Agriculture Monitoring System Using Smart And Innovative Farming: A Real-Time Study

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Abstract: — In this article, we propose to develop an optimal crop irrigation/agriculture system based on a network of wireless sensors. The work intended to strategize and maintain a control organism utilizing crop sensor that senses with data managing with a web application and a smartphone. Consisting three modules mobile applications, web applications and hardware. Initial module was developed and executed in the device of the connected control box to collect crop data. Using Soil moisture sensors employed to observe the soil relative to a control unit. Second one module holding a web use developed and executed to operate all related details to crop data and farming area information. Applying data mining to assess data to calculate humidity, soil temperature, and humidity for ideal prospect conduct of crop nourishment. In last part, it is largely observed to maintain crop irrigation with a mobile app on a mobile device. Given process helps manual or automatic user management. The electronically managed practice processes data from the soil moisture sensor for irrigation. On the other hand, an end user can choose for manual management of crop irrigation in operational management mode. Given system can conduct warnings with an API LINE for a LINE app. This mechanism was executed and verified in farms and fields. Results indicated that the execution was advantageous in cultivation. A soil moisture capacity has been adequately maintained for plant evolution, cost reduction, and increased cultivated production. Furthermore, this effort signifies the impelling force of agriculture by digital invention.

Index Terms: — Information discovery, Data mining, Wireless sensor systems, Smart farm, Agriculture data investigation, IoTs

1 Introduction

Continuous development in technologies brings welfares to most societies. In these modern days, the Internet of Things (IoT) is playing an essential part in everyday life by expanding our insights and our ability to change the environs of our surroundings. It is mainly the environmental and agro-industrial sectors that extensively use the IoT to both diagnosis and management. Furthermore, it thoroughgoing provides a consumer /user with information on the foundation and characteristics of a related commodity (Talavera et al., 2017). Therefore, this research work purposes to implement the IoT to the optimization of computer-assisted agriculture. In this agricultural optimization, a cultivation farmings require the installation of a wireless sensor network (WSN), for farmers, this WSN improves the effectiveness and efficiency (Capello et al., 2016; Fang et al., 2014, Hashim et al., 2015, Kodali et al., 2014). It is helpful for assessing agricultural variables like soil conditions, biomass of animals or plants and weather conditions. This is also helpful for evaluating and controlling variables like humidity, temperature, and shocks throughout product transference or vibrations (Pang et al., 2015). Besides, WSN is also considered advantageous for monitoring and controlling factors that impact yield and crop growth. These can be utilized to regulate an optimal harvest times, which agriculturalist is best suited for which circumstances, to check machinery, detect diseases, and more related things. (Ndzi et al., 2014). The current research focuses on the data, including humidity, soil temperature, and humidity in cultivated farmings. With objective to develop an adequate organism, we need to store data and use an approach to explore the knowledge and interactions gathered with the user. For keeping all data, a system will be formulated and executed based on a web app. A database will be taken in consideration for decision making to handle automatic crop irrigation. Agricultural stored data will be assessed to improve and revise the surrounding environment and to calculate the need of water for plants onwards. Among the critical conditions, some tasks applied like data mining for extraction the ideal/best value from accurate mensuration using automatic crop, climate, and land and monitoring devices.

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Mining of data is applied in agriculture field to explore knowledge and build understanding of it (Kamilaris et al., 2017; Tripathy et al., 2014). The connotation procedural methodology was mainly employed to search for new relationships among large variables large databases. This supports to assess and determine direct/indirect connections among the features of agricultural information, affirming systematic decision-making (Tripathy et al., 2014). Therefore, an analysis of farming data performed by the connotation procedures was performed employing an Apriori algorithm during an acquisition of broad-spectrum instructions, whereas a linear regression was regressed to a model finding out connections between different input factors and a result variable. Furthermore, the work intended at designing and implementing the WSN method for sensing the crops using sensors, as well as managing data interface with a user through a web application and smartphone. This designed method can upkeep diversified farming and assist farmers who have connectivity anywhere and whenever with a system. The paper is systematized as follows: Part 2 deals with correlated works, part 3 of the suggested investigative system, part 4 of an analysis of agricultural data, part 5 of the outcomes and discussions, and lastly, section 6 end with the conclusion.

2. Related Review of Literature

Segment of selected literature review defines that we will discourse related previous investigation on two characteristics. The first concerns the use of the IoT, whereas the other one concerns the analysis of agricultural data based on IoT devices.

Use of IoTs

In current days, IoT has been recognized a best tool in several agricultural research works, as described by (Ojha et al., 2015, Talavera et al., 2017). Technological uses in agricultural science are supportive to expand the quality or, yield of crops, and minimize expenditures. A WSN application in fastidiousness farming helps farmers statistically, facilitating them take well informed precautions (Kodali et al., 2014; Fang et al., 2014). Fang et al. (2014) presented a new incorporated info structure (IIS) for located area surveillance and ecological control, grounded on connected objects, to improve the efficiency of complex tasks. The recommended IIS syndicates IoT, Cloud Computing, Geoinformatics (RS, GIS, and GPS) and e-Science for environmental monitoring and management, with a case study on regional climate change and its ecological responses. One of the most current problems in the world. The scientific world. The results showed the significant advantages of this IIS, not only in the collection of data supported by the IoT but also in Web services and applications based on cloud computing and e-Science platforms. Effective monitoring and decision-making have been improved.Furthermore, the IoT has been implemented in an agro-industry yielding chain (Ruan and Shi, 2016; Capello et al., 2016; Li et al., 2013; Medela et al., 2013). Medela et al. (2013) implementted IoT to an agro-industry yielding chain. Agriculturists recommended an inventive design constructed on the IoT model, associating specific distributed and wireless sensors with a simulation of climatically situations, to follow a development of the grape for the cellars. Li et al. (2013) introduced the info structure model for farming grounded upon connected objects, via disseminated architecture. The current study presents the monitoring and traceability of an entire agricultural production procedure were carried out using distribution of IoT servers. Furthermore, an info exploring system was formulated to acquire, implement, manage, standardize, query commercial and locate data from cultivated yield. Pang et al. (2015) suggested a common based on value model/framework to deliver statistical evidence to the consumer /end-user on the properties and origin of a produce. Capello et al. (2016) employed an IoT for an actual controlling facility to track yields from the end-consumer to the site. Ruan and Shi (2016) introduced an IoT module to evaluate the pureness of fruits in online provisions, the non-traditional retail service that confronts distinctive transportation conditions such as expensive logistics and product perishability. Numerous researches have undertaken to increase the practicality of related objects (Luan et al., 2015; Hashim et al., 2015). Diedrichs et al. (2014) undertook an improvement of the WSN, constructed on IEEE_802-15-4, to be used for the categorization of frostiness in fastidiousness farming by gauging the degree of hotness or coldness. Fourati et al. (2014) recommended a decision support system built on web that communicates through WSN for agriculture planning in olive groves. Reaching at this point, the researchers utilized sensors to calculate temperature, humidity, rain and solar radiation. Hashim et al. (2015) inspected the regulation via microelectronic device ('Arduino') of soil humidity, high/low temperature and used with a smartphone app based on Android for more functionality and flexibility. They came to know that controlling agriculture presented cost and flexibility advantages over expensive components like high performance PCs. Luan et al. (2015) have aimed as well as established a synthetically mechanism that integrates alarming situation if shortage of water drought and forecasting and anticipating provision of cultivation quantity in an IoT-based platform, parallel computing and hybrid programming. Kaewmard and Saiyod (2014), Kanoun et al. (2014) observed an irrigation mechanisms having WSN to collect environmental data and manage a farming system using phone device. Kaewmard and Saiyod (2014) delivered a sustainable long run explanation of problems for an agriculture automation to extract data from environmental measures or vegetable crops. Many researchers have implemented an easily movable measurement technology, consisting air temperature sensors, soil moisture sensors and air humidity sensor. Chen et al. (2014) recommended poly-layered humidity and soil temperature monitoring systems availing WSN to develop allocation of water and gather fundamental data for inquiry on changes in intelligent precision irrigation and soil water infiltration.

Table 1:
Preparation Parametric

'(Parameter)'	'(Value)'	'(Voltage)'
-nodeMCU-	-	[135 to 215 mA]
-Temp & Humidity-	-DHT22 Sensor-	[2.5' mA]
-Relay Component *5-	-1 Channel-	[5 mA]
-Solenoid-	-Plastic ¼-	[1.3' mA]
Architecture	-Crop cultivation-	-

Li et al. (2012) have recommended a connected object-based greenhouse environmental monitoring system that provides a real remote monitoring of ecological data on the greenhouse effect, collectively using a mobile network, a wireless network and the Internet. Likewise, Lukas et al. (2015) aimed to formulate a reliable water allocation controlling structure for irrigators via WSNs built on Lora, helping the farmer to see the obtainability of water for cattle yet while the barn was one or three km far. Wong and Kerkez (2016) introduced an actual data structural design and a Web service that contains a capacitive-adapt controller that informs regarding parameters to each detection node in a WSN according to a formerly described strategy. Sarangi et al. (2016) recommended the agricultural assistance organism built on 'Wisekar' to deliver mechanized and admired value facilities those incorporate an agricultural consulting call center with interoperability of an IoT web repository.

AGRICULTURE DATA ANALYSIS

A use of an IoT contributes towards extensive or large data that delivers worthful facts and figures. Considering this motive, several researches have contributed to transform this data into identification of knowledge and valuable information (Kamilaris et al., 2017). Another study, Pahuja et al. (2013) have intended an internet based microclimate managing and controlling mechanism for conservatories. This mechanism was based on the computer network to collect and analyze sensor data related to plants to control irrigation, climate, pests and fertilization. Tripathy et al. (2014) utilized the data derivation as of a WSN to explore information through mining of data. The research emphasized on leaf point diseases and evaluated cultivation time and environmental disease relationships constructed on monitoring of field via wireless sensors. A classifier has been accomplished to foresee leaf related diseases. Kehua Xian (2017) has suggested a novel practical online managing organism for cloud-based connected objects. Having accumulated sufficient data from a farming IoT organism, demonstrating of relevant operational criteria was verified to endorse an application for a deep analysis of agricultural data. Though, merely a few researches have implemented data mining to yield valuable knowledge and information, so that work in progress can exploit IoT data.

RESEARCH METHODOLOGY

PRACTICALITY AND IMPLEMENTATION OF TEST

The research will validate factual setting up in 3 points 'villages'. These three examples of the village are separated from each other and show differences in agriculture. The first example of a community is the cultivation of home-made vegetables and lime. A second example of a village includes a home-made vegetable and salad farm. The last case of the village holds an integrated production structure that provides salad farms, mushroom, and chicken farms. These models of Figs represent the three examples of villages. 1-3. All the examples of villages have shown that the connected objects can be helpful to provide and assist farmers in any farming field. Furthermore, farmers can easily spare their time on additional activities to increase their earnings. Information on real-time IoT machines in every rural side has been utilized to regulate the activation and deactivation of automatic fire extinguishers mechanically. At first, we gathered the IoT info for 2 months (60 days) and accomplished a performance examination with the collected data. The resulting IoT info related to humidity, soil temperature, and humidity and it was gathered by every 15 minutes, then day-to-day ordinary values were valuable to analyze data. Furthermore, we documented the yields of vegetables and lime grown-up at home to decide the relationship between agricultural products, and IoT information.

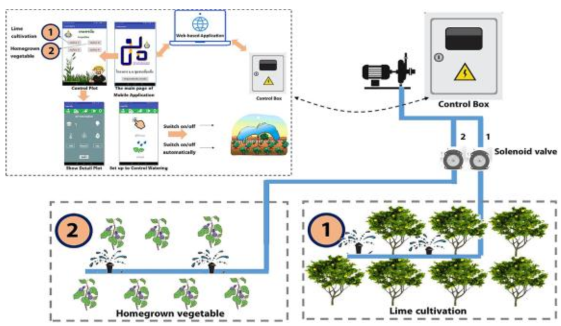


Figure 1: *Example: Module for 1st village.*

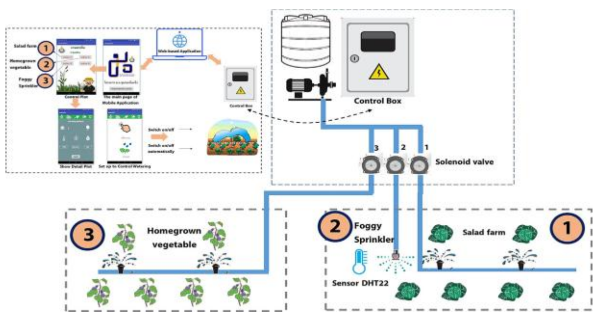


Figure 2: *Example: Module for 2nd village.*

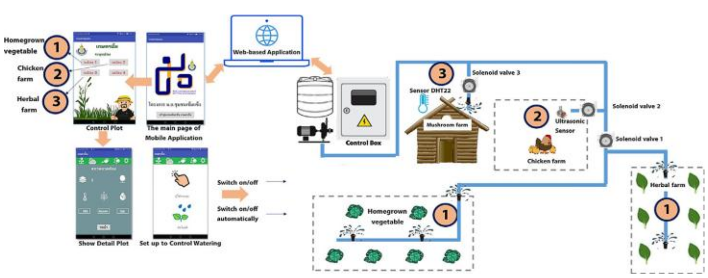


Figure 3: *Example: Module for 3rd village*

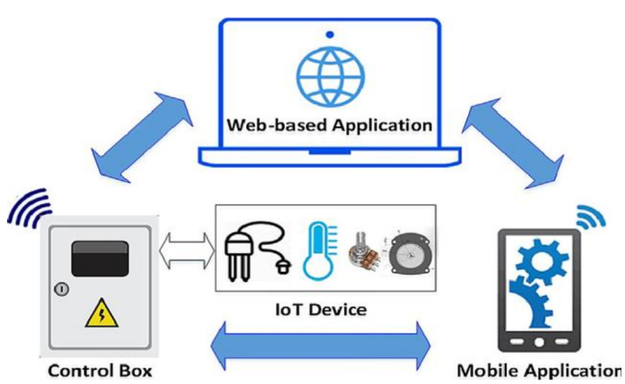


Figure 4: *Overview: Link of a system.*

Aim and outline of the organism

Looking at this piece of research-work intends to develop, and execute schemes by using sensors in of crops field, and management of data using Web application, and a smartphone. These three modules consisting Web applications, hardware, and mobile applications as represented in Figure 4. Denoting in Figure 4, a first module was structured and established in the controlling module. The control box is formed to manage IoT mechanisms and acquire data of crop. IoT devices and the control box employed in this research are displayed in Tab: 1. A second module presented as Web application. The module provides real-time IoT information management devices in every village. A Web app agrees with a decision maker to handle the circumstances of water supply requirements of every crop. Besides, an administrator can view information details from IoT devices to manage all types of cultivation. The data were evaluated to forecast crop water requirements in conducting next cultivations. A Web application to show the details of each cultivation and control the IoT data of every installation are presented in FIG. 5. A last module was utilized by the agriculturalist on a smart phone. A mobile app was formed for managing irrigation when analyzing data. A mobile app has delivered in two ways, so the farmers can manually manage flooding or that the recommended organism can by design activate/deactivate water relied on IoT information, as revealed in Fig. 5. Let's sum up the prescribed organisms in the method suggested with a system. The construction of the order consists of 3 parts: the level of acquisition of environmental data, the level of data and communication, and the level of application. The ecological data acquirement level is intended to gather data on ecological aspects from device control and sensors. The next level carries relevant sensor data collected for recorded on a server. An application layer is helpful for data management and accumulating the data to monitor and control cropping.

IMPLEMENTATION

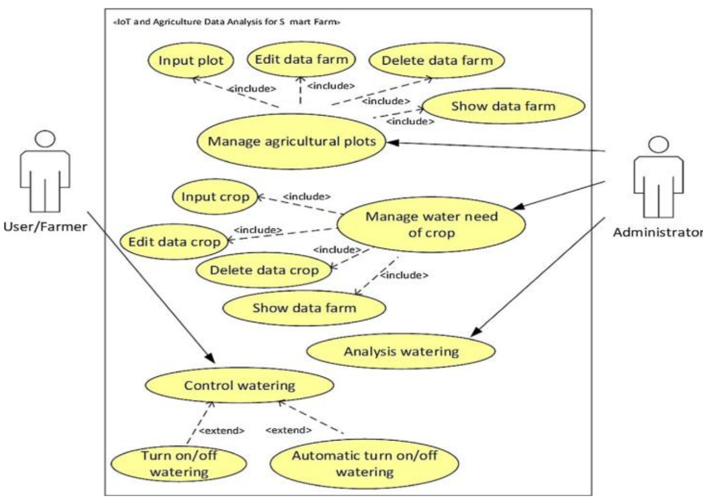
The recommended structure is applied in three fragments, namely a mobile app, a control box, and a web application. A control box retains the automated mechanisms in a sealed housing, as per presented in 'FIG: 7'. A regulating unit can be placed near the farm or at anyplace by connecting the DHT22 sensor, a soil moisture sensing device, ultrasonic sensor and a solenoid valve to the control box. Current study describes IoT is implemented via soil moisture sensors to measure soil moisture in crops and to control the activation and deactivation of water sprayers robotically. A solenoid valve was employed to manage the flow of water by avoiding unnecessary actions. A 'DHT22 sensor' was helpful to manage a dampness of the mushroom crop. Implementation of ultrasonic sensor helped to gauge water level in a chicken farm. Another portion is the Web app this obtains info on NodeMCU agriculture. Access of Internet via a Wi-Fi connection. A web app has been applied to control agricultural packages and also control crop water or to assess what makes irrigation mechanism better. Figure 8 delivers an example of a Web page showing water requirements and IoT information for each structure. Furthermore, this part involves the analysis of agricultural data described in section 4. Lastly, this part describes implementation and interface for a farmer. A mobile app takes into account you to manage the activation/deactivation of an electric organism through a farmer. This mode of application consisted on two things; manual and automatic. A computer organism was made active parallel installations of IoT devices through determined values of field instruments were set up excluding user intervention. An agriculturalist manually can control and activate or deactivate the water with a mobile app. 'Figure 9' is an example of an irrigation control app through a phone. Usage of main functions is notifications via the LINE application, irrigation monitoring and setting crop details in each field.

FARMING DATA ASSESSMENT

Mining of data has been implemented to obtain useful and essential information from data on many cultivation farms obtained with the IoT. The procedures of information exploration are discoursed in (Han and Kamber, 2006). Mining of data involves the extraction of information from great quantities of data. This document distributes mining of data into four stages, as given below:

PRETREATMENT OF DATA

Essential step helps in process of discovering information because the quality of the data provides quality of the experience. In this actual world, the data tends to be meaningless, inconsistent and inadequate. Therefore, this phase possibly helps improving the efficiency, and accuracy of following operations. The phase comprises the data integration, transformation and data cleaning. The work engaged a great amount of IoT device data on temperature of soil, moisture and humidity to forecast crops health, and the data from a first village example is presented in 'Fig. 10'. The IoT info was converted into a discrete format that supports data exhibiting.



DATA DIMINUTION

Another stage can encrypt specific data into a slighter precise illustration. A reliability of the real data has been kept safe so that the extraction of the reduced data is additional proficient, producing the matching (or practically the same) outcomes of the assessment. The work engaged the reduction of numbering, in which non-parametric techniques for keeping reduced illustrations of data contain histograms. We statistically showed histograms of equal width with identical width slots and three slots for low, medium, and high levels

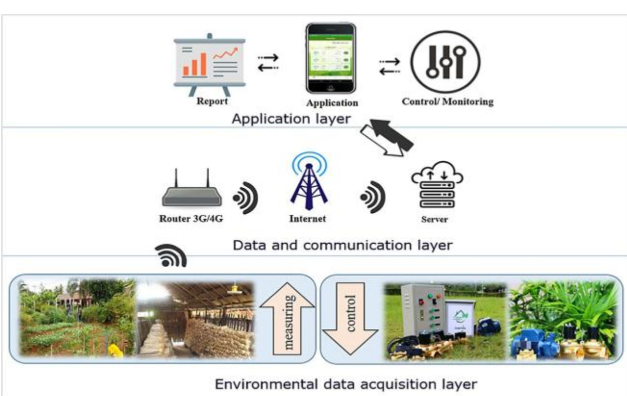


Figure 6: *Architecture: A Control System.*

Data identification/modeling: further, this stage obtains information from an organized data. Typically, the data modeling/identification implements intellectual approaches to recognize arrays in specific data. Assessment instruments can contain association, arrangement, grouping, etc. The connotation rules are the mining of data method used in this research work. The connotation rules are helpful instructions, therefore, these instructions help to determine the relationships between instinctively unrelated agricultural data. These were applied to discover connections between soil moisture, temperature and humidity, as well as yields of vegetables and lemons at home. Depending on two main criteria that the connotation rules support, use, trust, and exemplify relationships and rules as repeatedly accurate if / models. The research work indicates the smallest support was '0.75', and the correctness was healthier as '90%'.

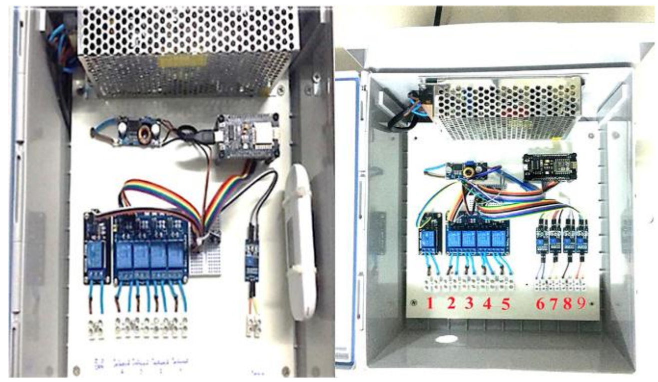


Figure 7: *Set-up: A control box design.*

An analytical algorithm easily accessible in "Weka 3.6.9 (http://www.cs.waikato.ac.nz/ml/weka/)" was adopted to obtain the relationship rules from the data. Being agriculturalists, it also referred linear regression to model that link between different input and outcome variables. The type of model is displayed in Eq. (1),

$$y = \beta_0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_\rho x_\rho+ \varepsilon, \qquad \text{Eq: (1)}$$

Where y is the outcome variable,
xj are the input variables, for j = 1, 2, …,ρ − 1,
β_0 is the value of y when each xj equals zero,
β_j is the change in y based on a unit change in xj for
j = 1, 2…, ρ − 1, and ε is a random error term that represents the difference in the linear model and a particular observed value for y. Result variables are the products of vegetables and lime grown at home (both have model), whereas input variables are soil moisture, temperature and humidity. The R indicates as environment to adapt the models to a 95% confidence level, indicated in the equations of models. (2) and (3) for products coming from the cultivation of vegetables (Prod_Veg) and lime (Prod_Lemon), respectively, for homegrown.

"Prod_Lemon=0.89*Temp+0.07*DHT−0.02*Humidity−25.87".Eq:2

"Prod_Veg=0.16∗Temp+0.10∗DHT−0.04∗Humidity− 7.29". Eq: (3)

RESULT ASSESSMENT

The part involves an assessment of the outcomes from data identification/modeling. Answers in our effort will discourse with an actual performance.

OUTCOMES AND DISCUSSION

A recommended organism can involve IoT instruments to assemble the data on a discovery of moistness knowledge. From an economic point of view, the proposed method was regarded an investment for the reason that of its low cost of around USD $93.27 per package. We paid attention on a first example of a village. An improvement in the productivity of cultivation of lime designates a return on investment in two months. Furthermore, better productivity entails that the farmer can spare more time on other activities. Moreover, this research was conducted in a diverse cultivation environment with three examples of villages. Every village held different agricultural and crops targets. The discovery of knowledge can be used to recommend an irrigation managing strategy while the farmer wants to have mixed plants.

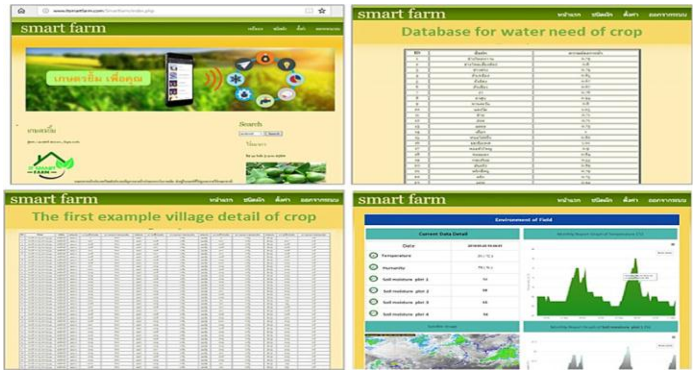


Figure 8: *Information and Installation: Water need and a web-page.*

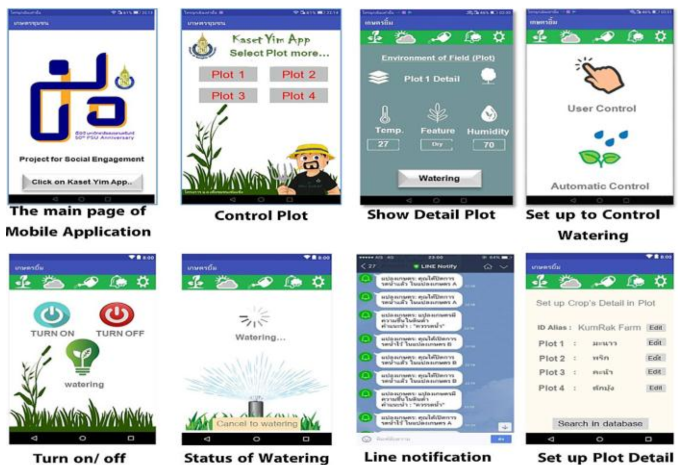


Figure 9: *Example: Water control management application*

CONCLUSION

IoT has been used in agricultural science to recover crops, reduce costs and improve quality. Looking at these motives, we have suggested an app of WSN to cultivate irrigation in this research work. We have aimed and executed a system for controlling environmental dynamics in the fields. This system consisted of three parts: mobile app, web app and hardware. In initial part, designing and implementing of a control box was formed. This control box comprised electronic control systems and computer hardware and connects sensors and extracts crop data.

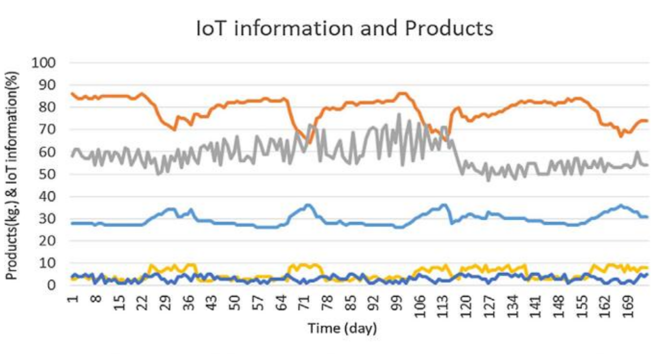


Figure: 10: *IoT Information: 1st village example.*

This control box was architecture for actual tests. The executed project attached and supported IoT experience from related measures defined in the study. Second one part described a Web app originated, and executed to manage the features of data of crop, and domain knowledge. At this level, wide-scale IoT data is saved and utilized in data assessment. As a significant experience, this research implemented connotation data mining rules to obtain valuable learning on the impacts of the climate and environment. Obtained outcomes explained that the proper temperature for the high fertility of regionally developed lemons and vegetables were between 29 ° C and 32 ° C. Furthermore, the appropriate moisture for great lemon fertility was between '72% to 81%' range. The end portion comprised of regulating crop irrigation via a mobile app on an android phone. This enabled end-user manual and automatic operative command. An end-user can apply the automated function constructed on the data of the soil moisture sensor for irrigation. Nevertheless, manual control was permissible in the efficient control method. A system communicated information via the 'LINE API' of the 'LINE app'. A developed method was set up in "Makhamtia district, Suratthani province, Thailand". Achieved outcomes exhibited definite privileges for agriculture. Moisture capacity in the soil has been satisfactorily verified for vegetables, consequently decreasing costs and growing agricultural fertility. This research study exhibits an extraordinary possibility for applications of digital technologies in cultivation/agriculture.

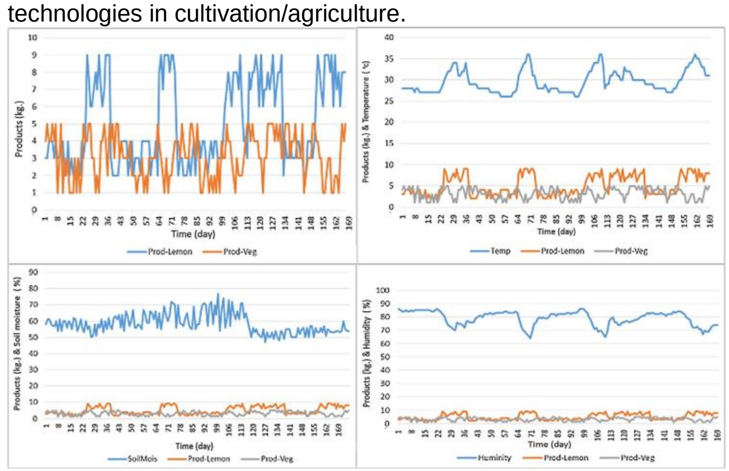


Figure 11: *Analysis: Comparative assessment IoT and Productivity*

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