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An Android smart application for an Arduino based local meteorological data recording

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Abstract. The Meteorological conditions could be with high importance for many applications. Even this information is available in many media resources, but they are not measured for a certain position. In this paper, authors present design for a private weather station that can be established in any place. The design mainly based on a group of sensors used for supplying the information of temperature, humidity, and air speed. An Arduino Uno microcontroller is utilized to process the incoming sensing data and send them via wireless Bluetooth module to mobile phones. The mobile phones are equipped with an Android smart application to display this data. This low-cost design offers an online weather information for any local projects that need such data.

1. Introduction

Weather conditions have been recorded using many simple devices. The well-known cup anemometer for example is used to measure the wind speed, while the wind vane was utilized to indicates the direction. These devices are still in use beside many others, like barometers to measure the air pressure and thermometers for sensing the temperature or some other to measure the humidity and the rain density [1], [2]. Based on these main devices many recent technologies have been used to give more precise and sophisticated weather data sensing and recording. These new technologies offered the benefits of mobility, remote access, precession and adaptation [3], [4]. After 2005, Arduino starts to be one of most preferred projects tool for both beginners and professionals [5], [6]. Among many projects, meteorological data recording has its share from Arduino applications. Plenty of related works are presented in the literature, the authors in [7] offers a climate measuring system which can deliver its system to pc using a wireless tool based on Zig Bee. H Saini et al [8] present the same idea but with more measuring information and comparing their results with the official weather information. The same purpose for the weather data measuring but for industrial application, is presented in [9]. Many researches combine the Arduino microcontroller with smart applications [10], [11] which makes such projects easier for the end users. In this paper, we try to establish our local meteorological data recording to measure air temperature, humidity and the wind speed using DHT, Anemometer sensors respectively. The data is fed to the Arduino Uno which plays the rule of the main

processor to translate the sensing data to a measuring values that can be displayed. A Bluetooth wireless connection is established between the weather local station and the smartphone using HC-05 Bluetooth module. The received data via the Bluetooth of the mobile phone is displayed using AppBuilder smart application tool. The rest of the paper is organized as follows: section 2 is dedicated for system model, in section 3 the implementation of the local weather station is presented, finally section 4 is utilized to list our conclusion.

2. The system model

The main element in our system is the micro-controller Arduino Uno which has its input fed from the DHT sensor and the anemometer sensor. The Arduino Uno, shown in Figure 1, is an open source microcontroller that can hold the main job of the electronic circuit. All the sensors are connected to its terminals (as will be explained in the next section) and also it deals with the data as a software inputs which is processed using the programming script to get the required output.

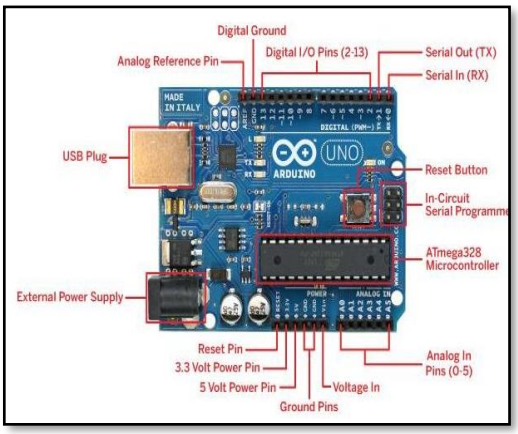
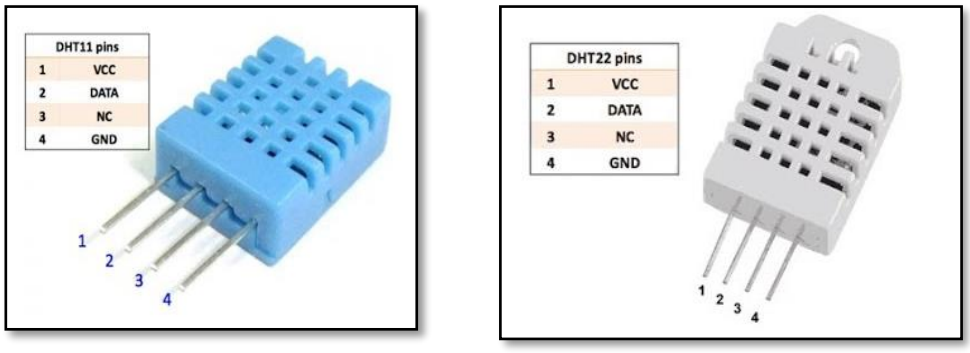


Figure 1. Arduino Uno electronic board

The DHT sensor shown in Figure 2, is one of simple to connect sensor because no interface circuit is required for its connection to the Arduino inputs. This sensor mainly constructed of two individual elements. The first one is the resistive component which is utilized to sense the humidity, and the second part is using the function of negative resistance rule to sense the temperature. The designers used two types of this sensor, DHT-11 and DHT-22, the latter is more precise in its measuring. Figure 2, [12], shows both sensors.



(a) (b)

Figure 2. DHT sensor, (a) DHT 11 (b) DHT 22

Table 1, gives a specification comparison between them.

Table 1. DHT 11 and DHT 22 characteristics comparison

Specification title	DHT 11	DHT 22
Temperature scale	$0 - 50℃, \mp 2℃$	$-40 - 125℃, \mp 0.5℃$
Humidity scale	$20\% - 80\%, \mp 5\%$	$0\% - 100\%, \mp 2.5\%$
Reading rate	One reading/second	One reading/2 seconds
Sensor size	$15\text{mm} \times 12\text{mm} \times 5.5\text{ mm}$	$15.1\text{mm} \times 25\text{mm} \times 7.7\text{ mm}$
Applied voltage	$3 - 5$ volt	$3 - 5$ volt
Maximum current while reading data	2.5 mA	2.5 mA

The wind speed measurement is driven from the anemometer sensor that illustrated in Figure 3.

Figure 3. Anemometer sensor

This sensor usually mounted outside to deliver the wind speed measurement to the Arduino board. The main idea of this sensor that it has a DC motor inside it which is synchronize with the rotation of the cups. The mechanical power that came from the rotary motion of the cups introduce an induced voltage in the DC motor that fed an analog signal to the Arduino that indicates the wind speed.

The wireless communication element represented by the Bluetooth serial port protocol (SSP) module HC-05 shown in Figure 4, is used to establish the link between the Arduino Uno board and the mobile phone via Bluetooth technology.

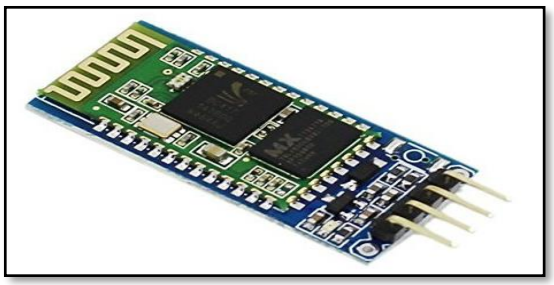


Figure 4. HC-05 Bluetooth module

The overall system model is illustrated in Figure 5.

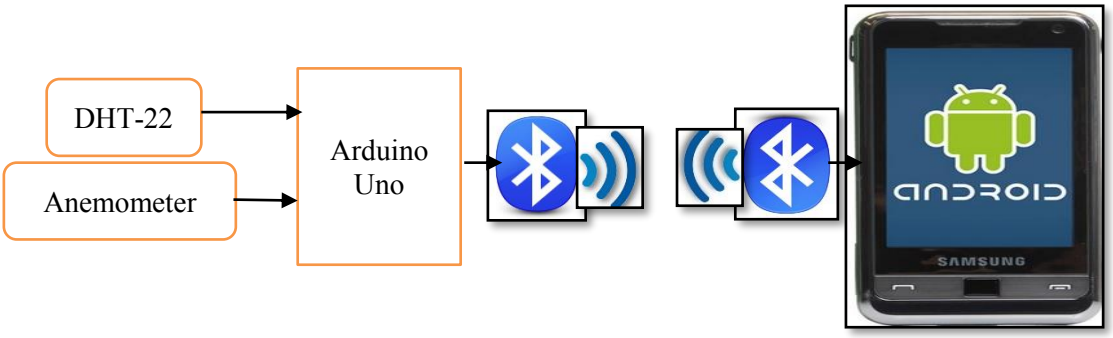


Figure 5. Local meteorological data recording system model

3. Software Architecture

In this paper, two software programs were used to control and monitor the full system

3.1. Arduino program.

The Arduino IDE platform is an open source software to rewrite all types of programs. The flowchart process in the Figure 6a present how the Arduino measure temperature, humidity and wind speed. After measuring the Arduino UNO send the results to end user by Bluetooth HC-05 to Android smartphone.

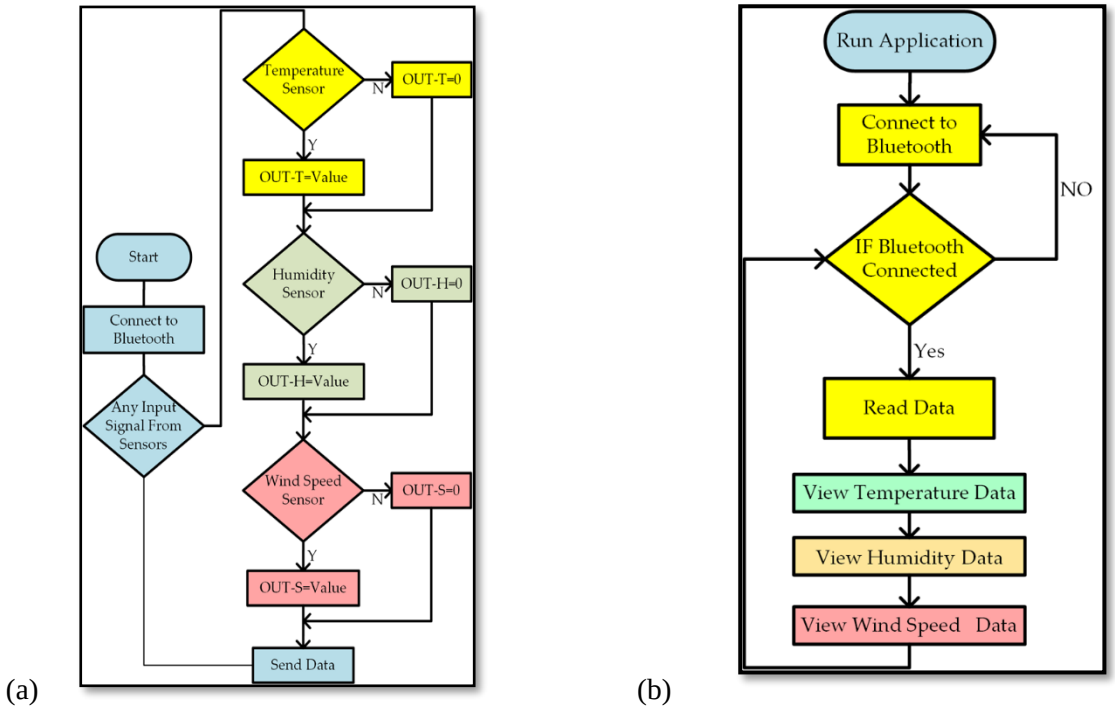


Figure 6. (a) The flowchart of Arduino program , (b) the flowchart of AppBuilder program

3.2. AppBuilder program

Appybuilder software is an open-source program was used to design and implementation android smartphone application. Figure 7, show the main window of the Appybuilder software and the flowchart of the final application of the system is present in the Figure 6 (b). Figure 6 (b) is present how the monitoring system application received the data from the hardware system.

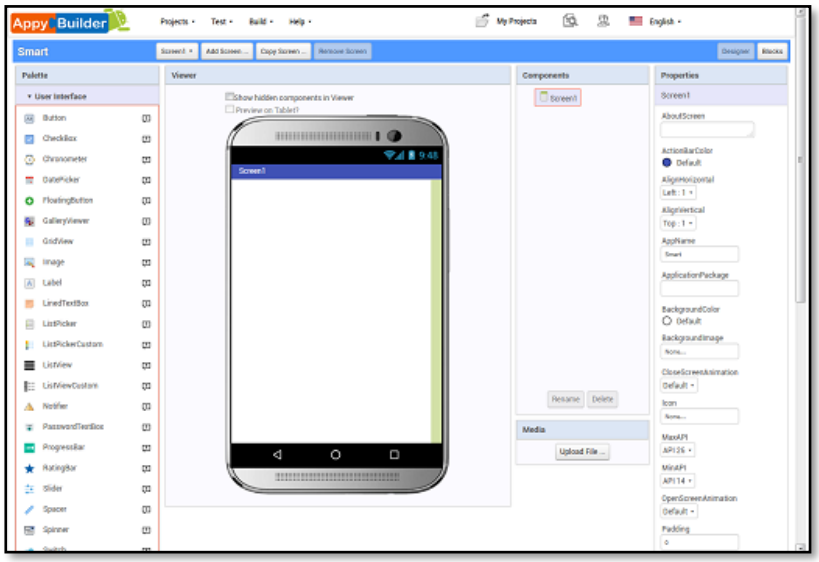


Figure 7. Main window of the Appybuilder platform [13]

4. Experimental results

The hardware circuit of the full meteorological system is shown in Figure 8. In this system the DHT 11 and wind speed sensors are connected to the Analog and digital input ports of the Arduino UNO R3. After the Arduino UNO reads all measuring data from sensors, this data is sent using Bluetooth to an Android smartphone.

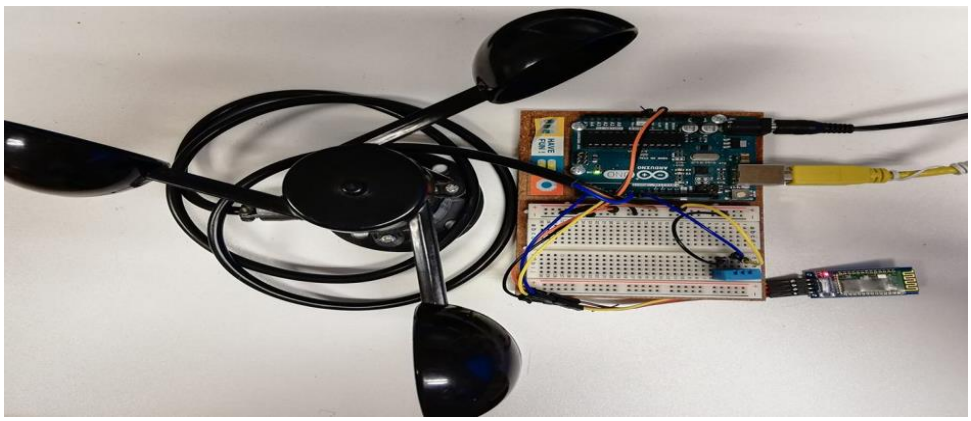
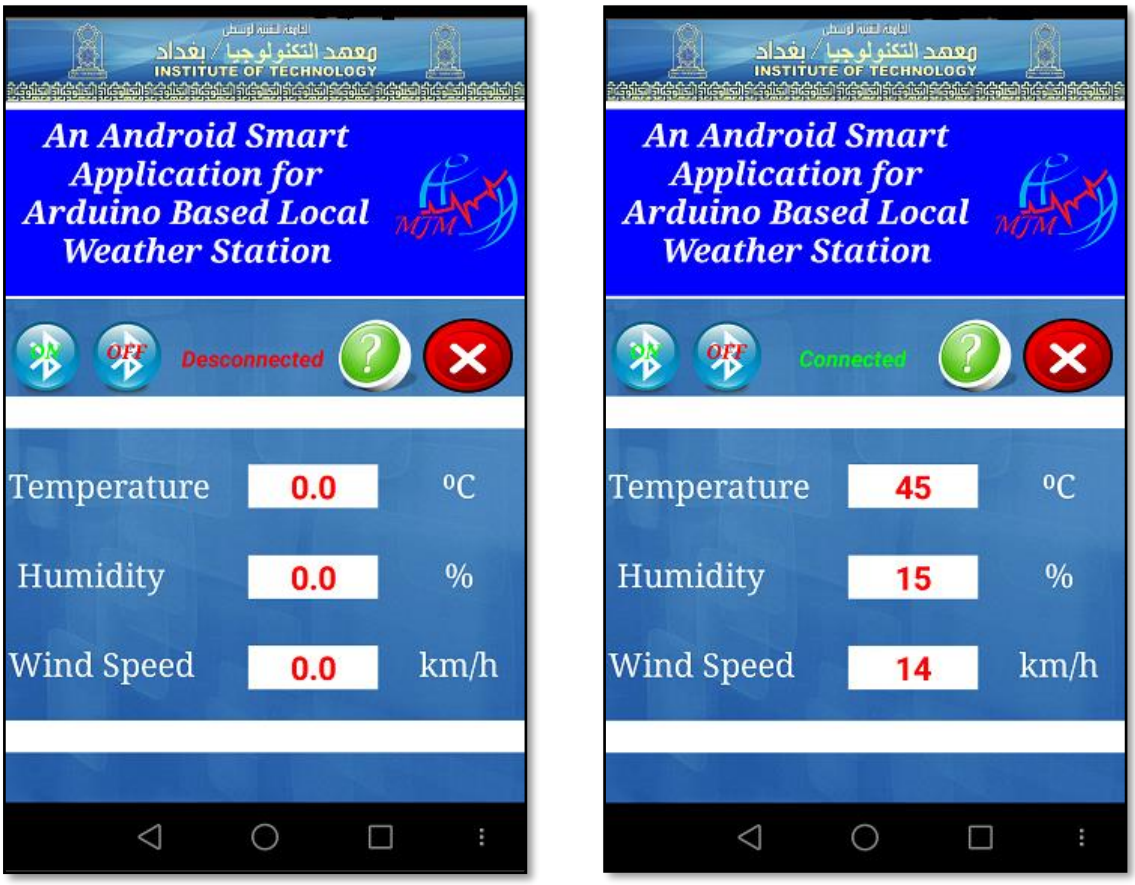


Figure 8. Practical circuit of the meteorological system.

The main windows of the Android application of the meteorological system is shown in Figure 9. Figure 9a. present the main application windows before Bluetooth HC-05 connection to the smartphone device (end user) and Figure 9b shows main application windows with all measuring results of the meteorological system after Bluetooth connection to smartphone.



(a) (b)

Figure 9. Final smartphone application of the meteorological system. (a) main window before Bluetooth connected, (b) main window after Bluetooth is connected

5. Conclusion

The meteorological station implemented in this project allows to integrate sensors and commercial devices, in an open and low cost platform with respect to other alternatives in the market. The advantage of using a platform such as Bluetooth is that it facilitates the integration of all types of sensors and actuators, through their Analog and digital interfaces of the Arduino. the users are provided with a new application design that can be installed on Android smartphones to monitor the status of the system. The power consumption of the designed weather station in this paper is considerably lower than other commercial applications, including that of other hardware development platforms.

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