An IoT Based Smart Irrigation System

Md. Rezwan Hossain Naeem, Shadman Gawhar, Md. Belawal Hoque Adib, Sanjid Ahmed Sakib, Abir Ahmed and Nafiz Ahmed Chisty
Department of Electrical and Electronic Engineering
American International University-Bangladesh
Dhaka, Bangladesh
rezwanhossain7@gmail.com, tsg9210@gmail.com, md.adib818@gmail.com, shordarsanjid@gmail.com,
abir.ahmed@aiub.edu, chisty@aiub.edu

2021 2nd International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST) | 978-0-7381-3042-2/20/$31.00 ©2021 IEEE | DOI: 10.1109/ICREST51555.2021.9331092

***Abstract*— This paper aims to deliver a smart and cost-effective irrigation system. The main objective of this paper is to integrate a real-time monitoring system, remote controlling and cloud computation of acquired data. The system operates on some designated parameter ratings. Depending on the parameter values, the system executes actions such as switching the motor on and off. Adding to that, this paper also offers a user-friendly experience with the help of the mobile application which enables the users to operate the system. A website has also been developed for the user which contains various news and parameters related to agriculture in Bangladesh. Along with that it contains a manual guide of threshold parameter values for various crops. This will also help the user to figure out if their surroundings are suitable enough for their desired agricultural system.**

Keywords*— Internet of things, smart irrigation, real-time monitoring, remote controlling,

I. Introduction

In the modern age, the Internet of Things (IoT) plays a vital role to automate conventional systems. It has been taken up as a solution to many common engineering problems which has led to being fruitful. To build up an automated system IoT concept needs to be integrated with various types of sensors data which will then process data according to the user's requirement. Agriculture in Bangladesh aspect is a huge deal because of the overly exaggerated population nurtured by her. In the quest of feeding the whole nation, agriculture plays a vital role. So, an effective and more widespread way of agriculture is to be much preferred over any other sort of system.

In Bangladesh agriculture is always done in the conventional way which promotes manual labour and working in the field day and night. Smart agricultural systems are not as widespread as they should be. The reasons could be many. To list a few- people are not enlightened enough to operate a smart farming system, the financial aspect of the costing of the paper. But to preserve and allocate crops for the large portion of the people in this country, an efficient way of farming should be the first option to avail to. Making the farmers vent towards automated systems more than applying manual labour, not just for the sake of their health but to also increase productivity and thus the growth of the economy. Automation in agriculture not only will contribute to the efficiency of agriculture but also reduce the tendency of manual labour for farmers.

This paper proposes the modern aspect of farming but also in a cost-effective way. An IoT based smart irrigation system can be quite helpful to the farmland users in terms of its cost-effectiveness and the not so sophisticated modelling of the system. This paper operates by accumulating a few basic and essential data regarding agriculture and then comparing them with the pre-set threshold datasets it takes decisions and executes preferred action. It also offers a user-friendly interface for the developed mobile application for the sake of the aspect of easy to use resolution for the user. Moreover, a website developed has also been linked up with the application interface. The website contains data about the threshold values of different agriculture systems for different crops. Also, there is some visual representation of many environmental as well as technical parameters on the website. This will give the user an out and out idea if they can switch their preferred agriculture system.

II. Literature Review

Smart farming has been present around us for quite a lot of time. But the application of it has not been far and wide due to the sophistication and the financial aspect of the models. For instance, keeping the various physical parameters such as soil moisture level, pH level, nutrient content of the soil in check at once leads to an effective but also a sophisticated system. [1] Controlling the extent of power distribution, the system can undoubtably present a better outcome. [2] Shifting the dynamics completely has also been a notable tinkering aspect in search of an efficient farming system. [3] The use of latest technology which is the real-time data generation also contributes greatly towards the maximization of output. [4] A not so popular approach in our part of the world is greenhouse which has been the epitome of mesmerizing outcomes. This has not been such a successful project for the most of this side of the world for the relatively increased fertility the soil here possesses. [5] A remote controlling system also promises a viable avenue for providing utmost positive outcome in agricultural systems. [6] A setup that consists of a solar-charged energy source will preserve the fuel, a natural resource which is at risk. Real-time monitoring of such systems ensures the preservation and the accurate use of natural resources. [7] Similar to this paper, monitorization of various parameters such as water, soil moisture, temperature, humidity is an effective way of maintaining an agricultural system. Although the use of GSM module does take up a relatively increased amount of power and and is somewhat a costly option. [8] Agriculture does not only depend upon the management of resources. The health of the plant also plays a role here. The preservation of plant health plays a vital role in aggravating the system efficiency. [9] Also, the target can be achieved by simply controlling the water motor and selecting the direction of the flow of water. [10] A smart farm can also use a machine-learning algorithm to provide an efficient way of farming which will be highly dependent on the data being accumulated. [11] A system that provides a real-time monitoring setup which enables the farmer to monitor the crops 24/7 with the help of sensors and take action accordingly to the environment. [12] Lowering manual labor costs and effective usage of water for irrigation is also a point of interest in this vast field. [13] Application of automated greenhouse systems can also bring improvement far and wide but also the implementation can be hassled because of the present fertility of the soil in this part of the world. [14] Accumulating all the valid and cost-effective methods it can be verified that, to bring up a viable system Internet of Things (IoT) is a handy and powerful tool. [15]

In a developing country like Bangladesh, modern farming can bring a huge change. For instance, Bangladesh shelters a huge population compared to the land available. So, efficiency in agriculture should be deemed as a go-to option without a slight of doubt. To apply modernize farming in a broader prospect, a simplistic way of use should also be maintained. Too much sophistication in a system might result in the system being obsolete or left isolated.

This paper offers a user-friendly mobile application for the user to monitor and execute actions accordingly. A website is accessible from the application providing data regarding different agricultural systems also. This will act as a manual guide to the user if they wish to switch from the system they are using now. Moreover, facts regarding agriculture are also accessible through that website alongside an agriculturally based news portal too.

III. Proposed Model

This paper mainly revolts around the automation aspect of the project as much as it can be controlled manually. The overall operation has been discussed in the upcoming portion with a valid diagram.

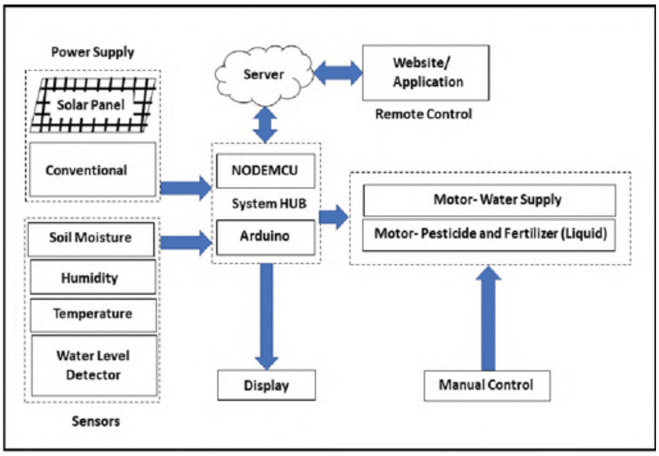

Fig. 1. Block Diagram of the System

Fig. 1 represents the proposed system model. It provides an overview of the whole process of the system. Three different types of sensors have been implemented for measuring three different parameters simultaneously. The data is then sent to the system hub which consists of Arduino and NodeMCU. A display is also installed for viewing the output figures at the spot. NodeMCU transports the data to the digital platform of the server for processing of the data. Then those data are sent to the mobile application of the user. The user then can perform manual tasks or can choose not to as Arduino will be executing the required commands if the parameter levels fall below the threshold values. Another motor of the system is used for pesticide. After a certain amount of time or at a specific time interval this motor is switched on to provide the legitimate volume of substance then switch off by itself.

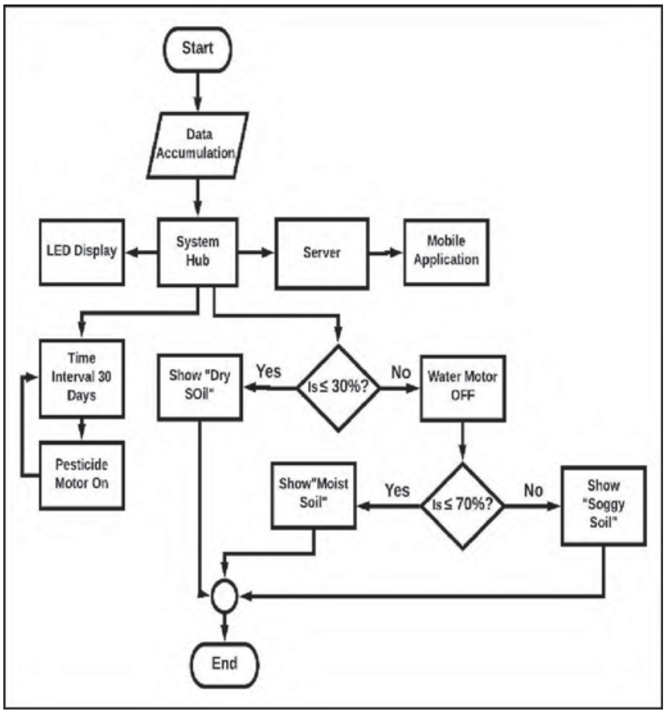

Fig. 2. Decision Making Mechanism of the System

Fig. 2 represents the flowchart which shows the decision-making process done by the system. At the start, data will be accumulated from the sensors placed in the system. The data will be sent towards the system hub which will then process the data and send it to the server along with the on-spot display for output. The server will then process the data to acquire a proper visualization of the data and present it via the mobile application. Apart from the two aforementioned tasks conducted by the system hub, the system hub has another duty of processing the data and executing commands. As the flowchart shows, depending on the rating of the soil moisture the hub brandishes various output scenarios in turns that operate the water motor installed. The ratings have been divided into portions depending on the generalization of the ratings. For instance, when the soil moisture level is below 30%, the display is showing the output "Dry Soil" and the water motor is being switched ON. When the moisture level goes over the 30% mark, the system will determine that the soil is "Moist Soil". When the soil moisture level reaches 70%, the system reacts to it by displaying the soil is "Soggy Soil" and simultaneously switching OFF the motor. Another motor is instilled within the system which has a time interval function for controlling the pesticide motor. This motor switches its functionality based on a time interval. For the demonstration the time interval has been set to 30 days visualized in the fig. 2.

IV. Simulation And Implementation

The following discussion consists of the parts where the software simulated results and the hardware results have been achieved and discussed accordingly. Software simulations were mainly done on the proteus simulation software.

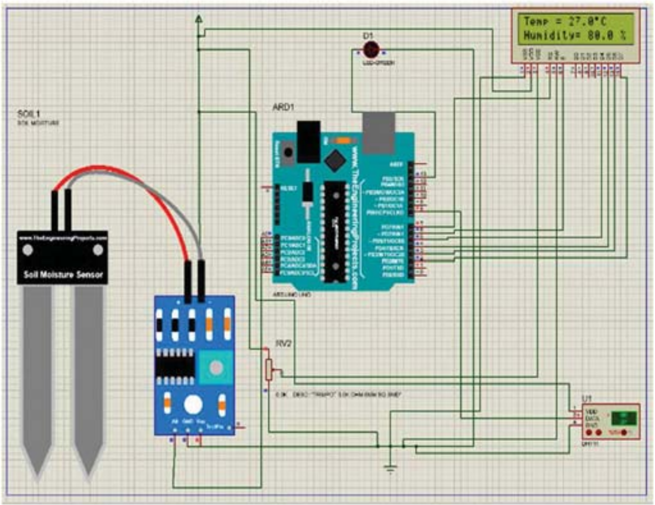

Fig. 3. Schematic Layout of the System

Fig. 3 resembles part of the simulation outcome. The simulations were performed via the Proteus 8 software. Due to the library limitations of the software, NodeMCU was not used in the simulation. Other than that, the components which were available to use are Arduino UNO, soil moisture sensor, DHT11 sensor and a 16x2 LED display. A normal LED light has been used as a substitute for submersible pump in the schematic. The results validated in fig. 3 represent the outcome of temperature and humidity readings which is the final phase of the rating visualization process.

The soil moisture sensor here has a non-customizable maximum set value which gives the output at 100% moist. The data gets sent to Arduino which is acting as the system HUB and then towards the display. The DHT11 also has a similar operation pattern. Although the values can be customized in terms of DHT11.

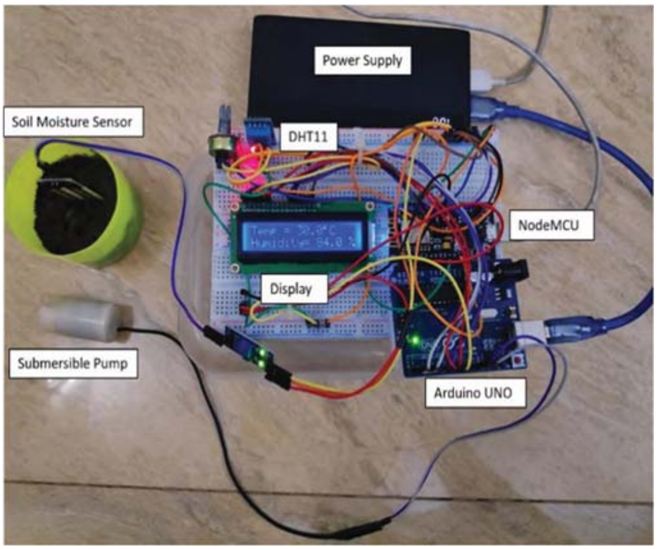

Fig. 4. Hardware Setup of the Prototype

Fig. 4 is the hardware implementation of the system. The setup consists of a Arduino UNO, a NodeMCU, a soil moisture sensor, a DHT11 sensor, a 16x2 alphanumeric display, a submersible pump and a power bank as the power supply. In fig. 4, the output generated of temperature and humidity have been illustrated.

V. Result Analysis

The outcomes and the data processing of the whole system have been given examined in this segment while providing a proper layout of the application and necessary parts of the website.

A. Mobile Application for Monitoring and Controlling:

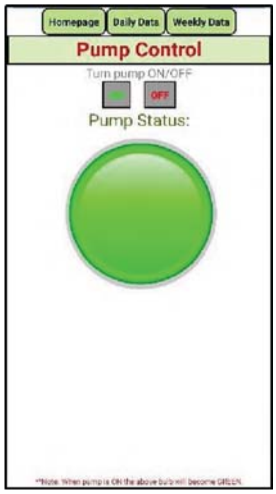

Fig. 5. Application Start Page

Fig. 6. Pump Control Interface

Fig. 5 resembles the first page that will be visible to the user. From here the user can access the daily data interface, the weekly data interface and the interface from where they can control the function of the pump. The “Homepage” panel takes the user to the main page where the real-time data is illustrated the parameters along with the pump status. “Daily Data” presents the graphical representation of the ratings for a few days, whereas “Weekly Data” will illustrate the graphical analysis of the same data set but for a longer time span. The “Pump Control” panel will present an interface from where the user can control the function of the pumps installed. Lastly, the “News & Instruction” panel will give the user access to the developed website.

Fig. 7. Real-Time Data Illustration

Fig. 6 is the interface of the pump control menu. From here the user can manually switch the motor on and off. On top of the interface, there are various buttons. The functions of this panels are same as the buttons from the start page of the application.

Fig. 7 illustrates the real-time data generated for any given time. The temperature ratings are shown at the top of the interface which is read at 30.9 degrees. The soil moisture and humidity ratings are shown in a state of a meter. A range of values have been set within the meter. Range of ideal ratings are colored green whereas the dry and moist ratings fall under the red and blue colored ranges respectively for soil moisture. For humidity levels, red has been considered to be high whereas blue is an ideal and green is low. At the bottom of the interface the pump status has also been illustrated.

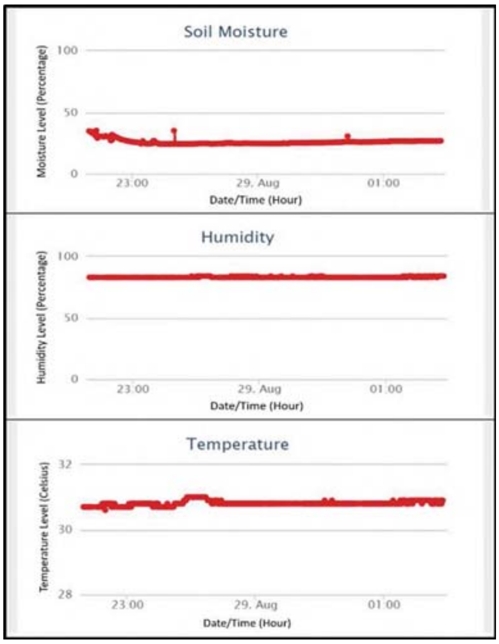

Fig. 8. Graphical Analysis of Parameters

Fig. 8 shows the interface user will come across when they access the "Daily Data" button. This interface illustrates the graphical illustration of the data generated on a daily basis. This will be shown as a trend. From fig. 8 the user can determine the gradual changes in the ratings of temperature, humidity and soil moisture.

A. Website Outline:

The website is essentially developed to provide information about various threshold parameters for different crops. Besides, numerous information regarding agriculture in Bangladesh is also included and presented on the website. The website can also be viewed in the Bengali language for a better understanding of the user.

Fig. 9 represents the overall situation regarding soil moisture conditions around the country. The green areas around the land contemplates the land possessing the ideal soil moisture values. Whereas the red areas mean the soil is dry from the ideal ratings. Blue areas contemplate the areas being moist.

In fig. 10, the rainfall condition across the country has been contemplated accordingly. It represents the data regarding the probability of rainfall over the country. The red areas indicate the probability of rainfall in those areas is very low. On the other hand, the southern portion of the country is much more likely to face rainfall as it is tainted in blue.

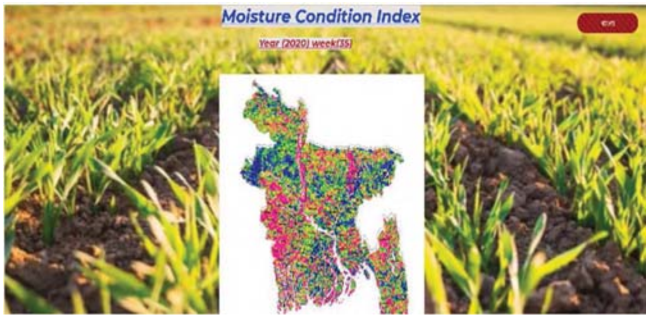

Fig. 9. Overall Moisture Condition

Besides the overall condition of the state of agriculture countrywide, a segment of page also illustrates the manual guide regarding the parameters of crops such as rice, wheat, sugarcane and maize. Provided parameter values will assist the user to setup their own system as per their own need.

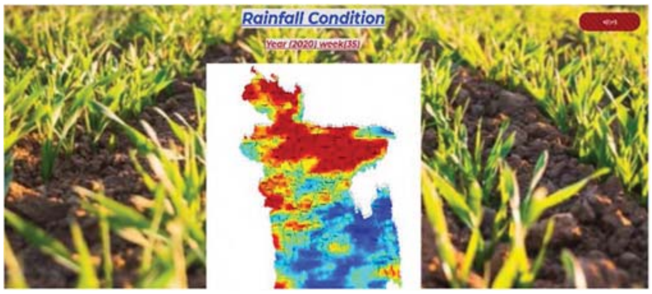

Fig. 10. Overall Rainfall Condition

The generated results can help a user in increasing the efficiency of their own agriculture systems. When compared to the "conventional" approach, IoT based farming has always been efficient. The goal was to make such a device. For this paper, the parameters for temperature, humidity and soil moistures were established generally. On which the decision-making process of the system largely depended. Also, a time interval active motor for pesticide has also been used which will help preserve the health of the crops. The mobile application will provide the user another avenue on the easy-to-use aspect as it will be easier to monitor and execute operations such as the functionality of the motor from the mobile application. The access of the website from the application contributes to the fluidity in the usage pattern of the user too.

The methodology applied in this paper enables the user to attain a cost-effective farming setup which will enhance the efficiency of their harvest and the quality too. Along with that helps the user to avail of a user-friendly experience from the use of the mobile application.

VI. Conclusion

A smart irrigation system was the desired outcome of this paper. The results and the visual outcomes indicate the fulfillment of the initial project goal. A mobile application offering a user-friendly experience contributes to the lessened sophistication of the system. Moreover, the developed website providing rich content for the farmer plays a huge role in enlightening the user too. The prototype in question possesses adequate room for improvement nonetheless but the sustainability period can be predicted from three to five years.

The prototype put together is just a hint of a machine in a smaller scale. The pricing that came within the components were a bit overpriced as of the scarcity of rather some useful apparatus. Nevertheless, there is always room for improvement. Application of image processing in terms of acknowledging the health of the crops can be added as a feature to further the development of the projects. From the communication point of view, the application of connectivity with satellite networks will also speed up the data communication system and help the system generate real-time data in a lesser period.

REFERENCES

[1] P. K. Singh, A. K. Kar, Y. Singh, M. H. Kolekar, and S. Tanwar, Eds., *Proceedings of ICRIC 2019: Recent Innovations in Computing*, vol. 597. Cham: Springer International Publishing, 2020.

[2] F. B. Culibrina and E. P. Dadios, "Smart Farm Using Wireless Sensor Networl< for Data Acquisition and Power Control Distribution," *Information Technology*, p. 6, 2015.

[3] N. Kaewmard and S. Saiyod, "Sensor data collection and irrigation control on vegetable crop using smart phone and wireless sensor networks for smart farm," in *2014 IEEE Conference on Wireless Sensors (ICWiSE)*, Subang, Selangor, Malaysia, Oct. 2014, pp. 106–112, doi: 10.1109/ICWISE.2014.7042670.

[4] Md. M. Islam, S. Sourov Tonmoy, S. Quayum, A. R. Sarker, S. Umme Hani, and M. A. Mannan, "Smart Poultry Farm Incorporating GSM and IoT," in *2019 International Conference on Robotics,Electrical and Signal Processing Techniques (ICREST)*, Dhaka, Bangladesh, Jan. 2019, pp. 277–280, doi: 10.1109/ICREST.2019.8644300.

[5] P. M. Pawar, B. P. Ronge, R. Balasubramaniam, A. S. Vibhute, and S. S. Apte, Eds., *Techno-Societal 2018: Proceedings of the 2nd International Conference on Advanced Technologies for Societal Applications - Volume 1*. Cham: Springer International Publishing, 2020.

[6] Chetan Dwarkani M, Ganesh Ram R, Jagannathan S, and R. Priyatharshini, "Smart farming system using sensors for agricultural task automation," in *2015 IEEE Technological Innovation in ICT for Agriculture and Rural Development (TIAR)*, Chennai, India, Jul. 2015, pp. 49–53, doi: 10.1109/TIAR.2015.7358530.

[7] N. Katyal and B. Jaganatha Pandian, "A Comparative Study of Conventional and Smart Farming," in *Emerging Technologies for Agriculture and Environment*, B. Subramanian, S.-S. Chen, and K. R. Reddy, Eds. Singapore: Springer Singapore, 2020, pp. 1–8.

[8] R. S. Krishnan *et al.*, "Fuzzy Logic based Smart Irrigation System using Internet of Things," *Journal of Cleaner Production*, vol. 252, p. 119902, Apr. 2020, doi: 10.1016/j.jclepro.2019.119902.

[9] A. P. Kale and S. P. Sonavane, "IoT based Smart Farming: Feature subset selection for optimized high-dimensional data using improved GA based approach for ELM," *Computers and Electronics in Agriculture*, vol. 161, pp. 225–232, Jun. 2019, doi: 10.1016/j.compag.2018.04.027.

[10] C. Kumar Sahu and P. Behera, "A low cost smart irrigation control system," in *2015 2nd International Conference on Electronics and Communication Systems (ICECS)*, Coimbatore, India, Feb. 2015, pp. 1146–1152, doi: 10.1109/ECS.2015.7124763.

[11] V. Poulkov, Ed., *Future Access Enablers for Ubiquitous and Intelligent Infrastructures: 4th EAI International Conference, FABULOUS 2019, Sofia, Bulgaria, March 28-29, 2019, Proceedings*, vol. 283. Cham: Springer International Publishing, 2019.

[12] T. Inui, M. Kohana, S. Okamoto, and M. Kamada, "IoT Technologies: State of the Art and a Software Development Framework," in *Smart Sensors Networks*, Elsevier, 2017, pp. 3–18.

[13] S. Patnaik, A. W. H. Ip, M. Tavana, and V. Jain, Eds., *New Paradigm in Decision Science and Management: Proceedings of ICDSM 2018*, vol. 1005. Singapore: Springer Singapore, 2020.

[14] S. S. Reka, B. K. Chezian, and S. S. Chandra, "A Novel Approach of IoT-Based Smart Greenhouse Farming System," in *Green Buildings and Sustainable Engineering*, H. Drück, R. G. Pillai, M. G. Tharian, and A. Z. Majeed, Eds. Singapore: Springer Singapore, 2019, pp. 227–235.

[15] A. M. H. Sad, M. M. S. Choyon, A. H. M. Rhydwan and C. A. Hossain, "An Interactive Low-Cost Smart Assistant System: Information Kiosk as Plug & Play Device," 2020 27th Conference of Open Innovations Association (FRUCT), Trento, Italy, 2020, pp. 193-199, doi: 10.23919/FRUCT49677.2020.9211057.