IoT based Automation of Public Garden and Botanical Garden

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Abstract. People in urban areas appreciate and enjoy the beauty of nature as carefully manicured grass and flowers in public gardens. Senior citizens find this place best for their social networking, while children enjoy their recreational activities here. Botanical garden generally refers to a place where, variety of flora species are planted and grown for the purpose of scientific study. Maintaining a garden or botanical garden takes lot of maintenance effort along with monitoring various parameters such as moisture and light; ambient factors like temperature and humidity of air are also important factors. The focus of this paper is to demonstrate and implement a cost-effective way to monitor and control soil moisture, ambient air temperature and humidity in such gardens by means of controlling drip irrigation pumps and water sprinklers.

Index Terms—NodeMCU (Esp8266), Soil moisture sensor, Humidity and Temperature sensor, LDR, Relay module, Server

1. Introduction
A garden is normally referred to an outdoor place (exceptionally indoor too) where variety of plants are grown and maintained to make people cherish the taste of nature, relax and rejuvenate. A garden generally includes both natural and manmade elements as the plantation is made in their non-native place. A garden is the only place in most urban and sub-urban areas in which greenery and birds are found. This helps to maintain an ecosystem. On the other end botanical gardens are meant for studies related to plant science, herbs for medicinal applications and for agricultural or other industrial applications. In botanical gardens not only plants of large variety are grown, but also experiments are conducted to enhance certain characteristics of it by selective pollination, cross-pollination and many more techniques, so that new hybrid species can be generated. Maintaining a garden is not an easy job, whether it is a public one or a botanical one, especially, when it contains a large variety of flora. Different species have different requirement of soil, water, minerals and light. Therefore, plantation and post-plantation care is much required. In early days, monitoring required to visit each plant area periodically and checking soil, moisture parameters of concern and fulfil the requirement of irrigation, minerals, sunlight, etc. This thing involved most human beings for monitoring and hence prone to human errors too. Thanks to the advent of technology, that this monitoring now can be handed over to some smart sensors and in response to that a control system can be deployed such that it handles the operation of drip irrigation, pumps and water sprinkler.
Numbers of papers have reported the prototype for automatic irrigation system based on X51 microcontroller, which control solenoid valves of garden into different zones for adequate irrigation [1]. Also GSM based systems to monitor the parameters like; soil moisture, humidity, pH etc. are reported [2]. Such systems are able to generate message to the monitoring person using various AT commands. With time the systems were made able to make decisions, like in drip irrigation, pump switched on if the soil moisture drops below the threshold level as defined [3]. Same system can be arranged for sprinkler action or mineral feed actuator. An interactive system allows adjusting the threshold parameters using keypad and displaying the current values of parameters on LCD. The wireless interface of sensors is realized using Bluetooth protocols [4]. An automated irrigation system works on any microcontroller based board (including Arduino board ATmega328), which senses the moisture level in soil to control the pump [5]. Moreover using Arduino interfaced with GSM module has been used to interact with the user by means of SMS and hence control the irrigation pump [6] another horizon in which researchers are working is to make data collection, review and management more efficient and reliable. A Smart focused on IoT Weather Station Garden Device, which can be used to Track plant growth every day, and forecast plant growth predictably rainy. Device will record data and give consumer the result With the Mobile Software called Blynk App [7]. IoT based device introduced is Works on the basis of the sensor knowledge and the appropriate growth for the plant Calculated. Using the moisture sensor and temperature monitor, information such as the moisture content and the temperature will be measured and automated watering will be achieved depending on certain measurements [8].

This paper intends to bring into effective way of general public garden control utilizing NodeMCU (board based on ESP 8266). The proposed system will help to manage plant treatment in the public garden in effective and automated fashion with minimal human intervention, which would have caused larger power wastage owing to the incompetence, negligence of the workers. This article has two distinct purposes, namely monitoring vital parameters for a garden (soil moisture, temperature and humidity) and controlling solenoid valve / irrigation pump for water supply to the garden in accordance with the parametric values received from sensors. Also, the system controls sprinklers in garden to water grass, switch ON/OFF the garden lights during specific time period using ambient light as controlling parameter and control the pumps and lighting devices for fountain. All vital parameters are displayed on interactive screen connected using internet of things (IoT). An IoT system consists of sensors / devices that use some form of networking to “link” to the cloud. Once the data is received at the server, the program processes it accordingly to initiate further action like display refreshing, controlling various devices, generating alarms and communicating with remote user.

2. System components

2.1 Node-MCU:
Node-MCU is an open-source firmware and development kit that helps to build prototype. It includes firmware which runs on the ESP8266 Wi-Fi SOC from Espressif and hardware which is based on the ESP-12E module. It uses an on-module flash-based SPIFFS file of Systems. It is asynchronous and event-driven. The ESP8266 Node-MCU has total 17 GPIO pins broken out to the pin headers on both sides of the development board. These pins can be assigned to all sorts of peripherals. These pins include a 10-bit ADC channel, UART interface, PWM outputs, SPI, I2C & I2S interface etc. The programmable ROM is programmed on-board via the USB, allowing the programming step to be easily integrated into the product manufacturing and testing process.

2.2 DHT11
The sensor comprises moisture measuring component and a (NTC) temperature measuring device, which attaches to a high performance 8-bit microcontroller, providing excellent quality, quick response, anti-interference capabilities and cost effectiveness. It measure both parameters and provides the user with direct digital data in data packets serially, therefore, rectifying need of data conversion from analog to digital and reducing the time and resources required for the same. The usage is relatively straightforward, but it needs careful planning in order to collect data.
2.3 Solenoid valve
A solenoid valve is an electromechanical device in which the solenoid uses an electric current to generate a magnetic field and thus operates a mechanism that regulates the fluid flow through an opening a valve. The magnetic field on the plunger exerts force and in turn, pushes the plunger towards the middle of the coil so that the orifice expands/closes.

2.4 LDR (Light Dependent Resister)
A light-controlled variable resistor is a photo resistor (more popularly called light-dependent resistor, LDR, or photo-conductive cell). With rising incident light intensity, a photo resistor's resistance decreases; in other terms, it exhibits photoconductivity. A photo resistor is made from semiconducting material like cadmium selenide or cadmium sulphide, which offer high resistivity if not energised, but the electrons gets excited easily upon receiving photons and resistivity drops drastically.

2.5 Siren
As siren two different techniques are employed: namely piezoelectric crystal based buzzer and resonating type hooter. The buzzer consists of a thin metallic disc/plate attached to a piezoelectric crystal connected electrically with an excitation source. When excitation current is applied to the crystal, it causes the piezoelectric crystal to contract and expands. This in turn generates vibrations in metallic disc/plate causing acoustic waves to be generated. That's the sound that you hear. Another type of siren uses resonating type hooter. Here a resonating cavity is used to enhance the sound generated to very high intensity by constructive interference called resonance. Such devices are used in highly noisy environments like industries or on busy places like railway stations or large public gathering.

2.6 JSON
JSON or JavaScript Object Notation is an open standard format for data communication, which is human readable form. It is mainly used in data transmission in array like format. Because JSON is language independent format it is used widely as a replacement of XML and AJAX systems.

3. System operation

3.1 Block diagram and Experiment set up
In Fig. 1 is the block diagram of proposed system with microcontroller board, relay module, sensors and wireless communication. Core part of the system is ESP8266 NodeMCU board that is responsible for all data collection, processing and generating control signals. These control signals in turn drive relay board and establish and maintain communication. Three sensors, namely: resistive soil moisture sensor, DHT11 (temperature and humidity sensor) and LDR (for light sensing) are connected to the NodeMCU board and logs data periodically. The logged data is sent to server for further visual and data analysis.
3.2 Working of circuit
At the time of initialization (running the program first time for setting up the system), the microcontroller board acts as an access point. At the same time, microcontroller board searches for available Wi-Fi networks. When user connects to the NodeMCU, it prompts user to establish connection with network of choice. User can also enter Wi-Fi credentials manually by entering IP address of controller in browser’s URL space. After connecting to the network there is no need to enter Wi-Fi password every time the controller reboots, as far as the current Wi-Fi network is active. Once, the connection is established with network the controller starts process of acquiring the data from sensors, which are in this case soil moisture sensor, light sensor (LDR), temperature and humidity sensor (DHT11).

Data can be in form of integer or floating point, to send data over internet using HTTP protocol; it needs to convert into string form. These strings are then concatenated in one string holding domain name of the web server where database is hosted, followed by the path of a PHP file on the server and at last data defined and separated by ‘&’ and ’,’ respectively. This string is than posted on to the server using HTTP GET method. If data is posted correctly and there is no connecting error at server side and
on network then server sends response of 200, which means data is inserted in to database successfully. Also, in response server sends time, date and status of the pumps, lights and sprinklers, if user wants to control them manually. This data is in JSON format. At next step controller parse this JSON data and converts them into integer form. At last NodeMCU manipulates the digital outputs if needed and loop repeats again.

MySQL table where NodeMCU logs sensor data and user can manipulate status of relays to control external devices. Time information is also logged for visual representation and analysis. Same information is depicted in form of flowchart (Fig. 4), user interface (Fig. 5) and MySQL Tables (Fig. 6).

4. Result

Smart garden shows the automatic working processes in particular threshold values which optimize man power and accurate timing. Figure 7 shows Sensoe_data.csv file for database which has different column and row, indicates status of sensor value and relay output that turn on and off the motor, street
light and buzz the siren for specified time. Fig. 8(a) and Fig. 8(b) Shows graphicly visualisation with help of database.

| Table | aminstrate | Action |
|-------|------------|--------|
| auto_soil | | Browse Structure Search Insert Empty Drop |
| auto_soil_screen2 | | Browse Structure Search Insert Empty Drop |
| microcontrol | | Browse Structure Search Insert Empty Drop |
| microcontrol1 | | Browse Structure Search Insert Empty Drop |
| microcontrol1_screen2 | | Browse Structure Search Insert Empty Drop |
| sensor | | Browse Structure Search Insert Empty Drop |
| sensor1 | | Browse Structure Search Insert Empty Drop |
| sensor_screen2 | | Browse Structure Search Insert Empty Drop |
| switch | | Browse Structure Search Insert Empty Drop |
| switch_screen2 | | Browse Structure Search Insert Empty Drop |

Figure 2. Data base

![Figure 8 (a). Graph of Temperature and Soil Moisture V/S Time](image1)

![Figure 8 (b). Graph of Humidity V/S Time](image2)

5. Conclusion

In this paper, Internet of things is exploited as an emerging technology that helps to provide smart gardening, this system is quite easy to deploy for monitoring and controlling to botanical garden area. IoT based monitoring provides potent results and ease of access. Remote monitoring enables a person to monitor the plant from faraway places, or may be on the go. Automated control saves labour costs, and provides consistency of operation, which in turn results in better care for plants.

Appendix: *Click following link for Additional database related information:* [https://drive.google.com/drive/folders/1Js3lbont3wbV66qHtDLiqg9l_bPQfCHU?usp=sharing](https://drive.google.com/drive/folders/1Js3lbont3wbV66qHtDLiqg9l_bPQfCHU?usp=sharing)

References

[1] Rajpal A, Jain S, Khare N and Shukla A, “Microcontroller based Automatic Irrigation System with Moisture sensors”, Proc. of the International Conference on Science and Engineering (ICSE).RG Education Society press,2011,pp.94-96,2011.

[2] Vilas M, Sagar M, Ingale G, and Gawali G “Public Garden Automation using GSM Technology”, International Journal for Research Trends and Innovation Vol. 2, Issue 3, pp.100-102, 2017.

[3] Pawar P, Pawar S and Vare J, “Public Garden Automation System”, Journal Of Information, Knowledge and Research In Electronics And Communication Engineering, Vol. 04, pp.1446-1449, November 2016 to October 2017.

[4] Gowri S and Divya G, “Automation of Garden tools Monitored using Mobile Application,” International Conference on Innovation In formation in Computing Technologies (ICIICT), Chennai, India, IEEE prees,2015,doi:10.1109/ICIICT.2015.7396084.
[5] Nagarajapandian M, RamPrasanth U, SelvaKumar G and Tamil Selvan S “Automatic Irrigation System on sensing Soil Moisture Content,” International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering, Vol. 3, pp.96-98, January 2015.

[6] Vashista A, Rathore H, Jain G, “Automatic Gardening System using Arduino,” SSRG International Journal Of Electronics And Communication Engineering (SSRG-IJECE), Vol. 3, pp.119-120, August 2016.

[7] Binti Arbain N and Dan Darrawi bin Sadli M, “An IoT based Smart Garden with Weather Station system,” 9th Symp. on computer Application & Industrial Electronics(ISCAIE), IEEE Press, 2019, pp.38-43. doi: 10.1109/ISCAIE.2019.8743837.

[8] Sambath M, Prasant M, Bhargavraghava N and Jagadeesh S, “IoT based Garden Monitoring System,” International Conference on Physics and Photonics Processes in Nano Sciences, IOP Publishing LTD, press, 2019, doi:10.1088/1742-6596/1362/1/012069.