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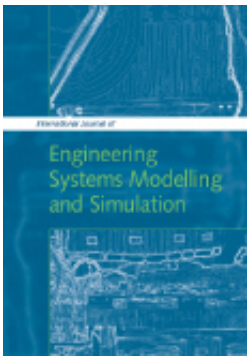

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Predictive analysis of smart agriculture using IoT-based UAV and propagation models of machine learning

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Predictive analysis of smart agriculture using IoT-based UAV and propagation models of machine learning

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Abstract: Every year, unfavourable weather conditions cause many crops to fail. Every time, over 12 million dollar losses are recorded. This article provides a proper background for delivering the yield's current state. The project proposes to employ IoT-based unmanned aerial vehicles (UAVs) and tensor-flow machine learning to estimate crop yields. This framework enhances agricultural yield accuracy by using UAVs. The IoT-enabled UAV module captures data and texts it to the farmer or rancher. The data cloud storage's server uses MQTT for safe data transmission. The cloud server leverages UAV for continuous surveillance and harvest forecasts. Predictive analysis using propagation model has an accuracy of roughly 85% compared to real-time analysis for the same crops at the farm.

Keywords: predictive analysis; unmanned aerial vehicle; UAV; smart agriculture; machine; learning; internet of things; IoT.

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1 Introduction

With the headway of innovation in this day and age, significant upgrades are wild in pretty much every field running from lodging to medical services. Enabling a rancher with a portion of this innovations are a critical essential of these periods. Ranchers particularly in agrarian countries namely Africa, actually depend on their instinct and use procedures that are longer than extremely old for

developing yields. These strategies request a tremendous measure of difficult work and steady management by the ranchers. Because of this, more than 12 million US dollars' worth of income is lost every year because of harvest harm (Hong et al., 2016). An essential driver of this is that the plants neglect to get the ideal conditions required and furthermore because of an absence of powerful oversight (Khalil et al., 2005; Robinson, 2008). While already, research has been done in this space, the arrangements proposed don't remember the financial rank of the normal rancher in such countries (Pudumalar et al., 2017).

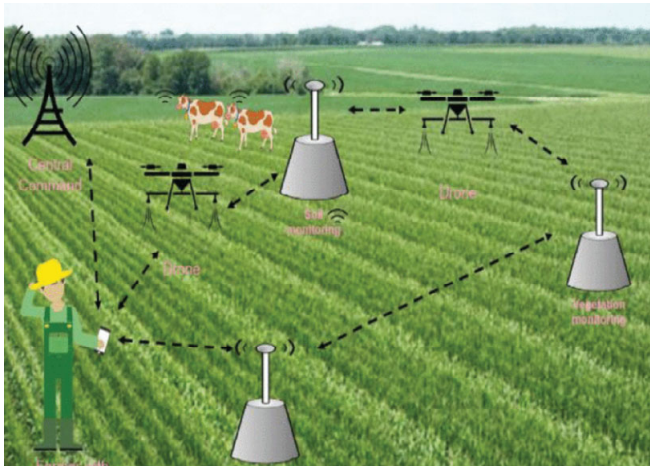
In course of recent ages, it is experienced that the world faces the quick climatical conditions periodically changes. In Tamilnadu (a state in India), the sign shows us an unpredictable rainstorm (Krithika and Veni, 2017). Different pieces of the nation get unpredicted measures of precipitation and the ranchers are by and large ill-equipped. As the barometrical conditions continue to change quickly, ranchers succumb to the absence of information that is needed to gauge sort of ranch conditions, methods and loam form is fundamental for budding a sort of harvest (Afrisal et al., 2013). Also, from time to time it happens that rancher over use a specific land parcel to such a degree that it leaves the land without all minerals. Consequently, have the option to foresee and conjecture the execution of the yield for a wide range of natural conditions. This proposed model gives an answer by building an equipment put together framework which with respect to sending will gauge the measure of water present in the dirt continuously, distinguish the dampness level and temperature of the climate (Sudharsan et al., 2020).

In the event that the measure of dirt moistness in the climatical dips under the limit fact, at that point the framework can alarm the user by sending a text message to that particular user. The rancher can additionally screen the situation with a harvest utilising a mobile application or any application web (Brown et al., 2017; Sudharsan, 2019). Secondly, the piece of undertaking manages the forecast of yield form according to the dirt environments (Fatmi et al., 2017). These frameworks utilise best in class techniques to progress the exactness of outcomes and give moderate anthropological intercession. Through the assistance of internet of things (IoT) and artificial intelligence based unmanned aerial vehicle (UAV), a keen, dependable in minimal expense novel arrangement is created which is fit for mechanising a few strategies from the watering of harvests to anticipating the soundness of the yield.

This research works on the improvement of smart agriculture for ranchers to know their crop yield and their farm condition using IoT platform (Sudharsan, 2019). The importance of IoT has become vital to the society, since its rapid growth in the Internet technologies and communication systems. In the current scenario, we get access to internet via smart mobile phones, computers, tablets, televisions etc., at anytime and anywhere. In the similar fashion, the IoT is being developed which is not used only 'human' but also 'things' (Fatmi et al., 2017). It is used various fields of applications such as the home appliances, agriculture, medical devices and so on. The internet is applied in various fields, it conveys an idea in which the 'things' is well communicated and interconnected or interrelated with different solutions. Mainly, internet for communication to other devices, over the cloud and some field of services (events, database, semantic, service based and application specific).

This IoT can communicate with various sources developed. They are, Bluetooth, Wi-Fi, Zigbee, Radio frequency Identification, Near Field Communication, Lo-Ra etc (Misbahuddin et al., 2018)., these mediums are used depending on the application requirement. It may be Short-range, long range, low power, high data rate, security (secured data transfer) and also type of portable devices (Sensors and Actuators) used in the application. For very long range and higher bandwidth 'TV Whitespace' can be used for data transfer, even the target device is very far away from the source operating device. In other-words, this IoT denotes the worldwide network connections and its addressed devices. According to (Ren et al., 2010), the IoT connects to various sensors and actuators components, providing the ability to them for transmitting the information from one host to other host using various mediums. This will lead database collection and management, big data analytics, cloud computing etc.,

Figure 1 Network precisions value in agricultural farm (see online version for colours)



2 Related works

The flora veil goes through include extraction, predominantly utilising 2 techniques: objects-based or key-point-based (Brown et al., 2017). Also, further mathematical highlights are removed by conveying the spatial connection between the crops. At long last, the highlights vectors removed are taken care of two irregular woods grouping in multi-grouping. In this interaction an enormous number of choice trees are produced at the hour of preparing which at long last aides yield the likelihood of each class mark (Sudharsan, 2019).

Fatmi et al. (2017) has utilised information driven strategies to construct a dirt dampness structure utilising

support vector machines (SVMs) and relevance vector machines (RVMs) (Misbahuddin et al., 2018) for right on time expectation of the dirt dampness level dependent on the natural conditions. The information is gathered utilising remote hubs and has been tried on the Laboratory recorded information. These structures are versatile, also supports its exactness for 42 days (Ren et al., 2010).

Krishna et al. (2017) presented the utilisation of PIPENET that identifies, limit and measure explode, spills and other water irregularities like blockages ready to go and the strategy to compute the measure of energy utilisation by sensors in an organisation, as indicated by information stream rate, number of hubs and distance between them. Nagaraj (2021) described an unceasing rainfall observing framework with wireless sensor networks which is conveyed in three volcanic islands. These actions stream and climatic conditions through WS_{ens} incorporated with various S_{ens}. Prakash et al. (2016) illustrated the effectiveness of H2O, the board framework in India by smallest expense structure dependent on S_{ens} organisation, to oversee support of water assets and controlling H_2O wastage.

Sudharsan and Deny (2020) describes the rainfall determining prototype planned utilising wireless sensor network, this prototype predicts rainfall in streams utilising the straightforward computations to give ongoing outcomes and save the existences of individuals by ringing alert. Thenkumari et al. (2021) worked on re-enactment instrument to distinguish pre and post calamity rainfall hazard examination by utilising wireless sensor networks and presented an investigation of rainfall examination and prediction of rainfall using GISs. Peña-López (2005) surveyed Rainfall predicting and crop growth rate for all seasons in India utilising propagation models of machine learning techniques. Atzori et al. (2010) applies the ANN techniques for the informational index gathered from fifteen stream check stations, introduced a glimmer rainfall. Besides, the presentation of the prototype is determined. Gubbi et al. (2013) – assessed the exactness of counterfeit neural organisations, however by considering two normal machine learning demonstrating devices, of Support vector machine and Multilayer perception.

Bandyopadhyay et al. (2011) describes various sensor for monitoring the crop yield and agricultural farm and its related physical parameter under the background of IoT. The sensors used for sensing the information and gathering it related to the application environment. In other words, the sensors will sense some physical parameters. The network layer is responsible for connecting to smart devices (Single board computers) as a gateway. It adds the features, that it can transmit the data and process the data from the sensors in the physical layer. The final layer will be the application layer, in this layer it delivers the application explicit administrations to the client (users). Three-layer architecture has been overcome by the five-layer architecture since it focuses on only few aspects of IoT.

The five-layer architecture has the additional layers such as transport layers processing layer and business layers being both perception and application layers are common for both 3- and 5-layer.

1 Transport layer will send the sensors data to processing layer from the perception layer using wireless via Bluetooth, Wifi, LAN, NFC, RFID etc.

2 The processing layer will do the job of middleware services. This Middleware services will Manage, store, analyse and process very huge amount of data from the transport layer. It employs various databases, big data analytics and cloud computing.

3 The business layer which included the entire IoT module, profit models and user's privacy.

In a classic social IoT setting, we treat the gadgets and services as bots where they can set up connections among them and adjust them after some time. This will enable us to consistently give the gadgets a chance to collaborate among one another and accomplish an intricate undertaking.

To make such a model work, we need numerous interoperating parts.

1 Require a 'unique technique of object identification'. (i.e.) an ID has been assigned to every device or object based on the Classical parameters namely: UUID, MAC ID, product code or other custom method for object identification.

2 The second will be the 'metainformation' which comes along with ID of a device/object. The metainformation will give the description of the device's development and operation.

3 After metainformation, 'security control' plays a vital role in object communication which is much similar to 'friend list' setting in Facebook (social application).

4 Next is 'service discovery', similar to service cloud in which have to store the data in the dedicated directories commonly termed as database management system (DBMS). It is very important for devices to keep up-to-date information/data for future services.

5 The final part will be the 'service configuration', the goal of this part is to provide better integration, services to new users.

3 Proposed methodologies

This segment depicts the arrangement of equipment parts and the details for setting up a savvy cloud-based foundation.

3.1 Server in cloud

An Amazon's AWS T3. MicroEC2 occasion (Asensio et al., 2014) is arrangement. The web application is sent on this worker. It additionally goes about as a data set for putting away the information got. These information's are utilised

for the assessment of recorded information for the prescient examination.

There is no single agreement on architecture for IoT, which is accepted universally. Different architecture has been proposed by several researchers. There are two main architectures, they are: Three layer and Five-layer architecture. Among these, three-layer architecture is more basic one which has perception layer, network layer and application layer. This perception layer is commonly known as physical layer. In which, it has sensors for sensing the information and gathering it related to the application environment. In other-words, the sensors will sense some physical parameters.

Figure 2 Field level architecture

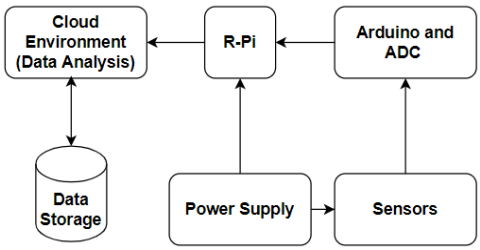
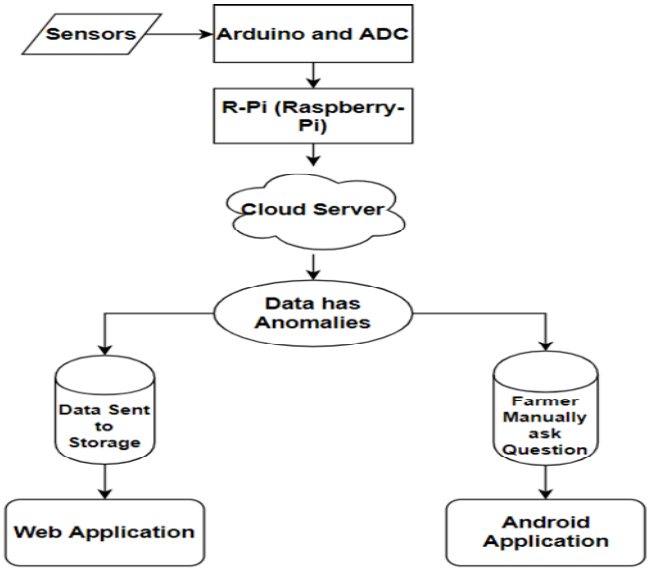


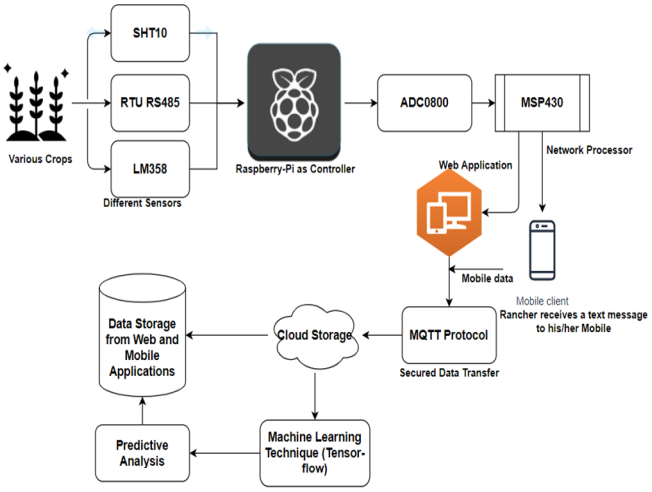
Figure 3 Flow of the framework proposed



The network layer is responsible for connecting to smart devices (single board computers) as a gateway. It adds the features, that it can transmits the data and process the data from the sensors in the physical layer. The final layer will be the application layer, in this layer it delivers the application explicit administrations to the client (users). Three-layer architecture has been overcome by the five-layer architecture since it focuses on only few aspects of IoT. The flow of the proposed filed level architecture and framework is depicted in Figures 2 and 3.

Shockingly, a significant downside of this plot is the absence of admittance to the ongoing information just as absence of power over the ranch gear the rancher is exterior to the ranch. There is no savvy arrangement as of today that can guarantee worldwide admittance to the information without web access. Thus, the utilisation of web application than the android application is exceptionally supported for this errand. The R-Pi acts gateway to transmit the information from sensors to the serve/cloud environment, where the data is stored for future requirements and reference as illustrated in Figure 4.

Figure 4 Prototype model of smart agriculture using IoT infrastructure (see online version for colours)



3.2 Components

An R-Pi is a savvy however, sensibly amazing arrangement, ideal for this utilisation. This prototype of little gateway computer is particularly helpful, but an implicit Wi-Fi and Bluetooth breakout boards. This structure of prototype is cost effective and reduces the expense of additional Bluetooth and Wi-Fi modules that would have been required something else.

1 SHT10 – The SHT10 S_{ens} is utilised to peruse the temperature and dampness close the crop. The information is gotten as advanced waves.

2 RTU RS485: The RTU RS485 is utilised to distinguish the measure of dampness existing in the dirt in which plant is kept.

3 REES52: The REES52 is a modest yet productive approach to distinguish air excellence. It is fit for detecting the occurrence of different gases.

4 LM358: This LM358 is utilised to screen the measure of daylight the plant is getting and dependent on this sum, it tends to be resolved regardless of whether the harvest is getting an ideal measure of light that is required for its appropriate development.

The network processor CC3100 and Computational processor MSP430 is interfaced with sensory components and made to communicate the emergency signals through global system for mobile (GSM) like messaging service and SMTP server. This simple mail transfer protocol (SMTP) server can be achieved by implementing a TCP/IP stack and Ethernet interface in a MSP430 controller.

ADCs: This converter (ADC0800) will function as converting the incoming analogue signal to digital signal and transmit it to over the web application or mobile applications using ESP8266 (Wi-Fi Module)/ HC-05 (Bluetooth Module) via a proper gateway. Here, the gateway is being the Raspberry-Pi (R-Pi).

Firmware: The firmware used for implementation is python with the version of Python3 should be introduced on the worker. This is utilised to path and prepare the IoT-based UAV framework. In terms machine learning, tensor-flow is used and it is an open-source library for predictive analysis of the growth rate of crops in agricultural farms. MySQL is used as cloud server with MQTT (Mosquito Queuing Telemetry Transport) for secured data transfer.

$$bji\left(\tilde{g}_{ji}\right) = \begin{cases} 1 & 0 \le \tilde{g}_{ji} \le 0.4 \\ 0.4 / \tilde{g}_{ji}\left(1-p_2\right)\left(1-P_2 e^{0.4-\tilde{g}_{ji}/P_1}\right) & \tilde{g}_{ji} > 0.4 \end{cases} \quad (1)$$

$$n = \lambda P_{rise,i} \quad (2)$$

$$\lambda = \log 2 / \left[\begin{matrix} P_{rise,\,j} - P_{rise,\,j} \log \\ \left(P_{hut,\,j} \middle/ P_{rise,\,j} \right) - P_{rise,\,j} \end{matrix} \right] \quad (3)$$

Plated edged harvest development relies upon different variables from the sort of soil the harvest fills in to the measure of dampness it gets. For distinguishing foreseeing, the sort of yield that is destined to be appropriate to develop on the horticultural land, we utilise a technique like that utilised by Stoianov et al. (2007), Kanagarathinam and Sekar (2019) and Senthil Ganesh et al. (2021). The dataset utilised comprised of soil explicit subtleties of various districts of India. It additionally comprised of the ideal soil furthermore, dampness conditions required alongside the sort of soil needed for growing a specific harvest. The various yields considered are cotton, rice, mustard, wheat, and so on. The yield data can be transferred to the server using proper middleware services. The yield data for prediction analysis is computed by using equation (1).

The Middleware Services provides interconnectivity to all the devices around us. In other words, the omni-present computing is the core of IoT. The Middleware services is mainly used for different requirements of varied applications in order to make it more standard. This service will act as a software bridge between things and applications. In outline, the middleware conceptualises the hardware and provides an integration between the hardware and application which is commonly termed as application programming interface (API). This API, not only used for communication but also database management, Security control and privacy. In general, the middleware services are based on their design. This middleware services comprises of different categories. Namely, Event based, service based, database based, semantic based, and application-based middleware services.

The information detected by the S_{ens} is put away as components of NumPys cluster. Then each X sec, the information detected by S_{ens} is transmitted to MySQL (cloud server) for investigation. Here X is an esteem picked dependent on the transfer speed. Since network haste is never consistent, the worth of X isn't steady. The value of X changes dependent on the haste of the organisation that is checked every hour utilising python. A strategic relapse model is prepared to take the S_{ens} esteems as info and foresee whether the yield is getting all the ideal conditions.

$$X \sim \frac{1}{Nw} \quad (4)$$

In view of the forecast, the model likewise predicts with respect to which condition isn't being met. In like manner, the important advances are taken consequently. For instance, assume it is anticipated that the measure of dampness is low, the water siphon is consequently turned on with the goal that the vegetal gets sufficient dampness.

4 Results and discussion

At the point when the framework distinguishes an abnormality, the initial action made to send a text message to rancher advising the user that the condition isn't satisfied. It very well might be noticed that the rancher isn't accepted to have any earlier specialised information, the SMS shipped off to the user, contains a text message that the condition isn't satisfied rather than the crude values.

Rancher can then decide to act physically and abrogate the framework to take care of issue. On the off chance that after a usual length, no transmission of data is made from the rancher's side, then the framework physically makes a vital move to fetch back ideal conditions for crops/vegetable development.

Figure 5 Normalisation of input dataset (see online version for colours)

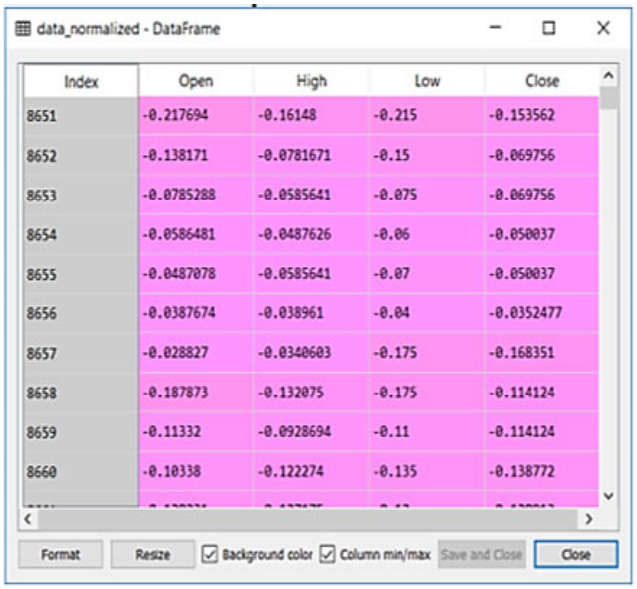


Figure 5 depicts the normalisation of input data dataset and made the predictive analysis of growth rate of crops for a duration of seven months period as illustrated in Figure 7.

The text message is sent utilising a text message API which is liberated from cost. This text message through API will send the details of crop name using SVM classifier, and the yield of the crop using the dedicated used in the proposed framework.

Figure 6 Different machine learning techniques used for prediction analysis (see online version for colours)

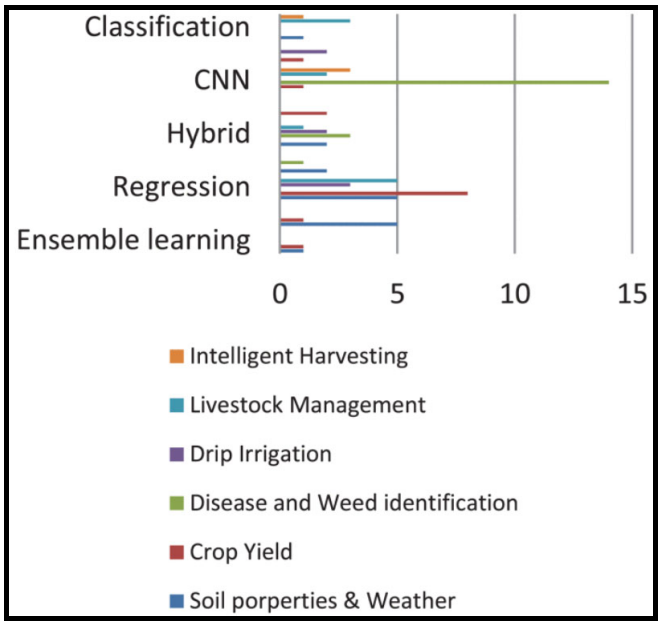
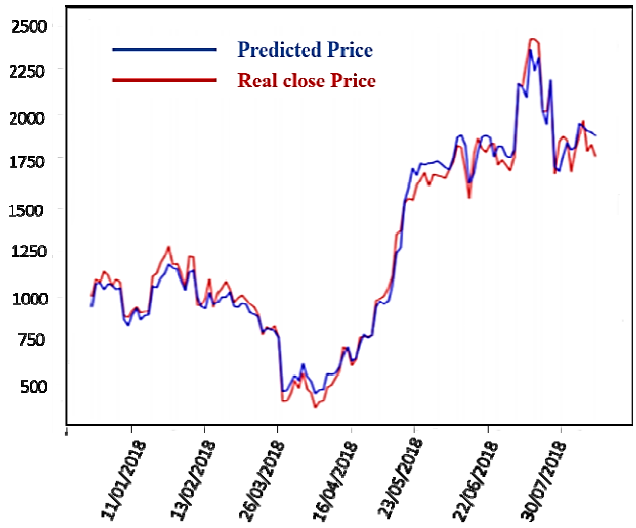


Figure 7 Prediction analysis of crop growth rate for seven-month duration (see online version for colours)



The main functionalities of this framework are listed as follows:

- Detect all the crops planted in the agricultural farm by the ranchers and update the status of those crops in the farm to the rancher via text message. And also, rancher can text a message to the intelligent device to perform rancher specific function.
- The framework consists of sensors to monitor and measure various physical parameter in the agricultural farm such as gas, humidity, temperature, and soil moisture level.
- The rancher receives the text message containing the details of crops, yield, water irrigation and soil moisture.
- The framework likewise includes a clock utilising which a rancher may path length for which, the user needs a specific state change. When the clock terminates, the condition of the gadget is naturally transformed by the framework with nope intercession required by rancher.

6 Conclusions

A productive solution for guaranteeing moderate savvy cultivating was created. The curiosity of the arrangement anticipated mendacities in the expense productivity and reasonableness of the research work. This task at last targets diminishing the measure of physical work needed to be finished by the rancher. It likewise points at assisting the rancher with being calm that the user's yields by transmitting the user the regular text message and unlimited authority on the rancher's field from anyplace on the planet.

With the progression of personal computer vision (PCV), a couple extra highlights to have been have the option to comprehend the sort of soil and the kind of seed utilising only a picture. PCV (Fatmi et al., 2017) can likewise be utilised to recognise unsettling influences in the ranch. For model, it tends to be utilised to recognise a few birds or creatures that may be harming the harvests (Misbahuddin et al., 2018). Another significant conceivable improvement is creating a PCBs particularly for the proposed framework and guaranteeing that it is protected exclusive the dirt utilising water sealing in addition to other things. The manufacture of a PCBs for this undertaking will increment the productivity and lessen the expense of the in this framework.

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