PROPOSAL REOPORT FOR WEATHER STATION

EXECUTIVE SUMMARY

With the recent changes in the world's climate and extreme weather, agricultural activities has been threatened with food security taking the center stage. Human livelihoods and critical infrastructure such as telecommunication and air transportation has been greatly affected by adverse weather condition. Consequently the need to have a collapsible mobile weather station powered by photovoltaic module that will read and record localized weather parameters of any location of interest cannot be over stated.

This proposal intends to develop a pilot mobile weather station powered by photovoltaic module that will read and record atmosphere temperature, relative humidity, atmospheric pressure, light intensity, rain drop frequency, wind speed and wind direction.

A microcontroller will be interfaced in the weather station design to process the weather sensors parameters into observable format for real-time on-site weather monitoring on the LCD and on a webpage which is also archived on a cloud database with the aid of a communication link.

The entire weather station will be powered by photovoltaic module, thus making the device independent of grid system.

Problem statement and Justification

Conventional weather station has the following drawbacks:

(1) They are bulky, stationary and expensive to deploy.

(2) They are wired with alternating current Components, therefore requiring high source voltage of power which makes them dependent on grid power system or the alternatively switch to diesel fuel generators.

(3) Due to their bulky nature, they cannot be moved around and consequently, researchers and meteorological agency utilises it generic weather data

(4) Deployment into disaster susceptible areas for long time localised weather information acquisition is always challenging.

The need of a low-cost wireless, weather station, without the aid of human assistance, but with precision sensors that has international proven data sheet and IoT technology integration which will function round the clock independent of grid power with the aid of solar module incorporation in rural and semi-rural areas will improve agricultural yield, timely disaster warning to local farmers and localised atmospheric data for the purpose future research analysis and forecasting cannot be over emphasised. This necessitated the need to design and develop a collapsible mobile solar powered weather station incorporating IoT with the following design consideration:

(1) Utilisation of miniature of miniature components for the purpose of collapsibility and mobility for easy deployment in any location of interest

(2) Incorporation of photovoltaic module in order to harness abundant and natural solar irradiance in Nigeria for round the clock functioning of the weather station without depending on grid power

(3) IoT technology interface in the design for real-time remote visuals of measured weather parameters in digital numeric values, continuous straight line graph on a webpage and in an excel file format archiving on the cloud data base.

Objectives of this research work

The following factors carefully guided the objectives utilised in this research and development work:

(i) A collapsible and mobile weather station that will measure localised atmospheric data.

(ii) A weather station that will utilise the abundant solar irradiance in Nigeria and incorporating back up battery.

(iii) An electric circuitry that will seamlessly have an Interface of Wi-Fi communication protocol, IoT technology and miniature electronic sensors which will enable weather parameter sensorsreadings visualised in real-time on -site via LCD and off-site via a webpage in numerical digital value and continuous straight line graph and also archived in a cloud database in an excel file format.

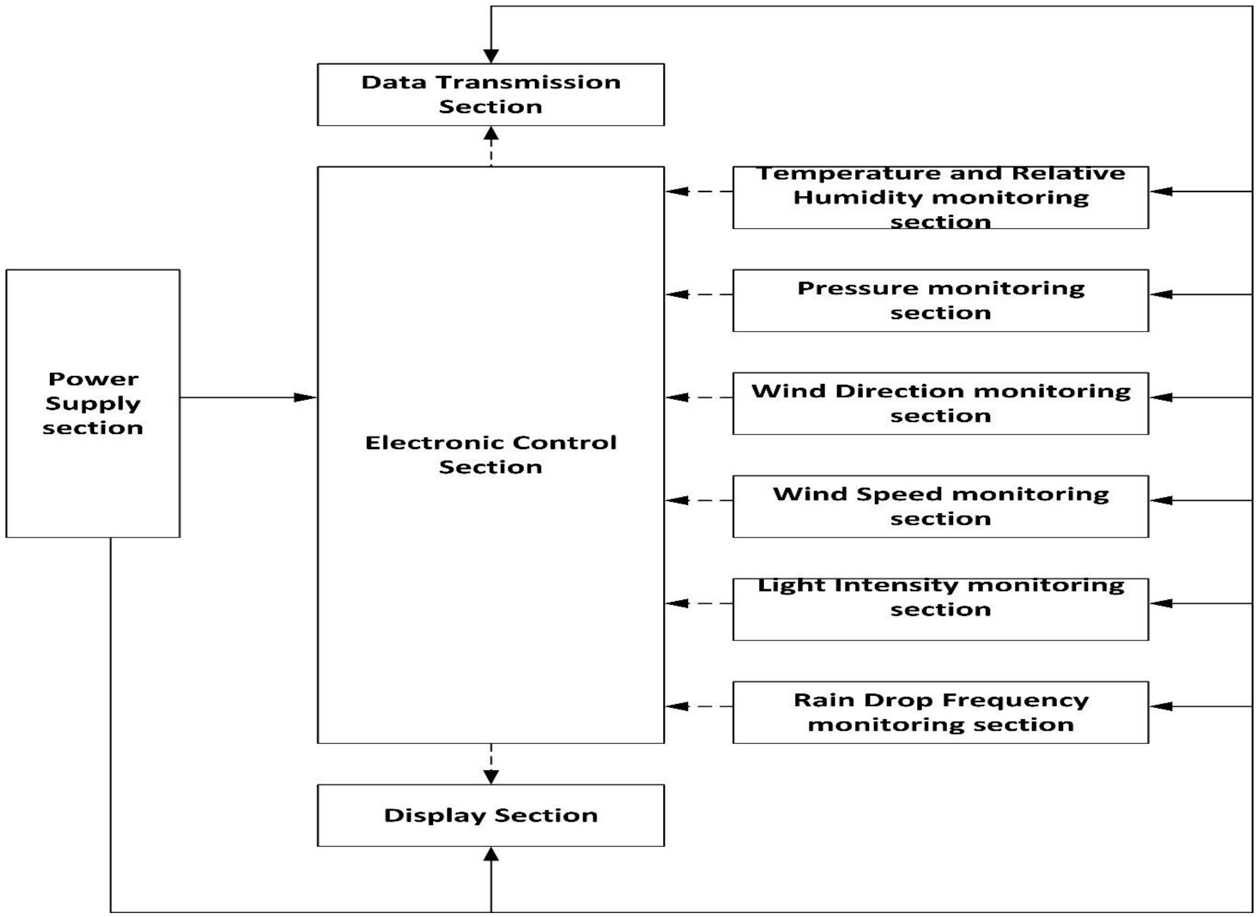
Materials and Methods

Power supply, electronic control, temperature and relative humidity monitoring, pressure monitoring, wind direction and speed monitoring, light intensity monitoring, rain drop frequency monitoring, display, and data transmission are the various components of the pilot solar-powered Internet of Things weather station in a reinforced composite plastic embodiment. This section provides an overview of the many design phases and some of the steps needed in putting the weather station into operation. In the system design, a block diagram is also used. The following is a list of the steps involved in implementing the device:

a. Block diagram showing the system design
b. Section by section explanation of the system design
c. Circuit diagram utilised in the implementation of the work
d. Hardware materials employed to develop the composite plastic embodiment

Hardware design

The block diagram of the device below depicts the different sections that make up the solar powered IoT weather station.



Block diagram of the device

Power supply section

The device is fuelled by solar energy through the power supply component since solar radiation is abundant in Africa. The primary elements of this section are the backup battery, charge controller, voltage regulator, and solar panel. The weather station's solar panel power supply allows it to function continuously. When there is no sunlight at night, the device uses the backup battery to keep the weather station running. A charge controller, which is attached to the solar panel's output, reduces the voltage to 12 volts so that the 12-volt battery can accept it. In order to control the 12V to 5V, which is the circuit's necessary operating voltage, a voltage regulator is also connected to the battery's output.

Electronic control section

The electronic control section, which consists of the microcontroller, is the main processing unit of the weather station. By connecting its input pins to the pin connections of the output sensors, it gets data from all of the weather parameter sensors. It then transforms the data into an LCD format that observers on-site can see and uploads it to a server for observers off-site. Furthermore, meteorological data displayed on the server and LCD is stored in an Excel file format for future examination by researchers.

Temperature and relative humidity monitoring section

The temperature and relative humidity detection unit produce an electrical signal that shows the temperature and relative humidity of the surrounding air by connecting the sensor and microcontroller with the correct pin connections. A cheap digital temperature and humidity sensor that senses the air around it using a temperature sensor component and a humidity sensor based on a capacitor. The output sensor component, which operates in a wide range of temperature and humidity, transmits a digital signal to the relevant data pin. It is accurate and faultless.

Pressure monitoring section

The BMP 180 sensor is used in the pressure monitoring area. The purpose of the BMP180 is to measure the atmospheric pressure in its immediate environment. The BMP180 is an I2C device with four pins: SDA, SCL, VIN, and GND, Vin and GND. The BMP180 is a high-precision server. The BMO 180 sensor senses pressure and sends the information as digital data

Raindrop frequency monitoring section

The rain sensor module is a simple rain detecting device. It is used to measure how much rain is falling. For further accommodations, the module has a separate control board, a rain board, a power pointer LED, and an adjustable affectability potentiometer. The LED that is attached to a 5V power source will activate when the DO output is high and the induction board is free of raindrops. As you drop a tiny bit of water, the switch marker will light up when the DO output is low. After returning to its initial state, the system will produce a high state when the water beads are removed.The rain drop sensor module produces analog output. It has an analog pin connected to it A0

Light Intensity Monitoring Section

Light intensity is measured in this part using an LDR sensor light dependent resistor, sometimes referred to as a photo resistor or photocell. The value of altering resistance is provided by its interaction with light. Light intensity decreases with less light and vice versa.

Wind speed monitoring section

Three cup anemometers are used to measure wind speed. At the foot of the shaft, which supports the three-cup anemometer, is a reed switch that is orientated perpendicular to the magnet. The shaft has a magnet attached to it. Every time the three-cup anemometer rotates due to wind and the passage of the magnet, the reed switch sends a logic zero to the microcontroller. As the process continues, the microcontroller counts the triggers. The microcontroller uses the Davis equation to determine the wind speed for each spin made after the chosen amount of time.

$V=(2.25T/)$

Where V is the speed in miles per hour (m/h), P is the number of pulse during sampling period and T is the period per second

Wind direction monitoring section

An output of 0V to 5V, or 0° to 360°, is produced by assembling a wind vane so that the shaft is directly connected to a continuous moving variable resistor. According to [14], the reference degree is 0° in the north, 90° in the east, 180° in the south, and 270° in the west.

Display monitoring section

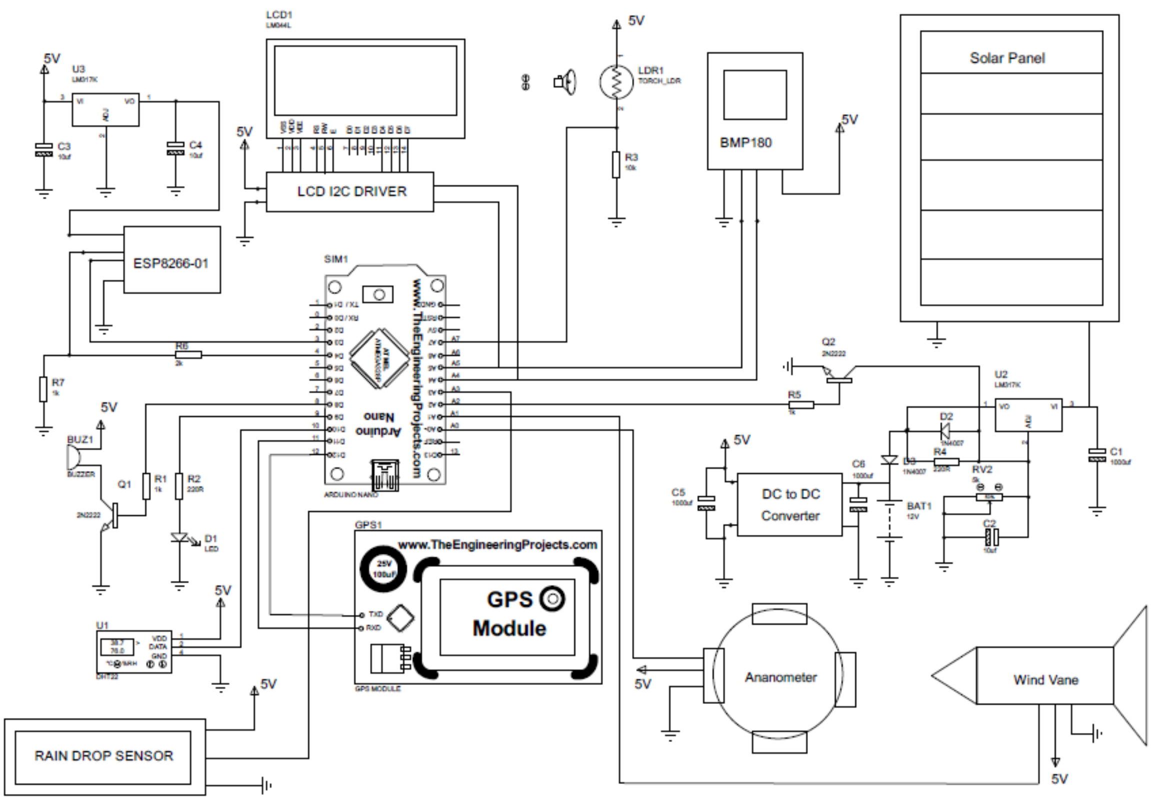
An LCD is utilised in the display monitoring section. It is coupled to a 20x4 LCD that shows the data processed by the microcontroller. Viewers on the scene can examine real-time weather parameters by connecting the microcontroller's output pins to the LCD's input pins.

Data transmission section

In the data transmission phase, the Wi-Fi module serves as a communication link between the microcontroller and an online server, enabling the submission of processed data. Users who are not on-site can evaluate weather information from the device from anywhere in the world by using the graphic and digital displays of atmospheric temperature, relative humidity, atmospheric pressure, frequency of raindrops, light intensity, wind speed, and wind direction on the internet server.

Circuit diagram of the device

Below is the overall circuit diagram showing the interconnections between components that were utilised to physically implement the weather station:



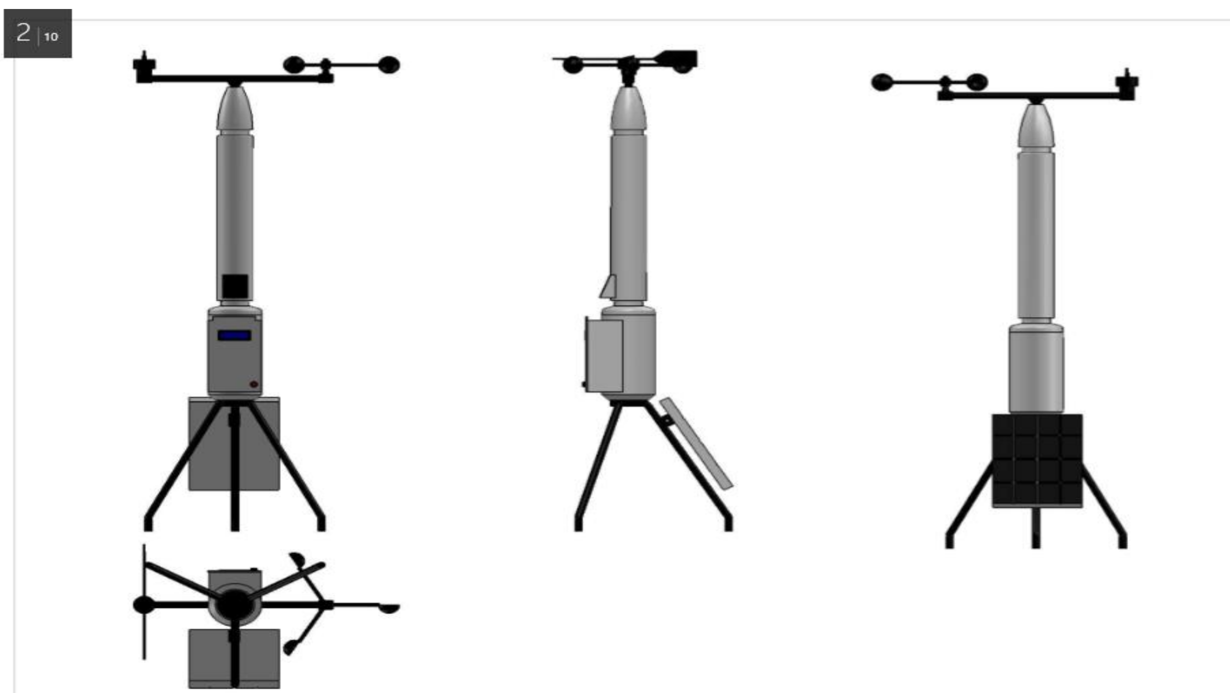
Development of the embodiment frame locally

For the development of the embodiment frame the following materials will be considered:

1. Resin
2. Accelerator
3. Catalyst

4. Fiber mat
5. Calcium dust
6. High density wood
7. Sand paper of different surfaces
8. Lathe machine
9. Solid work soft ware
10. Drill bit machine and drill bits
11. Plaster of Paris
12. Solid Work software

This section depicts proposed pilot weather station 3D solid workmodel showing front view, side view, back view and top view of plastic composite embodiment frame of the weather station respectively:



PILOT TESTING

After the pilot production of the weather station, there will be workshop calibration, field deployment in six geopolitical zones of Nigeria to considered locations such are as: urban, rural, coastal and high land areas. Acquired weather parameters from the weather station will be validated with that of NiMET weather station.

EXPECTED RESULTS FROM THE PILOT WEATHER STATION

1. The weather station is supposed to function round the clock independent of grid system due to utilisation of photovoltaic module and back up battery that will account for days of autonomy

2. Real-time localized weather parameters monitoring at the on-site via the LCD and off-site via a webpage and cloud database as a result of IoT technology integration in the weather station design.

3. Provision of accurate weather data that will be utilized for agricultural purpose, Meteorological Agency, telecommunication industry for signal attenuation mitigation, military forward operating base units and for research purposes in the universities.

Major Benefits of Collapsible and mobile solar powered weather station incorporating IoT

Collapsible and mobile solar powered weather station incorporating IoT is a paradigm shift from the conventional weather station because of the following features:

1. The weather station does not need wired Infrastructure or grid power system, consequently its deployment into tough to terrain of interest is possible and flexible.

2. The collapsible and mobile nature of the weather station, make it possible for quick relocation of the weather station for to any location of interest.

3. The weather station does not have operational disruption due to utilisation of photovoltaic module and back up batteries that can last during days of autonomy when deployed to the field.

(4) The integration of IoT into the weather Station makes real-time off-site visuals, and archiving of measured weather parameter automatic

(5) Carbon footprint is completely eliminated in the deployment and functioning of the Weather station, due to utilisation of abundant solar irradiance in Nigeria.

(6)Improved crop yield through better weather prediction.

(7)Early warnings and faster response to extreme events.

(7)Access to localized climate data for modeling and studies.

Implementation Plan

Project timeline (12 months)

Phase	Duration	Activities
Phase 1	3 Weeks	Literature review, patent search audit, system design, component procurement and assembly
Phase 2	3 Weeks	3D modelling, simulation and software development
Phase 3	4 Weeks	Careful soldering of electronic components and sensors on the PCB. Connecting the solar power system to interface with the entire circuitry
Phase 4	6 Months	Field testing of the thermoelectric refrigerator thorough performance evaluation
Phase 5	3 Weeks	Analysis of acquired thermoelectric refrigerator parameters by
Phase 6	3 Weeks	Validation of the thermoelectric refrigerator data

Estimated Cost Mobile Collapsible and solar powered Weather station incorporating Internet of things (IoT).

Below is a breakdown of the bill of quantityproposed for the pilot weather station production, the sum of Eleven Million six hundred and six thousand, one hundred naira (₦**11,606,100**) for the production of six Mobile Collapsible and solar powered Weatherstation incorporating Internet of things (IoT).

SECTION ONE: PROJECT BUDGET FOR HARDWARE

S/N	COMPONENTS	QUANTITY	UNIT COST (₦)	TOTAL COST (₦)
1	Detachable lithium battery bank	2	80,000	160,000
2	Solar panel	1	80,000	160,000
3	Charge controller	2	30,000	60,000
4	Temperature and relative humidity sensor	4	16,000	64,000
5	Atmospheric pressure sensor	4	8,000	32,000

6	Arduinonano	3	12,000	36,000
7	Router modem	2	18,000	36,000
8	TFT Display	3	20,000	60,000
9	Variable resistor	5	2,000	10,000
10	LDR	7	1,500	10,500
11	Jumper (du point cables female to female)	5 lots	1050	5,250
12	Frictionless anemometer	1	90,000	90,000
13	Frictionless wind vane	1	77,000	77,000
14	Multiple channel relay	3	3,200	9,600
15	Rain drop sensor	4	2,200	8,800
16	Double sided coated PCB	1	40,000	40,000
17	Automobile connectors	2 lots	7,000	14,000
18	Switches	3	300	900
19	Adjustable voltage regulator	3	8,00	2,400
20	Diodes	7	200	1,400
21	Ribbon cables	5 lots	3,000	3,000
22	GSM high frequency module	1	57,000	57,000
23	LIM DC to DC step down	3	5,500	16,500
	TOTAL			₦ 819,350

Total:₦ 819,350

SECTION TWO: PROJECT BUDGET FOR REINFORCED COMPOSITE PLASTIC AND STAND

S/N	COMPONENTS	QUANTITY	UNIT COST (₦)	TOTAL COST (₦)

1	Case and stand	1	530,000	530,000
	TOTAL		530,000.00	530,000.00

Total:₦530,000.00

SECTION THREE: PROJECT BUDGET FOR SERVER, MACHINE LANGUAGE AND ARTIFICIAL NEURAL NETWORK DEVELOPMENT

S/N	COMPONENTS	QUANTITY	UNIT COST (₦)	TOTAL COST (₦)
1	Server, Machine Language and Artificial Neural Network Development	1	585,000	585,000
	TOTAL		585,000.00	585,000.00

Total:₦585, 000.00

Grand total: ₦1,934,350.00

For six weather stations: **₦1,934,350.00 × 6 =₦ 11,606,100**

Staffing required

Principal Investigator: Dr. Akpan Udom Mark, a Chief scientific officer in research and development department,Scientific Equipment Development Institute, Minna-Niger state.

1. Scientific officer: his task will be extensive literature specification

2. patent search audit because this will guide in development of measurable technical objectives of the R&D work

2. Design and simulation engineer: he will be the task of interfacing with the scientific officer during design calculations, 3D modelling and virtual implementation of design to see if it meets measurable design objective specifications

3. Machinist: he will be tasked with the responsibility of surface finishing of the embodiment of the refrigerator

4. Composite Plastic Technologist: his is tasked with the responsibility of producing the embodiment of the device which will house the electronic and electrical components of the refrigerator, he also carries out final surface machining of the embodiment

5. The scientific officer and the engineer will also carry out the task of production sequence documentation and drafting of the working operational manual of the device

6. The engineer and scientific officer will carefully assemble and solder the electronic components on the double sided coated PCB produced and also carry out calibration test

7. A software and IoT expert will develop a machine language which will enable seamless interface communication between the electronic electrical hardware, sensor, web page and cloud database respectively

8. The scientific officer and engineer will carry out thoroughly performance evaluation of the device to see if specification measurable objective specifications and virtual implementation specification

Evaluation

Performance Metrics: Data accuracy, uptime, transmission reliability, user satisfaction.

Data Review: Weekly system diagnostics, monthly analytical reports.

Impact Evaluation: Comparison of weather-based decisions before and after deployment.

Conclusion

The goal of this project is to create a low-cost, portable, solar-powered Internet of Things weather station made of reinforced composite plastic. It will show on an LCD the current temperature, relative humidity, atmospheric pressure, light intensity, frequency of raindrops, wind speed, and wind direction. Additionally, send off-site observers digital and graphical meteorological data in an Excel file format to an online server for future analysis and preservation. Consequently, the weather station benefits from the combination of mobility, cost, efficiency, and real-time meteorological data collecting.