Implementation of IIoT based smart crop protection and irrigation system

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Abstract. A centralizing method in the area of IIoT (Industrial Internet of Things) contrived for understanding agriculture which is preceding the arrangements low-power devices [5]. This paper yields a monitoring procedure for farm safety against animal attacks and climate change conditions. IIoT advances are frequently used in smart farming to emphasize the standard of agriculture[6]. It contains types of sensors, controllers. On behalf of WSN, the ARM Cortex-A board which consumes 3W is the foremost essence of the procedure [9]. Different sensors like DHT 11 Humidity & Temperature Sensor, PIR Sensor, LDR sensor, HC-SR04 Ultrasonic Sensor, and camera are mounted on the ARM Cortex-A board. The PIR goes high on noticing the movement within the scope, the camera starts to record, and the data will be reserved on-board and in the IoT cloud, instantaneously information will be generated automatically towards the recorded quantity using a SIM900A unit to notify about the interference with the information of the weather conditions attained by DHt11[14]. If a variance happens, the announcement of the threshold rate will be sent to the cell number or to the website. The result will be generated on a catalog of the mobile of the person to take the necessary action [7].

1.Introduction

IIoT (Industrial Internet of Things) tendencies are often utilized in smart farming to boost the standard of agriculture [2]. But our productivity remains enormously diminutive as associated to world standards [1]. Societies after pastoral areas drift to a municipal extent for her lucrative commerce besides they can't deliberate on crofting. In detail, moderate smart irrigation systems are utilized to afford the solution for dissimilar variety of plants in spite of getting the solution for moisture related issues Weather conditions like temperature, humidity and moisture are difficult to check manually frequently[9]overcome all these a new system is proposed constructed on cloud of Effects (IoT).Wildlife requisite overlaps personage laypeople, creating fee to inhabitants and cultivated field. Wild animals regularly ruin eminence of crops [20]. The low productiveness is mainly due to the reasons, the crop ruined by means of untamed animals and yield ruined by way of nature object [34]. Cultivators are experiencing numerous challenges for attaining more production due to unexpected encounters of animals, slight sorts of species, beetles, some hazardous snakes and weather circumstances. Within the existing system, electrical protection is used to give up untamed animal assaults on vegetation which leads to the death of animals [2]. The surveillance and monitor of the tiny species, bugs and snakes are tough because of their aspect and flora of effort [5]. A well-known wild animal safety observation that

may final for a lot of Fencing is years. However, utilizing fences as a train is often [8]. Therefore, earlier than deciding on an acceptable fence, it is vital to examine native law regulations [3]. The high quality of fencing depends upon the material and structure [10]. Counting on how it's made and what it's made from, some everlasting fences can last as long as 30 years. Previously buying electrical fences, it is very meaningful to be certain that they're allowed to be used in the precise area, and for defense towards endangered animal species [12]. Furthermore, it is steered that electrical fences are marked with a warning signal to stop any doable human contact. Climatic conditions be keen on temperature, humidity and moisture are troublesome [13].

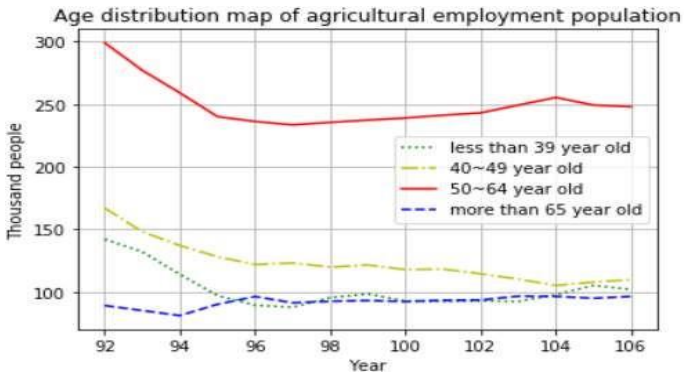

Fig.1: Age distribution map

The purpose is to grant monitoring device for crop safety to animal outbreaks and environment circumstances [15]. This supports to preserve stretch and cash by dipping the physical exertion, else obligatory if the cultivators themselves have to afford guard for their crops with their endless physical administration [16]. Wildlife regularly wreck eminence crops, because of which annual manufacturing of vegetation reduces inflicting monetary victims to cultivators [19]. Agriculturalist suicide is huge bother due to less harvest [21]. This low harvest is duet the circumstance of two most significant purposes i.e. Crop wrecked via untamed animals and Crop wrecked by meteorological conditions [27]. The ranchers will treasure these SMS containing location [4]. The prime thing of this task is to furnish a great reply to this distress [19]. Each time either the wild animal or species are identified through PIR sensor which stimulates the web camera and gives rise to alert the buzzer in the locality, associates to the farmer direct to the cloud [21]. When the moisture content is inferior to a terrifying level the sensor planted makes the water pumps to turn on [23]. This ensures the complete safety of crops from animals also as from the weather conditions thus prevent the farmers [22].

2.Literature Survey

IIOT tendencies are often utilized in smart farming to boost the standard of agriculture [2]. Farming the pillar of supports our country to the general commercial development. But our productivity is extremely low as associated to world standards [31]. People from rural areas drift to an urban area for other worthwhile trades and they can't concentrate on agriculture [14]. There are many disadvantages of the current traditional agricultural methods namely costlier and manual monitoring of the agriculture field [8] . Specifically, small-scale smart irrigation systems are utilized to provide the solution for dissimilar variety of plants in spite of getting the solution for moisture related issues Weather conditions like temperature, humidity and moisture are difficult to check manually frequently [4]. Farmer suicide is turning into big problem due to low productiveness amongst farms [3]. This low productiveness is due

to the fact of two main reasons, Crop ruined by means of untamed weather conditions untamed animal attacks, small types of species, insects, some hazardous snakes and weather circumstances.

Within the existing system, electrical fencing is used to give up untamed animal assaults on agricultural vegetation which leads to the death of animals [6]. The fundamental objective is to provide a fantastic answer to this problem, so that losses incurred will be minimized and farmers will have an accurate crop yield [26]. This low productivity is because of the fact of two most important motives i.e. Crop destroyed via untamed animals and Crop damaged by using nature object [18]. The main objective of this assignment is to furnish a fantastic answer to this trouble, as a result with the purpose of the economic losses incurred through the support of our farmers are minimized to get truthful crop yield [22]. This ensures complete security of vegetation from animals and defending the farmers loss. In the proposed system Raspberry Pi, PIR sensor, web camera, ultrasonic sensor, LDR sensor, temperature sensor, humidity sensor, moisture sensor, buzzer and monitor are used [15]. This field of this effort remains towards withdraw to monitor the system for crop security conflicting to subconscious occurrences and meteorological conditions When the moisture content is below a critical level which is determined by the sensor planted in the fields, as the system is automated the water pumps are switched on [33]. This ensures complete safety of crops from animals also as from the weather conditions thus prevent the farmers loss.

3. Materials and Methods

3.1 Block Diagram

The block diagram fig contains various sorts of sensors, controllers and actuators for WSN and ARM Cortex-A board which consumes 700mA or 3W power is the foremost component of the system [24]. Various devices like DHT 11 Humidity & Temperature Sensor, PIR sensor, LDR sensor, HC-SR04 Ultrasonic. All the sensors and camera are link-up with ARM Cortex-A. IoT components are proficient around agriculture grounds afterward which will be betrothed entering of client [25].

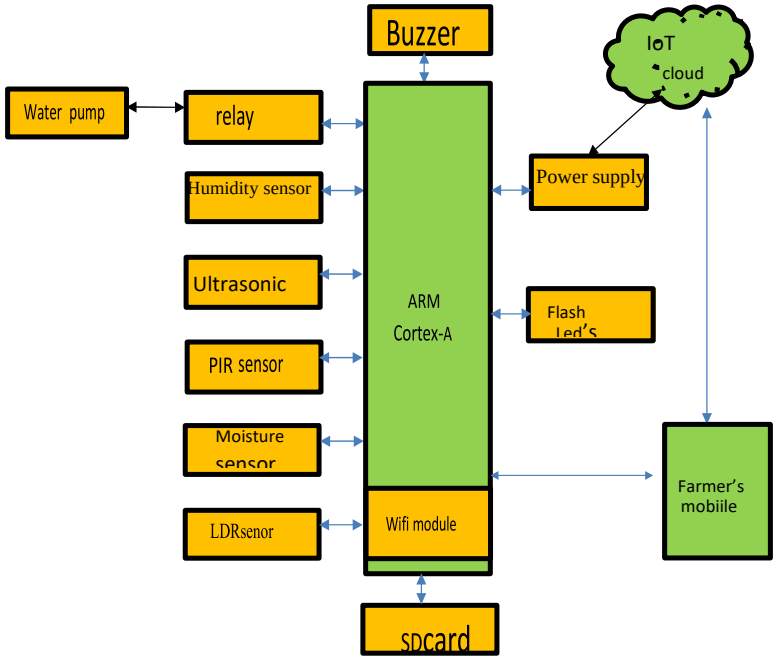

Fig. 2. Hardware block diagram

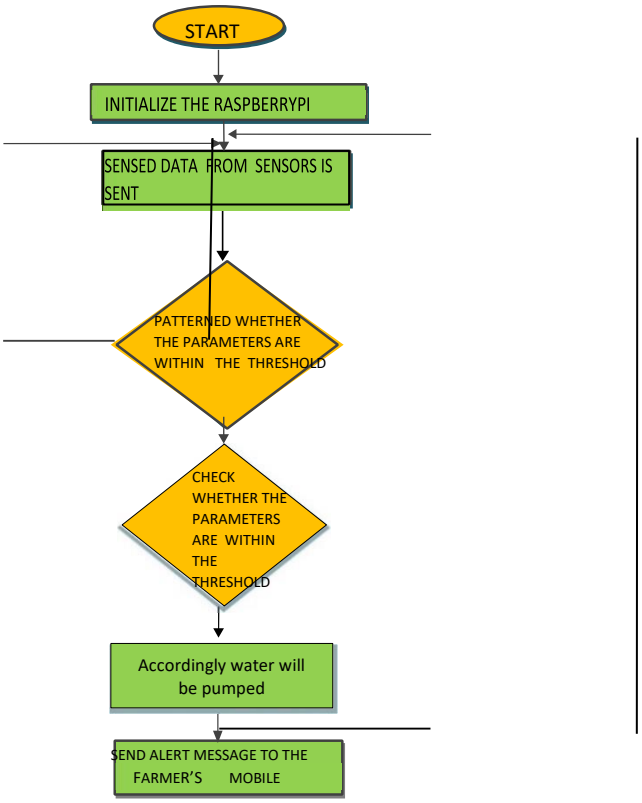

Fig. 3. Flow Chart

As per swiftly as the PIR feelers verve Extraordinary on perceiving effort confidential a fluctuate of 10 beats, the cardinal camera will be fetching ON which major seizures an print and then activates handling the depiction with the support of encryption given to the ARM Cortex-A and then the recognized indicators will be shipped to the Arduino[26]. Later that the restrictions are privileged the phase or no elongated if yes then it will be refunded and if it is no extensive, aware memo will be shipped to the itinerant [29].

4. Description of components used in Design:

The ARM Cortex-A is a instrument which devours 700mA or 3W or power [30]. Any decent smartphone mount will do the exertion of powering the Pi. In ARM Cortex-A on-board storage is unavailable [13]. The functioning physique is loaded on an SD card which is entrenched on the SD card slot on the ARM Cortex-A[14]. The functioning interpretation may want to additionally be loaded the usage of a card reader on any computer [15]. The standing LEDs :There are four standing LEDs on the RPi(ARM Cortex-A) that illustrate the standing of different movements as follows: REASONABLE" - SD Pass Access (via GPIO16) - considered as per "REASONABLE" on Typical B Rev1.0 sheets and "ACT" on Exemplary B Rev2.0 and Exemplary A panels "AUTHORITY" - 3.3 V Clout - considered as "PWR" on all panels Occupied Duplex (LAN) (Model B) - branded as "FDX" on all panels Connexion/Action (LAN) (Model B) - branded as "LNK" on all panels "10M/100" - 10/100Mbit (LAN) (Model B) - confidential (imperfectly) as "10M" on Classical B Rev1.0 boards and "100[15]".The PIR Sensor, Ultrasonic sensor, Soil moisture sensor and DHT 11 Humidity & Temperature Sensor The PIR Sensor Swap Can Sense the Infrared Rays launched by Human Physique Movement inside the Detection Space (14 Meters) and begin the Load - Mild Automatically. This Unit is Appropriate for Out of doors Use (Corridor, Staircase, Courtyard, etc.) The electrical energy is single unit of vitality saved on the end-use level is the same as 2.3 models of vitality formed[16].
HC-SR04 Ultrasonic Device Functioning: HC-SR04 is a 4-pin entity, whose pin expressions are Vcc, Trigger, Echo, and Ground [18]. This Ultrasonic Sensor is a much conscious device used in a number of functions the domicile computing distance or recognizing things are required [11]. The instrument works underneath the uncertain capability structure i.e; Distance = Speed × time [21]. The Ultrasonic source transfers an ultrasonic wave, this mark travels in the air and when it gains complained with the aid of specific cloth it obtains copied nearby to the system this copied wave is sensed via the Ultrasonic receiver module as available in the design Now, to analyse the distance the usage of the above methods, we had advanced know the Speed and time. Then we're using the Ultrasonic wave we advance the speed of the US wave at room surroundings [36]. The Soil moisture sensor previous than the soil is consuming water shortage, the phase output is on an extreme level, in any other case the output is on a low level [33]. By intake this system one can certainly marine the blossoming plant, in some further sides any unlike plant life needful reaction irrigating performance [32]. The aspects are sensitivity adaptable [31]. It has a persistent bolt gap suitable setting up [30]. A threshold degree can be shaped.

Required Specifications: The specification required is expressed in Table1. Specification Required

Limitation	Value
Operational Power	+7V dc structured
Soil Moistness	Digital Value is indicated by out pin

4.1 Relays & its action:

Relay is a charge that is electrical in nature that releases and ends underneath the governor of electrical circuit [8]. Within the preliminary form, it is going to be functioned by an electromagnet to launch or end single or several units of contacts [7]. The magnetic topic will most likely be generated by way of a conductor at applicable angles to the path of an electron to exercise along [6]. If the electrical conductor is collapsed straight into the type of the loop, the attractive order moulded is probably going to be worried alongside the amount of the curl [7]. The higher the current, the higher the attractive field power will be, all the different parts are equivalent [8].

Fig.4 Inductive Relay

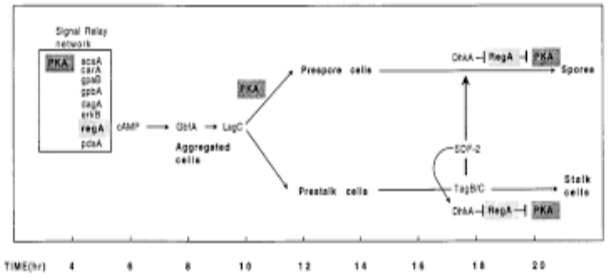

Fig.5 Signal Relay

USB Port Camera: A webcam is required for picture capturing and video streaming applications [10]. in this place, e interface webcam with Raspberry Pi and seize the image and video as well. On this vocation will interface Logitech web digital camera with Raspberry Pi[18].Gentle Dependent Resistor or CdS (Cadmium Sulphide) Cell is a resistor whose confrontation declines with growing incident gentle concentration. LDR will also be referred to as a photoconductor [19]. A buzzer is a signalling device, usually electronic, sometimes utilized in cars (automobiles), domiciliary home equipment be fond of as per a heat up furnace [23]. The aim is to compose a light-weight Emitting Diode, blink it'sno longer as severe when the LED is used as an indicator - proper in this place a catastrophic failure is of doubled importance [24]. The LED specification for its operational existence will likely be described within the following:

L70% = Time to 70% of lighting and

L50% = Time to 50% of lighting.

4.2 *Power supply*:

Energy provides is a spring of electrical influence [25]. A scheme or coordination that provisions electrical or additional manufacturers of liveliness to a capability or cluster of heaps is termed an affect useful resource entity or PSU [27]. Now, in this section, we should Modifier, Channel rectifier, along with present managers for +5V in accumulation to +12V (7805 and 7812) by way of a capacitor (1000µF) into same as revealed in the trail illustration inferior to [26]. Every voltage regulator output of values is related the same as completed which the same as output (+5V or +12V) are reserved hooked on deliberation [4].

4.3 Working principle:

The important gadget in this assignment is ARM Cortex-A. USB port digital camera and distinct sensors are interfaced with the board like DHT eleven Humidity & Temperature Sensor, PIR sensor, LDR sensor, HC-SR04 Ultrasonic Sensor [6]. As quickly as the PIR devices goes turned ON, on sensing the action inside vary of 14m, then the digital photographic camera will grow to become ON which foremost apprehensions a photograph later it begins to process the image, which will be saved on board as nicely as cloud, concurrently a message shall be produced robotically to the recorded cellular quantity making use of a SIM900A unit to notify regarding the invasion collectively through small print of inversion and moisture offered through dht11 device[7]. If movement recognition on account of animals, approved persons, who are farmworkers their attendance receives recorded automatically [19]. If recognized it is no longer a human after processing the reachable records the association rises a buzzer, to alert human beings about interference. But then if the impostor is an animal, then machine takes motion on the PIR sensors that have long past high [14]. If we categorize it as an interference attributable to smaller animals be keen on wild rabbits or pig and as a consequence of flip ON the DC motor [16]. If the PIR sensor is energetic excessive then the digital camera which is installed with the farm will swap on mechanically, buzzer turns on, and at existing an alert message will probably be given to the farmer regarding the animal intrusion [11]. With field, several sensors are prepared like a sensor which substances facts about moisture fabric with soil, Temperature - Humidity sensor, and digital camera for detecting features of the soil [2]. Information serene from the sensors is accumulated and ship it to ARM Cortex-A by means of the ability of gadgets which can be wired or wireless [3]. In server-side data is checked and then harmonized with idyllic values from the sensors and offers the values of temperature, humidity value, and soil moisture value. If the variant took place concerning the evaluation threshold then notifies to the mobile of the farmer or the web's web page with the productiveness of sensors this ensures the entire safety of plant life from animals additionally as from the climate prerequisites consequently keep away from the farmer's loss [24]. Raspbian may also be a free OS supported Debi an extended for the Arm Cortex-A hardware It utilities that make your Raspberry Pi run [20].

5. Figure

5.1 Timing Diagram

The module is taking a shot at the common marvels of ECHO tone. A serious heartbeat is sent for around 10us to set up the module [19]. Afterward, the module imparts a ultrasound sign of forty kHz to eight cycles by means of transmitter and assesses the reverberation delivered by the collector [21]. Utilizing this time stretch setting off heartbeat and reverberation as Distance = (Length x Speed)/2When speed = 340 m/s (Time of sound wave or ultrasonic sign) In this position we have isolated the result of rhythm and time with the guide of two relating signals.

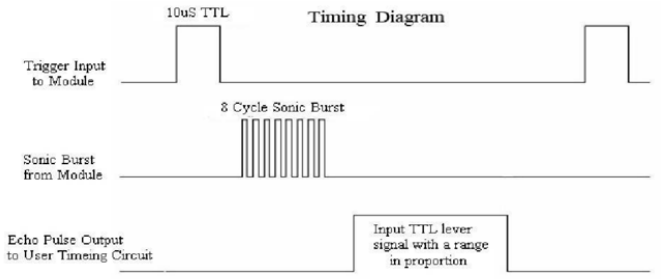

Fig.6 Timing Diagram of ECHO Tone

5.2 Vitality supply:

This full-bridge converter, sector shifted, 600-W high-efficiency power current is used in this province [28]. The 370 V to 410-V DC is switched to a controlled 12-V output[26]. The UCC28950 was once used to power synchronous rectifiers on the second side of the entire bridge converter to record-high performance. The DCM (Discontinues Current Mode) piece is intended to enhance the effectiveness of no-load and to understand the needs of the Novice Mode. In burst mode, the UCC28950 plays. It was once believed that the DCM comparator showed the synchronous rectifiers at lighter masses (< 20 percent) [27, 42].

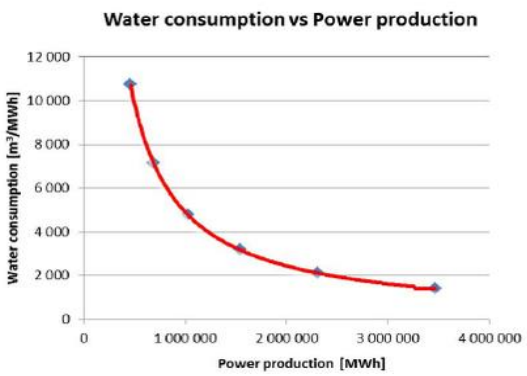

Fig.7 Water consuming Vs Power Production

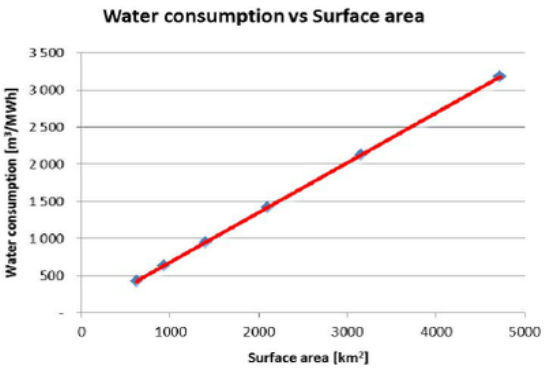

Fig.8 Water consuming Vs Surface Area

5.3 Data analysis:

The Extremely Sonic HC-SR04 emits ultrasound at 40,000HzSpan triggering pulse and echo will probably be ready to find out the gap, then it collides and bounces once more to the Extremely Sonic module [31]. The parts distance = speed*time is used to decide the interval. Assume, a thing is positioned at a distance of 10 cm absent from the sensor; the rate of sound via the clouds is 360 m/s or 0.037 cm/µs. Its expertise the sound wave needs to journey in 294 µs. However, the Echo pin double the gap (forward and bounce backward distance) [19]. So, to get the space in cm multiply the acquired journey time fee with echo pin via 0.037 and partition it with assistance[14].
Ex: If Speed = 340m/s = 0.034 cm/s
Time = distance / speed
Time = 10/0.034 = 294
Distance = speed* time/ 2

5.4 Water and Power Demand Study:

After the intensive examination of the utilized irrigation gadget framework and different ecological variables, it is achievable to quantify the water prerequisite per area of land as follows:
Factor of irrigation= 0.55
Level of evaporation= 0.4
Span for water system= 1 day
Drip Outlet diameter = 3mm
Accordingly,
Water= (irrigation factor)*(daily evaporation)*(irrigation interval)*
(Diameter of a drip)*10/2.54*0.001 required
= 0.55*0.4*1*10*3/2.54
=10.39Cubic-meter/Acre Aqua belongings vary for common class humus = 189 lit/24 hr.

5.5 Power supply:
The ability consumption of the voltage range half is the product of the voltage-time fastened and current time fastened built-in at each time, whereas the ability consumption of the current alter half is set by the product of the resistance and sq. of the current time constant, built-in at each time[19].
Sample Output energy with Dynamic pressure: A pump produces a moving charge of 1 m3/sec by tapping right into a lake, and by way of an output portion of the pipe 0.4m the water decreased to the same degree[22]. (pressure losses are neglected) This approach creates a dynamic strain because it carries the velocity to the fluid that was at rest.The fluid's given velocity is: circulate (m3/sec) / part (m2)= 1/0.4=2.5m/sec
The dynamic power of the strain is the same as 0.5 x density (kg/m3) x speed (m/sec)2= 0.5 x a thousand x 2.12=10 Pascal's
Power output Watt = circulate (m3/sec) x dynamic Stress (Pascal's) =2x5=10 watts.

6.Result and Analysis.

The fundamental objective is to provide a fantastic answer to this problem, so that losses incurred will be minimized and farmers will have an accurate crop yield. As it is now not feasible for farmers to barricade whole fields or remain on area 24 hours and defend it this gadget makes use of a movement sensor to observe wild animals imminent next to lock up to the sector [9]. Here it is presented an integrative method by the Internet of Things for smart Agriculture in an industrial level based on low powers campaigns and MATLAB is mostly used for the aim of technical computing and expressed in acquainted mathematical notation [32]. But here in this paper Python, which is a high-level programming language is considered. It can run on all of the working methods so it is efficient than MATLAB which is used earlier. As it is now not feasible for farmers to barricade whole fields or remain

on area 24 hours and defend it [34].So, this gadget makes use of a movement sensor to observe wild animals imminent next to lock up to the sector[25]. It consists of all the kinds of sensors, regulator, actuators required and raspberry pi as a coronary heart in this paper. In the proposed system on Raspberry Pi, all sensors are mounted together in a single phase when compared to the other systems, it is specially designed to be simple to learn and really easy to implement[15].it helps to preserve stretch and cash by reducing human labor ,In any other case required if the agriculturalists themselves had to offer safety to their yields with their fixed guide supervision[24].

7.CONCLUSION

Agriculture irrigation control stays unique of the determined significant interests in agriculture [4]. The simulation result describes the aqua utilization according to the field parameters in the cultivation field. Guideline of horticultural water system stays restrictive to the set up significant interests of farming [5]. The re-enactment result clarifies the utilization of water as indicated by field boundaries in the field of horticulture [20]. Equipment usage and water system control over Android telephones. In the field of IoT, we proposed an integrative way to deal with brilliant horticulture at modern level, zeroed in on low-power crusades and arising causes [7]. This field of this effort remains towards withdraw to monitor the system for crop security conflicting to subconscious occurrences and meteorological conditions [13].

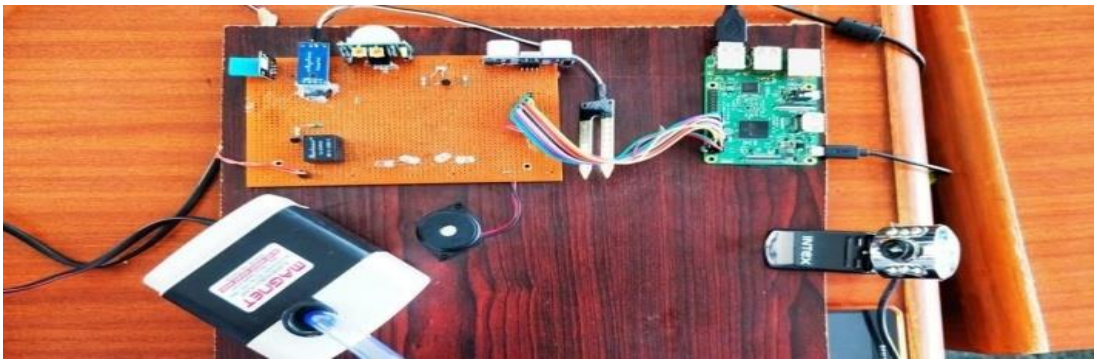

Fig.9 water system control over Android telephones

8. ACKNOWLEDGMENT

It is an incredible delight to thank our noteworthy President, Sri. Koneru Satyanarayana, for offering this second and discussion with offices to do a venture-based lab study. It is our pleasure to truly thank our pioneer Dr. Suman, HOD-ECE, for furnishing us with a powerful personnel and offices to change our thoughts into training.

REFERENCES

[1] J. Padhye, V. Firoiu, andD. Towsley, ―A stochastic model of TCP Reno congestion avoidance and control, Univ. of Massachusetts, Amherst, MA, CMPSCI Tech. Rep. 99-02,1999.

[2] Gwo-Jiun Horng ; Min-Xiang Liu Chao-Chun Chen ; The Smart Image Recognition Mechanism for Crop Harvesting System in Intelligent IEEE sensors Journals Year: 2020

[3] Archana Sahai- Security issues threats in IOT infrastructure international journal of advanced engineering, management and science. International Journal of Advanced Engineering, Management and Science (IJAEMS) Vol4, Issue5 ,May 2018].

[4] Budikartiwa, yayanapriyana & harissyahbuddin, Indonesia Production and Quality enhancement of mango using fan jet sprayer irrigation technique naniheryani. Indonesian Journal of Agricultural Science Vol. 17 No. 2 October 2016: 41–48DOI: http//dx.doi.org/10.21082/ijas.v17n2.2016.p41-48.

[5] Ismail Chahid & Abderrahim Marzouk. A Secure IoT Data Integration in Cloud Storage Systems using ABAC Access Control Policy Journal. Vol-4, Issue-8, August 2017.

[6] Adityashehrwat, NidhiSharma.,pradipshehrwat,&sandeepbhakar-.Awareness and performance of agricultural development schemes in context of farmers welfare in Haryana. Journal article economic affairs India.

[7] Bindu D -,"Basic sciences, Management & Social studies", International Journal of Engineering Volume 1, Issue 1, 2017

[8] Nanda, I., & Adhikari, N. Application and performance of FPGA using partial reconfiguration with Xilinx Plan Ahead. IOSR Journal of Engineering (IOSRJEN) www.iosrjen.org ISSN (e): 2250-3021, ISSN (p): 2278-8719 PP 01-03.

[9] Abhinav & Deshpande, "Design and implementation of an intelligent security system for farm protection from wild animals", ISSN (Online): 2456-0448 International Journal Of Innovative Research In Management, Engineering And Technology Vol. 3, Issue 2, February 2019.

[10] Krishnamurthy- International Journal of "Latest Engineering Research and Applications"2019 IJSRSET Volume 6 Issue 2 Print ISSN: 2395-1990 Online ISSN : 2394-4099 Themed Section : Engineering and Technology DOI : https://doi.org/10.32628/IJSRSET1962111.

[11] S. R. Chourey, P. A. Amale , IETE Zonal Seminar "Recent Trends in Engineering & Technology"-Special Issue of International Journal of Electronics, Communication & Soft Computing Science and Engineering, ISSN:22779477

[12] S. J. Sugumar and R. Jayaparvathy,- "An early warning system for elephant intrusion along the forest border areas," Current Science, vol. 104, pp. 1515–1526, 2013.

[13] R. Radha, K. Kathiravan, V. Vineeth, J. Sanjay and S. Venkatesh,-"Prevention of monkey trespassing in agricultural field using application agricultural specific flooding approach in wireless sensor network," 2015 IEEE Technological Innovation in ICT for Agriculture .

[14] Nanda, I., & Adhikari, N. (2019). Accelerator design for ethernet and HDMI IP systems for IoT using xilinxvivado 18.X. International Journal of Innovative Technology and Exploring Engineering, 8(10), 652–656.

[15] Gwo-JiunHorng ; Min-Xiang Liu ; Chao-Chun Chen-The Smart Image Recognition Mechanism for Crop Harvesting System in Intelligent .IEEE sensors.*Sensors* (IF 3.275) **Pub Date : 2020-10-04** ,*DOI:* 10.3390/s20195670.

[16] Nanda, I., & Adhikari, N. (2018). Application and performance of FPGA using partial reconfiguration with Xilinx PlanAhead. In 2017 IEEE Transportation Electrification Conference, ITEC-India 2017 (Vol. 2018-January, pp. 1–4). Institute of Electrical and Electronics Engineers Inc.

[17] Balaji S., Khan H., Janga Reddy M., Gurunadha Babu M.''Authentication frameworks for enhancing security in biometric systems'', International Journal of Mechanical Engineering and Technology,8(7),PP.1073-1080 . (2017),

[18] NarayutPutjaika, SasimaneePhusae, Anupong Chen-Im, PhondPhunchongharn&KhajonpongAkkarajitSakul,-"A control system in intelligent agriculture by using arduino technology," in Fifth ICT International Student Project Conference(ICT-ISPC), July 2016

[19] Addanki S., Nedumaran D. (2017),'Fabrication of ozone sensors on porous glass substrates using gold and silver thin films nanoislands',Optik,150(),PP.11-21.

[20] Ansari K., Panda S.K., Corumluoglu O. (2018) , 'Mathematical modelling of ionospheric TEC

from Turkish permanent GNSS Network (TPGN) observables during 2009–2017 and - predictability of NeQuick and Kriging models',Astrophysics and Space Science, 363 (3),PP. -

[21] Gopi Krishna P., Sreenivasa Ravi K., Hari Kishore K., Krishna Veni K., Siva Rao K.N., Prasad R.D. (2018) , 'Design and development of bi-directional IoT gateway using ZigBee and Wi-Fi technologies with MQTT protocol',International Journal of Engineering and Technology(UAE), 7 (2),PP. 125- 129

[22] Madhav B.T.P., Sreenivas Rao D., Supraja K., Tejaswini A., Phanikumar A., Nagarjunareddy A., Sai Prakash R., Meena Kumari A.N. (2017),'K15 nematic phase liquid crystal material based double-dipole reconfigurable antenna',Rasayan Journal of Chemistry,10(3),PP.866-872.

[23] Mahender K., Ramesh K.S., Kumar T.A. (2017),'An efficient ofdm system with reduced papr for combating multipath fading',Journal of Advanced Research in Dynamical and Control Systems,9(Special issue 14),PP.1939-1948.

[24] Mohammad H., Sastry A.S.C. (2017),'Implementation of C-DEC protocol along with sectorization concept for wireless sensor networks',Journal of Advanced Research in Dynamical and Control Systems,9(Special Issue 18),PP.223-234.

[25] Muralikrishna K., Mirza S., Dhula S.S., Ziaurrahman M. (2019), 'Design and analysis of nano-band pass and stop filters for high data rate applications', International Journal of Advanced Science and Technology, 28(16), PP.1315-1323.

[26] Narasimhanayak V., Lokesh V., Chaitanya V., Feroz M., Soundarya D., Sai Krishna V. (2017),'Design of bandgap reference circuits',Journal of Advanced Research in Dynamical and Control Systems,9(Special Issue 6),PP.840-846.

[27] Prasad B.S., Rao P.M., Madhav B.T.P.(2018) , 'Trapezoidal notch band frequency and polarization reconfigurable antenna for medical and wireless communication applications',Indian Journal of Public Health Research and Development, 9 (6),PP. 324- 328

[28] Prasad G.R.K., Siddaiah N., Srinivas Babu P.S. (2017),'Design and model analysis of circular cantilever sensor for early detection of Parkinson's disease',Journal of Advanced Research in Dynamical and Control Systems,9(Special Issue 16),PP.433-444.

[29] Rajendra Prasad C., Bojja P. (2017),'A review on bio-inspired algorithms for routing and localization of wireless sensor networks',Journal of Advanced Research in Dynamical and Control Systems,9(Special Issue 18),PP.1366-1374.

[30] Rajesh L., Satyanarayana P. (2019), 'Dual channel scanning in communication protocol in industrial control systems for high availability of the system', International Journal on Technical and Physical Problems of Engineering, 11(4), PP.22-27.

[31] Rajiya S.K., Monika M., Madhav B.T.P.(2018) , 'Circular slotted reconfigurable antenna for wireless medical band and X-band satellite communication applications',Indian Journal of Public Health Research and Development, 9 (6),PP. 296- 300

[32] Sampath Dakshina Murthy A., Koteswarao Rao S., Das R.P., Kishore K.L. (2017),'Recognition of facial features by principal component analysis using eigenvalues of variants',Journal of Advanced Research in Dynamical and Control Systems,9(Special Issue 14),PP.736-744.

[33] Santhosh C., Hari Kishore K., Pavani Lakshmi G., Kushwanth G., Rama Krishna Dharma Teja P., Ernest Ravindran R.S., Cheerala S.V., Ravi Kumar M. (2019), 'Detection of heavy metal ions using star-shaped microfluidic channel', International Journal of Emerging Trends in Engineering Research, 7(12), PP.768-771.

[34] Santhosh C., Ravindran R.S.E., Vulchi U.B.P., Thumati V., Gufran M.S., Bhavana D., Cheerla S.V. (2019), 'Design and verification of half adder using look up table (LUT) in quantum dot cellular automata (QCA)', International Journal of Advanced Science and Technology, 28(16), PP.1804-1809.

[35] Nanda, I., & Adhikari, N. (2020). Analysis and Design of Ethernet to HDMI Gateway Using Xilinx Vivado. In Lecture Notes on Data Engineering and Communications Technologies (Vol. 37, pp. 463–477). Springer.

[36] Siddaiah N., Prasad G.R.K., Asritha K., Hanumanthu P.V., Anvitha N., Chandra Sekhar T.N.V. (2017),'Design and model analysis of various shape cantilever based sensors for biomolecules detection',Journal of Advanced Research in Dynamical and Control Systems,9(Special Issue 16),PP.476-485

[37] Siva Kumar M., Inthiyaz S., Aditya M., Rupanjani P., Aravind B., Mukesh M., Tulasi S.K. (2019), 'Implementation of GDI logic for power efficient SRAM cell with dynamic threshold voltage levels', International Journal of Emerging Trends in Engineering Research, 7(12), PP.902-906.

[38] Siva Prasad B., Mallikarjuna Rao P., Madhav B.T.P. (2018) , 'Coplanar wave guide fed fork shaped frequency reconfigurable antenna for LTE, WI-FI and WLAN applications',International Journal of Engineering and Technology(UAE), 7 (1.1 Special Issue 1),PP. 366- 370

[39] Umar S., Priya N., Gayathri P., Subba Reddy T., Abdul A.M. (2018) , 'Design of jitter spectral shaping as robust with various oversampling techniques in OFDM',Smart Innovation, Systems and Technologies, 77 (),PP. 641- 647.

[40] C. Meshram, R. W. Ibrahim, A. J. Obaid, S. G. Meshram, A. Meshram and A. M. Abd El-Latif, "Fractional chaotic maps based short signature scheme under human-centered IoT environments," *Journal of Advanced Research,* 2020.