Layer:* The application layer contains all applications in which IoT has allotted. It acts as an interface between the IoT devices and the network. Some common examples of IoT Applications are smart homes, smart health, smart cities, etc. It has the authority to offer services to the applications. The services may be distinct for every software due to offerings based on the information accumulated by sensors. Some common issues of application layer are Cross-Site scripting, malicious attack.
2) *Support Layer:* The reason to make a fourth layer is to introduce the security system in architecture of IoT. Because of sending information/data directly to the network layer, the chances of getting threats have been enhanced. The support layer has two responsibilities. Firstly, it certifies that information is sent by the authentic users and is protected from cyber threats. There are many ways to substantiate the users and the information. The most commonly used technique is the authentication process. It is applied by using pre-shared secrets, keys, and passwords. The second responsibility is to send the information to the network layer. Some common issues of support layer are DoS Attack and Malicious Insider Attack.
3) *Network Layer:* This layer is likewise known as a transmission layer. It acts like a bridge that consists of and transmits information collected from physical gadgets through sensors. The medium can be wireless or wired. It also interconnects the network devices and networks with each other. Some common issues of network layer are Storage Attack and Exploit Attack.
4) *Perception layer/Sensor Layer:* The perception layer has the duty to recognize things and collect the facts from them. There are numerous varieties of sensors connected to the objects to collect information which includes RFID, sensors, and a couple of 2-D barcode. The data that is accumulated by these sensors can be about location, alternation in the air, environment, etc. Some common issues of perception layer are Replay Attack and Timing Attack.

B. IOT Devices

The farmers will be capable to reveal the conditions of the field across the globe by using smart agricultural system. In IoT-based smart agriculture system, sensors (light, humidity, temperature, soil moisture, etc.) are used to trace the area of the field and boost up the irrigation system. The complete hardware console is shown in Fig. 2

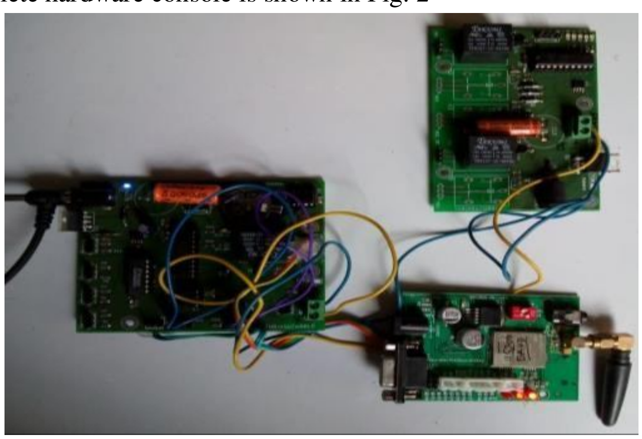

Fig. 2. Main Hardware Console

1) Fc-28 Soil Moisture Sensor: The sensor for soil moisture is very important to judge the soil condition. The two extensive uncovered pads function as a variable resistor in the soil detector sensors (Fig. 3). The conductivity between the surfaces will be more if there is more moisture in the soil. This will result in lower resistance and higher output of SIG [8].

Fig. 3.FC-28 Soil Moisture Sensor

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2) *DHT 11 Humidity & Temperature Sensor:* DHT11 Temperature & Humidity Sensor (Fig. 4) uses an electronic signal to enhance the performance of the temperature & humidity sensor system. High accuracy and excellent long-term longevity can be achieved using the proprietary digital signal processing strategy and sensing technologies for temperature & humidity.

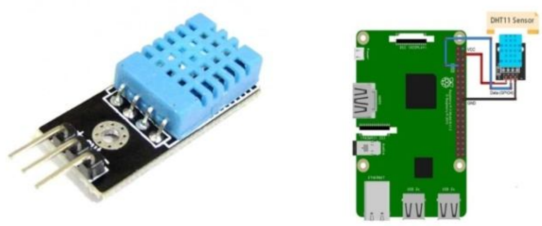

Figure 4 DHT 11 Humidity & Temperature Sensor

3) *KG004 Raindrop Sensor:* The unit of the rain detector (Fig. 5) is used to measure water. When raindrop falls on the rainy board it can measure the rainfall rate, it can also be used as a switch [10].

Fig. 5.KG004 Rain Drop Sensor

4) *Submersible Water Pump:* The submersible water pump (Fig. 6) is used in this system for irrigation purposes. The pump is used to draw water from the nearby resources like lake, river, pond, etc or from the underground resources to the field. Different types of water pump can be used for this purpose. The water pump will be driven with the help of a IoT controller, to utilize the water resources in an appropriate way and to avoid the misuse of water. So, a control system is connected along with it.

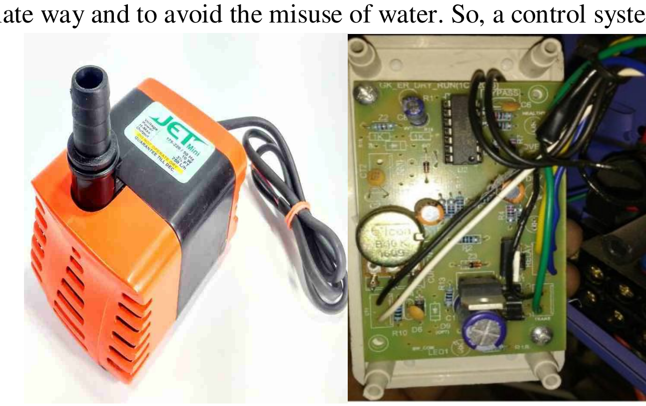

Fig. 6. Submersible Water Pump with Controller

The two types of control system are:

a) *MOTOR Monitoring System:* Electronic motor control system is installed with safety-controlled logic algorithm. The data is obtained from all the real time sensors installed on various location of the system. It updates the data to the central server using network module. If any sensor goes beyond its restricted parameter zone value, then an alert notification is automatically generated to the user by using the LCD display and the fault is recorded in the internal memory.

b) *MOTOR Controlling System:* Electronic monitoring Module is designed by using ARM controller. It monitors the AC voltage and AC current driving through motor. And transfer data to the controlling system. It displays the conditions of the motor whether it is healthy, overload, short circuit and dry run to the user.

5) *Microcontroller:* A microcontroller MSP430 is used to operate the whole system (Table 1). MSP430G2553 microcontroller chip (Fig. 7) is used in IoT module for agro system, is having 16 MHz MCU with 16KB Flash, 512B SRAM, comparator, UART/SPI/I2C, timer, etc. This microcontroller chip has been programmed by using Texas Instruments Launch Pad.

Table 1 Parameters of MSP430G2553 microcontroller chip

Non-Volatile Memory (Kb)	16
RAM (Kb)	0.5
ADC	10-bit SAR
GPIO Pins (#)	24
Features	Spy-bi-wire, Watchdog timer, Real-time clock
UART	1
USB	No
Number of I2CS	1
SPI	2
Comparator Channels (#)	8

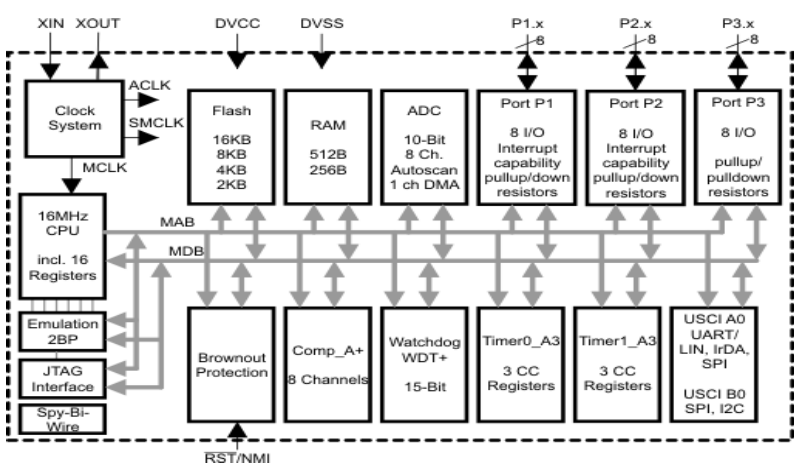

Fig.7. MSP430G2553 - SLAS735J

Features:

- Low Supply-Voltage Range: 1.8 V to 3.6 V
- Ultra-Low Power Consumption
  - Active Mode: 230 µA at 1 MHz, 2.2 V
  - Standby Mode: 0.5 µA
  - Off Mode (RAM Retention): 0.1 µA
- Five Power-Saving Modes
- Ultra-Fast Wake-Up from Standby Mode in Less Than 1 µs
- 16-Bit RISC Architecture, 62.5-ns Instruction Cycle Time
- Basic Clock Module Configurations

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C. Cloud Computing

Database system is used to store huge amount of data in it, and it can be access as per the requirement. But it has a drawback that it cannot be access from anywhere, so a database management system is attached with every system. But the concept of cloud computing solved the above issues because it is also a database management system that can be access online through across the globe without any kind of complications. So, this technology is used for the proposed system. The purpose of using cloud computing is storing the data obtained from different kind of sensors and to actuate the system as per our requirement. Cloud computing provide security and integrity of the data. The privacy is well maintained. There will be no third-party access and threats to the data can also be avoided. User must log in into the system with the appropriate User Id and password and after successful logging the cloud will automatically generate an OTP and send to the registered mobile number for further verification. Then the user can easily access the system.

D. Web Dashboard

Web dashboard (Fig. 8) contains multi pages and totally user protected through password and internal protection portfolio. Easy TABs are kept for quick command. Actuating status can be read by changing position of respective signs.

Any channel selection can be done in either auto or manual mode. When moving to the subsequent web pages, the total previous logs can be found for the purpose of statistical review and setting of managerial commands.

In addition, total graphical outlay through incorporation of visual basic will be displayed. The Dragging facility will give updates and results by flashing time and date with numerical values of data.

This proposed IoT based smart irrigation system will find excellent market within the country and outside. And this will enhance the new employment opportunity, better cultivation, export earnings will also be made possible at an early date. Data logs of the system is shown in Fig. 9.

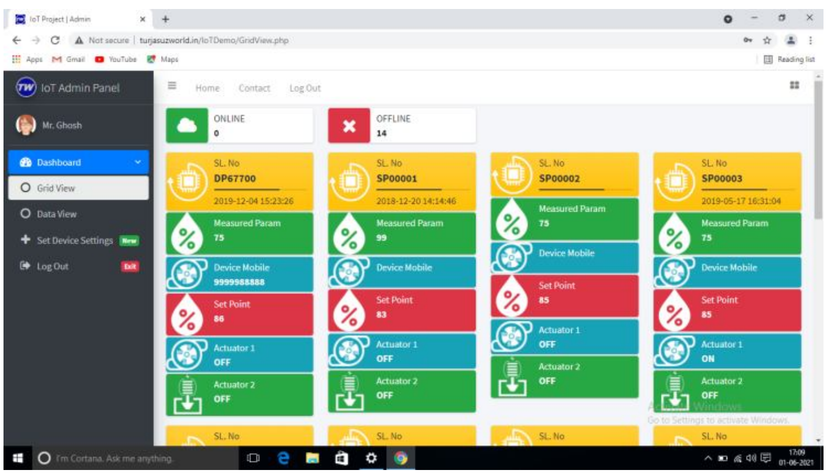

Fig. 8. Full Length Web Dashboard

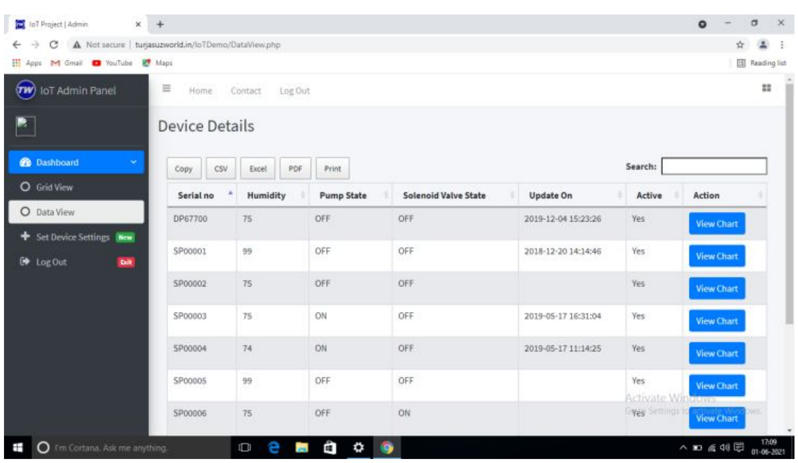

Fig. 9. Data Logs of the System

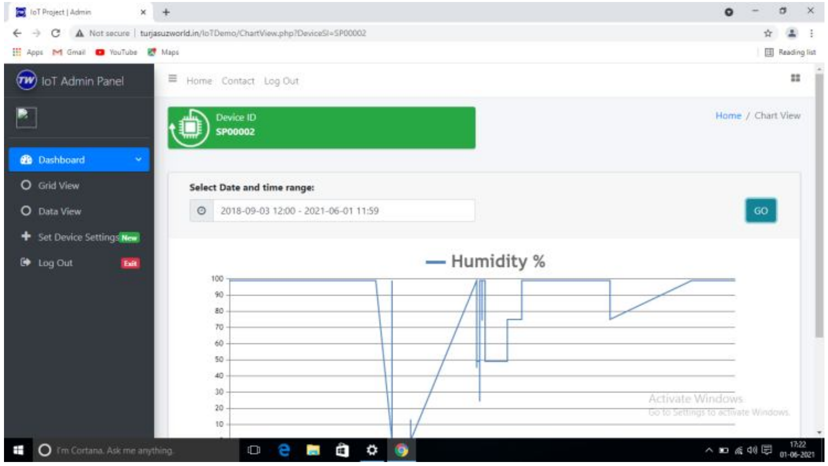

Fig. 10. Graphical Outlay of the Results

III. RESULTS AND DISCUSSION

In Table 2, the output for the five consecutive days is shown. There are four soil moisture sensors which are dipped into the soil for measuring the average humidity of the soil and the data is sent to the cloud for analysis.

Table 2.Experiment performed for 5 consecutive days

Data View (Real Time Slots)	Total Data Generation (Times)	Estimation as being furnished	Set Points (Humidity in %)	Atmospheric Humidity in %	Crops Types	Actuation Status	Time	Cloud Cyber Checking (Automated)
1st June 2021	800	Single Data per Day	77	30	Eggplant, Beans, Peas	ON	50 mins	In every 40 mins
2nd June 2021	800	Single Data per Day	79	40	Beans, Peas	ON	30 mins	In every 40 mins
3rd June 2021	800	Single Data per Day	98	44	Rice	OFF	1-2 hrs	In every 40 mins
4th June 2021	800	Single Data per Day	62	54	Peppers	ON	30 mins	In every 40 mins
5th June 2021	800	Single Data per Day	88	58	Cucumber	OFF	38 mins	In every 40 mins

For each crop, particular soil humidity is required, and these are termed as Set Points. These set points are present in the cloud database. When the Atmospheric Humidity (means Soil Humidity) goes beyond the Set Points then the submersible pump automatically gets started for irrigating the field. When the Atmospheric Humidity value reaches the Set Point value then the pump gets automatically switched off. For every interval of 40 minutes the proposed system sends all the data into the cloud server to update the cloud server. From the Table 2, it is seen that on 1stJune 2021, 2nd June 2021, and 4th June 2021 the submersible pump is switched ON from 30 mins to 50 mins to irrigate the field until and unless the Atmospheric Humidity value reaches the Set Point value. The proposed system can generate the data upto 800 times in a single day. So, a large amount of data which is stored in cloud and it can be used in the future for analysis and a perfect decision can be taken by using Machine Learning algorithms. From these processes, a large amount of fresh water can be saved, and which can be utilized afterwards. This can also preserve the soil nutrients which get eroded due to excess irrigation.

IV. CONCLUSION

In this paper, an IoT based automated irrigation system has been developed to minimize the loss of water in the field during cultivation. This water sprinkling system will maintain the humidity in the soil at particular value depending on different crops. This device has successfully passed the test and worked very smoothly with a high level of accuracy.

The cultivators and all concerned will find a total solution for the automated management of sprinkling. The whole product is indigenously designed, therefore discards straightway enormous expenditure over designing and its necessary implementation. And the most important thing is that the entire system is eco-friendly. The whole system can be run with the help of the solar power with a good battery backup. The power consumption of the entire system is very low, and the system is completely appropriate for the sustainable development of the environment.

V. FUTURE SCOPE

To meet the future requirement, a quantum jump towards undertaking multitasking load of water management as may be required by the cultivators at large can be done. In that case, Mod Bus structure can be introduced and along with large memory back up to support logs. Several slave cards with Rx Tx wired or wireless link can also be taken care off. Soilless cultivation is an alternative method to increase productivity where different kinds of crops are grown without the help of a soil. In this method, we need a setup which can provide the plant with the proper amount of water, essential nutrients required for plant growth such as nitrogen, potassium, etc. IoT System can be used to supply the water through the pipes and the data of amount of water flow and the productivity level of the crops can be analyzed by Machine Learning algorithms for future. Different types of machine learning algorithms such as linear regression methods are used to analyze the data of nutrients level, water level for different kinds of crops and to decide accordingly. In this Soilless Cultivation method, supervised learning and reinforcement learning techniques can be used to grow different kinds of crops naturally. Applications of robotics can also include for different purposes.

VI. ACKNOWLEDGEMENT

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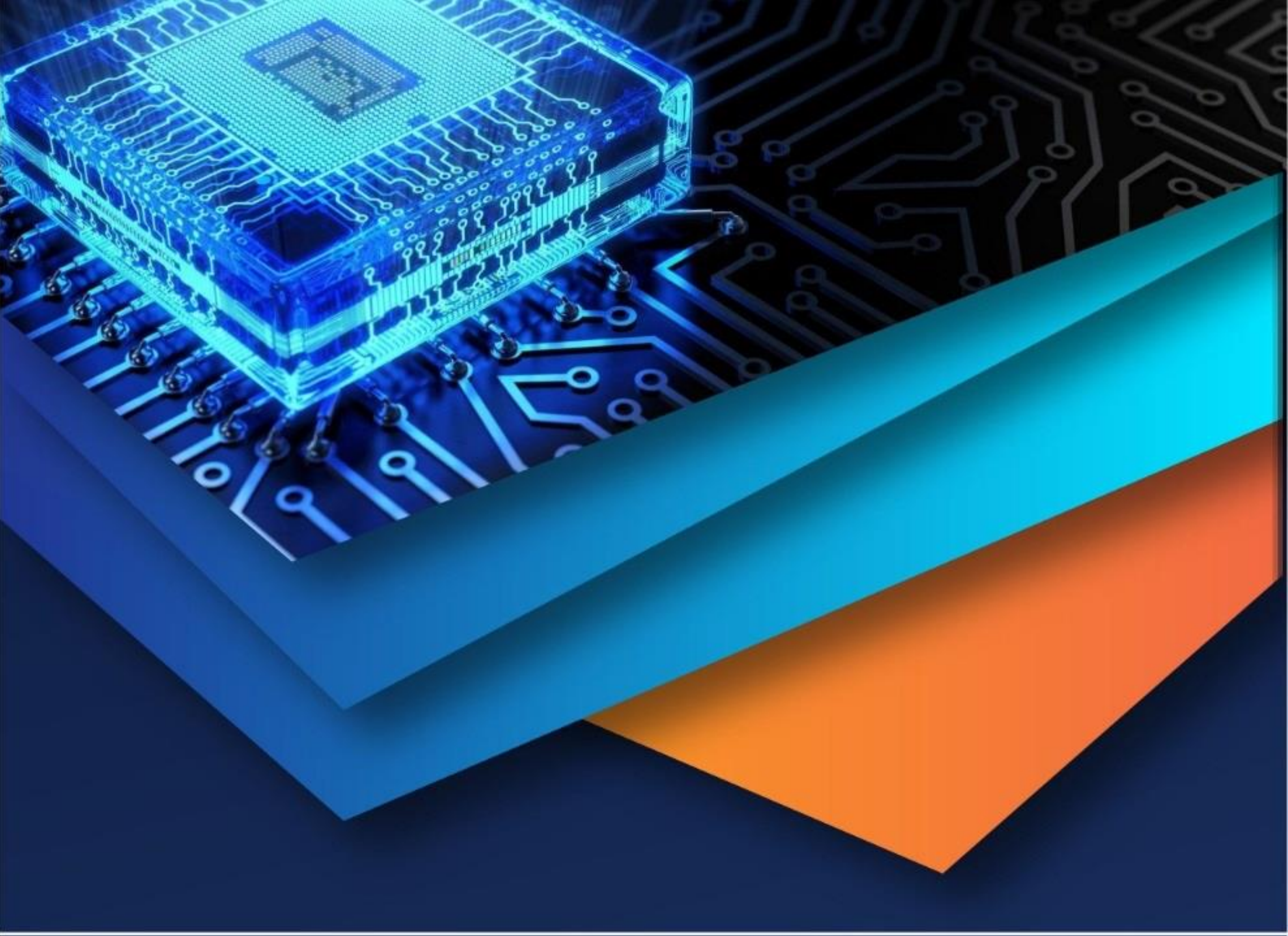

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