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Design of Smart Greenhouse Adaptation and Irrigation Control System based on Arduino and Android Application

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Abstract: *Greenhouse may be a reasonably place which might change plant growth environment, create the most effective conditions for plant growth, and avoid influence on plant growth because of outside changing. In this thesis, Android and Arduino based system to observe and control greenhouse irrigation, temperature and humidity designed. the most objective of Thesis toafford an inexpensive technology to manage agriculture process. The methodology was followed is low power consumption Arduino kit with Bluetooth module for show the results and control it. The result that obtained show that the system performance is sort of reliable and has successfully overcome quite few shortcomings of the prevailing systems by reducing the facilityconsumption, maintenance and complexity, at the same time providing a versatile and precise type of maintaining the environment.*

Keywords: Smart Greenhouse - Adaptation and Irrigation- Android Application

I. Introduction

The current human population growth trend, combined with changing consumption habits, rising demand, and garbage, is putting unprecedented strain on agricultural systems and natural resources. Therefore, one of the most important problems that humanity will face in the twenty-first century is food supply.that humanity will have to deal with in the twenty-first century. Agricultural habitats are the primary food producers. Approximately 275 million hectares of irrigated land are currently devoted to irrigated crops across the world. This region is expanding at a 1.3 percent annual pace. These crops account for only 23% of farmed land, but they provide 45 percent of total food production. In order to meet the need for food in 2050, 70 percent increase in global output is needed. This anticipated rise in global food production necessitates the expansion of farmed land or the intensification of production on currently farmed land. In low-production scenarios, a 53 percent increase in water use, as well as a 38 percent increase in farmed land around the world, will be expected to meet global food demands target in 2050.The key downside of expanding agriculture is the scarcity of land, which forces land use transformations, resulting in the loss of natural habitats. As a result of the deforestation processes involved, turning land to agriculture is the second largest global challenge to biodiversity preservation.Within this context, some authors use the “sustainability” concept to find a solution for the posedchallenge. The term “sustainability”, because it is today known, was borne in 1987 within the BrundtlandReport by the United Nations World Commission on Environment and Development. In thisreport, sustainable development is defined because the one that meets current needs without compromisingthe ability of future generations to satisfy their needs. Sustainability embraces three dimensions ofthe human and natural systems: social, environmental and economic. It remains as an ideal similarto democracy, justice and freedom. After this report, some significant events have resulted in new treaties calling for global sustainable development, such as the Rio Declaration of 1992, which protects and promotes the use of the earth's biologic natural resources in a sustainable manner. Furthermore, the Kyoto Protocol binds the signing countries to reduce their greenhousegas emissions, and the United Nations Millennium Development Goals gave orientations toimprove globally life means and the environment.[1]The concept of greenhouses is Protected agriculture known as cropproduction to non-conventional means in particular facilities to protectfrom inappropriate weather conditions, such as agriculture in tunnels orplastic greenhouses with controlled internal climate control and control(glass or glass Viper) to make sure heating or cooling in summer and winteras well because the appropriate moisture control and plant protection from hotand cold air currents, precipitation and agricultural pests, and which may be asophisticated agricultural and factor in increasing agriculturalproductivity and quantity of crops. Early automated control consisted ofindependent thermostats, humidistat, and timers. Even these simple devices allowed for significant improvements in production and product quality, as well as making growers' lives easier. Early electronic analogue controls were born out of the problems that came with using multiple individual thermostats and timers to regulate a greenhouse, also knownas “step” controls. By integrating the functions of many thermostats into one unit with one temperature sensor, these devices made a significant contribution to improving the growing climate and the performance. [2]

II. Problem Statement

In green houses there are lots of parameters like temperature, humidity and irrigation, which makes it difficult for humans to keep track of all of those criteria. Because of the plants' growth process, any major changes in one climate parameter can have an adverse impact on another climate parameter. As a result, ongoing 2 monitoring and control of those climate factors will yield maximum crop yield. Temperature, humidity and light-weight intensity are the three most common climate variables that the majority growers generally concentrate to. The solution for all that thing and other in use android application with Arduino to watch and control the greenhouse environment.

III. Methodology

This research divided into two parts: Software implementation and hardware implementation. In terms of software, an Android app is used to communicate with the Arduino in order to gather data from sensors and monitor the motor bump and cooling fan. The Arduino code collects data from sensors and sends it to the application. Sensors are used to obtain readings in the hardware implementation, a motor bump is used for irrigation, and thus a fan is used for cooling, all sensors and motors are attached to Arduino and perform specific algorithm.

1. Hardware Implementation:

Block Diagram:

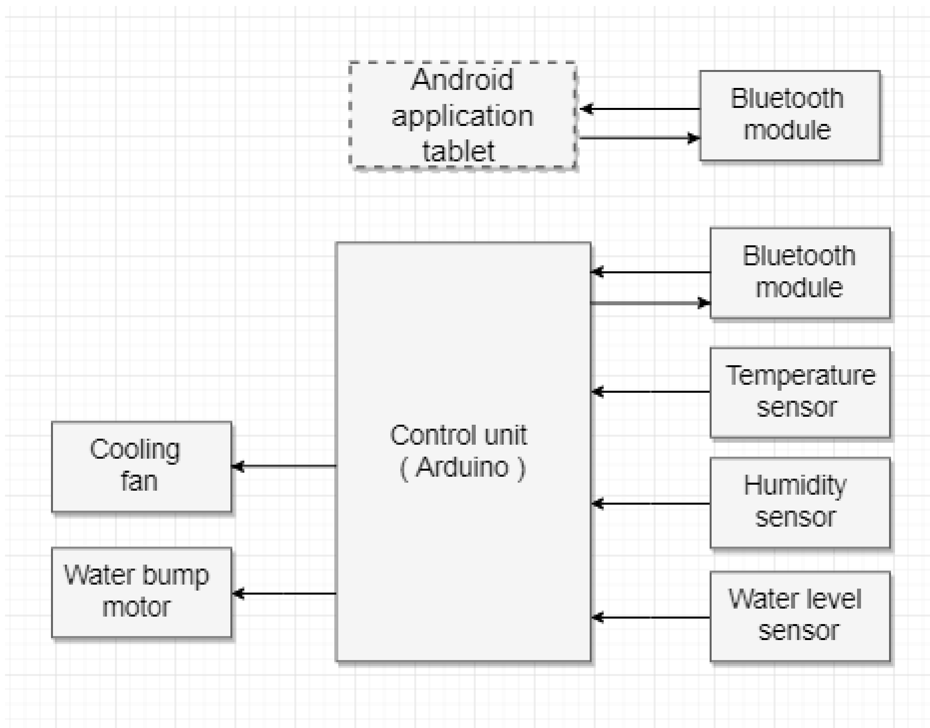

Figure 1: Block diagram of the system

Figure 1 shows the flow chart of smart greenhouse adaptation and irrigation systemsupported Arduino and android application.Firstly, the serial connection between Arduino and android application installed on tablet must be established. Then the Arduino reads the values comes from sensors and send the value of sensors to the appliance and also read the user command from application and executes them.

System components:

i. Bluetooth connection:

The system connection the Bluetooth module HC 06 establishes a link between the Android device and the Arduino. Bluetooth devices can communicate over distances of up to 10 meters and do not need to be in direct line of sight. Bluetooth connectivity becomes much more versatile and reliable as a result of this. It's also worth noting that Bluetooth excels at transferring low-bandwidth data., it is not intended as a replacement for high-bandwidth cabled peripherals. For high-bandwidth devices, such as external hard drives or video cameras, cables are still the simplest option. The heart of the Bluetooth specification is that the Bluetooth protocol

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stack.

By providing well-defined layers of functionality, the Bluetooth specification ensures interoperability of Bluetooth devices and encourages adoption of Bluetooth technology. The characteristics of Bluetooth technology-low cost, low power, and radio based-encouraged the concept of a private area network (PAN). A PAN envelops the user in a very small, mobile bubble of connectivity that is effortlessly available at any time.Bluetooth's freedom from cables and potential ubiquity make it ideal for carrying your personal network around with you.

ii. **Arduino Sensor readings:**

The Arduino board contains a 6 channel (8 channels on the Mini and Nano, 16 on the Mega), 10-bit analog to digital converter. This means that it'll map input voltages between 0 and 5 volts into integer values between 0 and 1023. This yields a resolution between readings of: 5volts/1024 units or, .0049 volts (4.9 mV) per unit. The input range and resolution is changed using analog Reference (25). It takes about 100 microseconds (0.0001 s) to read an analog input, so the maximum reading rate is about 10,000 times a second.

iii. LM35 Temperature calculation:

In Figure 2 show the pin configuration of the LM35.It is a high-precision centigrade temperature sensor which has a linearly proportional output voltage that corresponds to the Celsius temperature. The LM35 has more advantages about the linear temperature sensor that is calibrated in degrees Kelvin. Win, because the user does not need to remove a big continuous voltage from the output to get a convenient centigrade scale for temperature changes in each degree Celsius, the sensor output will change to 10mV. The sensor can measure the temperature within range 0 to 100.C, for example, the sensor output will vary from 0 to 1000mV. LM35 operates in the temperature range -55 ° to + 150 ° C, the LM35 is within the -40 ° C to range + 110 ° C [5].

Figure 2: LM35 Temperature sensor

The LM35 may be a common TO-92 temperature sensor. It is often used with the equation Temp = (5.0 * analogRead (tempPin) * 100.0) / 1024; However, this doesn't yield high resolution. this may easily be avoided, however. The LM35only produces voltages from 0 to +1V. The ADC uses 5V because the highest possible value. this can be wasting 80% of the possible range. If you modify aRef to 1.1V, you'll get almost the bestresolution possible. The original equation came from taking the reading, finding what percentage of the range (1024) it's, multiplying that by the rangeitself(aRef, or 5000 mV), and dividing by ten (10 mV per degree Celsius,
according to the datasheet).[5]

iv. DHT11 Humidity calculation:

The DHT sensors are made of two parts, a capacitive humidity sensor and a thermistor. Thereis also a very basic chip inside that does some analog to digital conversion and spits out a digitalsignal with the temperature and humidity. The digital signal is fairly easy to read using anymicrocontroller (https://learn.adafruit.com/dht).[3]

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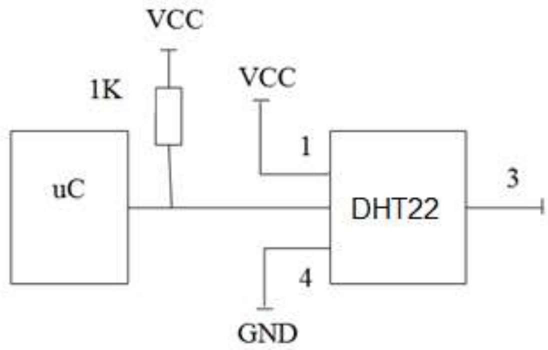	This sensor has a 4-pin: - Pin 1 is a power pin; - Pin 2 is data pin; - Pin 3 is a NULL pine; - Pin 4 is a ground pine.

Figure 3: DHT11 Humiditysensor Diagram

The voltage supply must be between 3.3V and 6V (recommended 5V). Communication betweenArduino Uno board ATMEGA328 microcontroller and DHT22sensor is made through MaxDetect
1-wire.
Calculation MaxDetect 1-wire: data consists of the integer part and decimal part.The formula is as follows:
DATA = 8 integer databit RH + 8 decimal data bits RH + 8 data bitsinteger T + 8 decimaldata bits T + 8 check-sumbit.
If the data is transmitted correctly, then check-sum should be:
Check-sum = 8 integer databit RH + 8 decimal data bits RH + 8 integer data bits T+ 8 decimal data bits T.
Calculation example for temperature and humidity:
After connecting the sensor to Arduino Uno board, I loaded the corresponding software for measuring temperature and humidity in the room. We obtained temperature of 20.9 °C and humidity of + 57,6RH.
The microcontroller receives 40 bits from the sensor: 16 RH data bits, 16 T data bits and 8 check-sum bits. Displayeddata were calculated as follows:
0000 0010 0100 0000 0000 0000 1101 0001 10001 0011
-Humiditycalculation:
binarRH = 0000 0010 0100 0000 ->decimalRH = 576
RH = 576/10 = 57.6%
- Temperature calculation:
binarT = 0000 0000 1101 0001 ->decimalT = 209
T = 209/10 = 20,9°C
- Check-sumcalculation:
Check-sum = 0000 0010 + 0100 0000 + 0000 0000 + 1101 0001 = 10001 0011
If the highest bit of temperature is 1, then the temperature is below 0 degrees Celsius. [4]

2. Software implementation

In software implementation, Arduino C used to program Arduino,and in the hardware implementation Arduino, smoke sensor, temperaturesensor, speaker, fire sensor, liquid sensor, Bluetooth shield.
Arduino C used to program Arduino for analyzing the data and sentit to android Tablet to give appropriate sound instruction. The Androidapplication will be programmed using MIT app inventor (tool developedby MIT to develop android application). The values of the sensors fromthe Arduino sent to the application to show the status of the factory.

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Thereare two main windows in App inventor 2The first screen is Designer screen

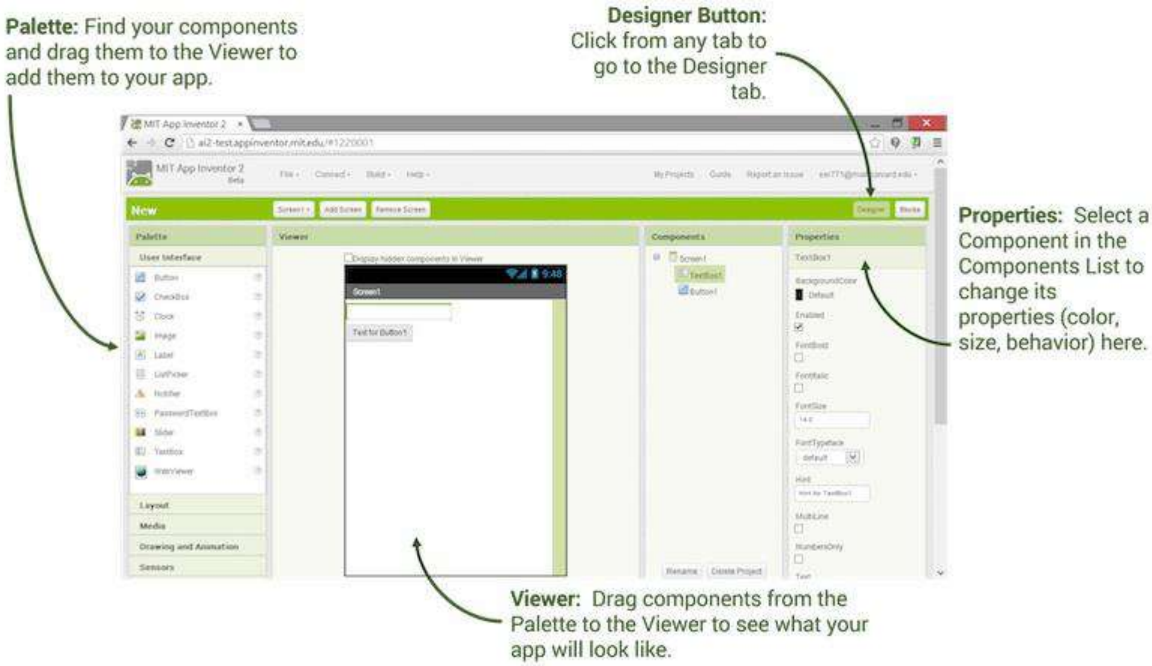

Figure 4: Designer screen

User interface

The program is designed to give the user easy access to the systemthrough the screens App Inventor programs describe how the androidshould respond to certain events: a button is being pressed, the phone isbeing shacked; the user is dragging his finger over a canvas, etc. Thisspecified by event handler blocksFirst, we designed our interface layout (Buttons, Screen of Status).

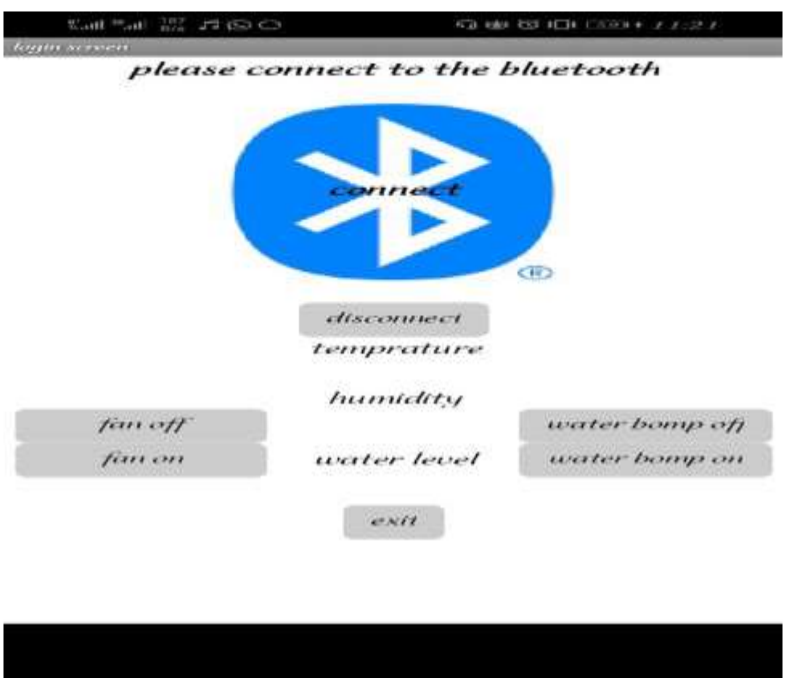

Figure 5: Android user interface

Firstly, user should establish serial communication between Arduino and the android application. Then there are temperature label, humidity label and water level label to point out the reading of sensor.

In the control part we've got four bottoms to regulate motor bump and cooling fan related to two labels to point out the status of every one.

• Mounting the tablet

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The tablet should be inside anti fire and anti-broken glass with hightemperature resistance.
The tablet should be mounted like the following figure to give easy access.

Figure 6: Mounting of the tablet

IV. Circuit Simulation

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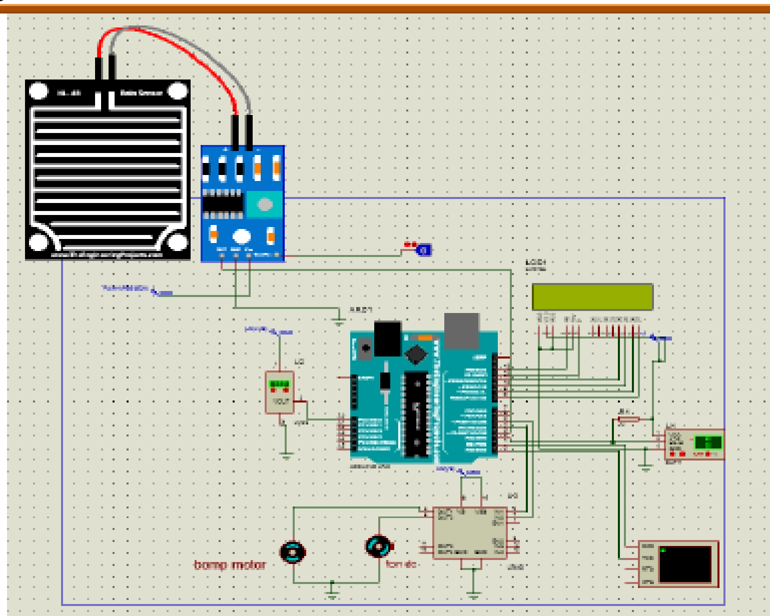

Figure 7: Simulation of system hardware circuit.

V. Result and discussion

1. Android application interfacing result:

Figure 8: User interface of android application

Figure 8 shows the user interface of the application which used to connect with Arduino to read data from Arduino and send commands to control motor bump cooling fan.

2. Testing of Temperature sensor:

Sensor of Temperature tested in room temperature the readings are not regulated and not stable.

readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	62	voltage 0.30	V	TEMP	30	C
readings	67	voltage 0.33	V	TEMP	32	C
readings	69	voltage 0.34	V	TEMP	33	C
readings	83	voltage 0.41	V	TEMP	40	C
readings	83	voltage 0.41	V	TEMP	40	C
readings	80	voltage 0.39	V	TEMP	39	C
readings	79	voltage 0.39	V	TEMP	38	C
readings	78	voltage 0.38	V	TEMP	38	C
readings	77	voltage 0.38	V	TEMP	37	C

Figure 9: Temperature sensor readings

3. Testing of water sensor:

The water sensor tested in leak and worked successfully, the readings and connection of the sensor shown in figure below.

water	0	voltage	0.00V
water	0	voltage	0.00V
water	0	voltage	0.00V
water	0	voltage	0.00V
water	2	voltage	0.01V
water	4	voltage	0.02V
water	6	voltage	0.03V
water	7	voltage	0.03V
water	132	voltage	0.65V
water	6	voltage	0.03V
water	7	voltage	0.03V
water	8	voltage	0.04V
water	9	voltage	0.04V
water	11	voltage	0.05V
water	645	voltage	3.15V
water	585	voltage	2.86V
water	563	voltage	2.75V
water	555	voltage	2.71V
water	551	voltage	2.69V
water	548	voltage	2.68V
water	548	voltage	2.68V
water	549	voltage	2.68V
water	549	voltage	2.68V

Figure 10: Water sensor reading

Figure 11: Readings in application and controlling motor bump and fan

Figure 11 shows that the reading from sensors to Arduino will be sent via Bluetooth to the application so that the user could see the reading from the screen of the tablet.

When the user presses the motor bump off or on bottom the motor will turn off or on and by pressing fan on or off the cooling fan will be turned on or off and the status will be displayed in the application.

The result is shown from devices and sensors it represent the condition of weather and the environment adjacent to the sensors inside of the greenhouse so it must be considered in the calculations of designing system like this system to be aware of the changing in this conditions and the sensors efficiency and accuracy of readings to avoid more defects and errors happens while implementation of perfect systems should be designed perfectly from the beginning and for some want go so far and design more advanced version of this system it is good base information's.

VI. **Conclusion**

A step-by-step approach in of smart greenhouse adaptation and irrigation systemsupported Arduino and android application for measurement and control of the three essential parameters for plant growth i.e. temperature humidity and irrigation has been followed. The results obtained from the measurement have shown that the system performance is sort of reliable and accurate. The system has successfully solved a number of current system flaws by reducing power usage, maintenance, and complexity while also providing a versatile and accurate method of environmental maintenance. Hardware and software costs are steadily declining, the broader acceptance of electronic systems in agriculture, and an emerging agricultural system industry in several areas of agricultural production, will lead to reliable control systems which will address several aspects of quality and quantity of production. Further improvements are made as more cost-effective and more reliable sensors are developed to be used in agricultural production.

VII. References

[1] José A. Aznar-Sánchez *, Juan F. Velasco-Muñoz, Belén López-Felices, Isabel M. Román-Sánchez, "An Analysis of Global Research Trends on Greenhouse Technology: Towards a Sustainable Agriculture", International Journal of Environmental Research and Public Health,20 January 2020, doi:10.3390/ijerph17020664, P1- P 22.
[2]Aleksandra Dimitrijevic, Milan Djevic, "Controlling A Greenhouse Production Processes and Environment", Annals of The Faculty of Engineering Hunedoara 2006, Tome Iv, Fascicole 3, (ISSN 1584 – 2673) Faculty of Engineering Hunedoara, 5, Revolutiei, 331128, Hunedoara.
[3]Compiled by lady ada, Tony DiCola, Kattni Rembor- 2012[Internet]. [cited2021 April 20] Available from. https://learn.adafruit.com/dht access.
[4]Mihai, Bogdan. (2016). Temperature and Humidity Measurement System. Proceedings of the 11th International Conference On Virtual Learning ICVL 2016.[5]Aizahaniff, "Security and Control System", May 2008.

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