Eastern Mediterranean University

Department of Mechanical Engineering

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EVALUATION

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Chapter 2 Literature Review **(%10)**				
Chapter 3 Design and Manufacturing **(%10)**				
Appendix **(%30)** Gantt Chart Log Book Drawings				
References **(S/U)**				
Overall Mark	**%**	**%**	**%**	**%**

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CHAPTER 1-INFORMATION

ABSTRACT

Weather data collecting plays an important role in human life, so the collection of information about the temporal dynamics of weather changes is very important. In any industry during certain hazards it is very important to monitor weather. The fundamental aim of this paper is to develop a system to design a weather data collecting system which enables

to storage the weather parameter. Such a system contains all of sensors like temperature, wind, pressure and humidity will be measured by using arduino. We will collect the weather datas by using solar panel for nonstop measuring. These measuring datas will be transferred to computer or programs by using sd cards.

INTRODUCTION

An automated weather station is an instrument that measures and records meteorological parameters using sensors without intervention of humans. The measured parameters can be stored in a built-in data logger or can be transmitted to a remote location via a communication link. If the data is stored in a data logger, recorded data must be physically downloaded to a computer at a later time for further processing.[6] Therefore, the communication system is an essential element in an automated weather station. Today, automated weather stations are available as commercial products with variety of facilities and options.[18] Although automated weather stations can be built and implemented in remote parts of Sri Lanka to bring down the cost of maintaining weather stations, until recently, not much emphasis has been given for building and using such instruments locally. Automated weather stations have been developed in universities by interfacing meteorological parameter monitoring sensors to microcomputer/commercially available data loggers with communication devices or through serial and parallel ports to obtain hard copies of weather data.[20] Recently, the University of Colombo developed an automated weather station with USB communication facility and a built-in data logging facility. The system used wired communication to transfer data to the monitoring station through the computer's built-in USB interface. The present work is a further extension of the earlier developments. The main objective of this work is to develop a standalone modular weather station with a remote communication facility to capture and transmit meteorological parameters.Remotely monitoring of environmental parameters is important in various applications and industrial processes. In earlier period weather monitoring systems are generally based on mechanical, electromechanical instruments which suffer from the drawbacks like poor rigidity, need of human intervention, associated parallax errors and durability. Kang and Park have developed monitoring systems, using sensors for indoor climate and environment based on the parameters mentioned in 2000 [2].Combination of these sensors with data acquisition system has proved to be a better approach for temperature and relative humidity monitoring in 2005.

Vlassov in 1993 introduces the usage of surface acoustic wave's devices as temperature sensor. This demand the development of a microcontroller based embedded system for weather monitoring. Such a system should monitor and provide data for remote examine. The collected data by weather monitoring system can easily be exported to a PC via a serial port to make subsequent data analysis or graphic and digital storage thus automatic data collection is possible without giving up PC resources [11].

1.1 Basic Meteorological Disciplines and Applications

Name of meteorology came from Greeks and meteorology which means sky events. Ancient Greeks made a technique to observe sky events like clouds, wind and rain. And also they worked to understand the relationship between them. The major factors in weather events is shown in figure1. Weather forecasting was important for farmers and sailors in those times. Today in our environment has more serious and important weather events because of changes and events in atmosphere. We need to find solutions to difficult and complex issues for behavior and the influence of atmosphere. For centuries, atmospheric air observation is utilized to understand and predict. The most important observations are temperature, barometric pressure, humidity and wind speed and direction measured by instruments in the station. Planes, radars, satellites and computer systems provide the most important information and convenience to meteorologists. The largest and fastest computers in the world are used for atmospheric studies and weather forecasts.

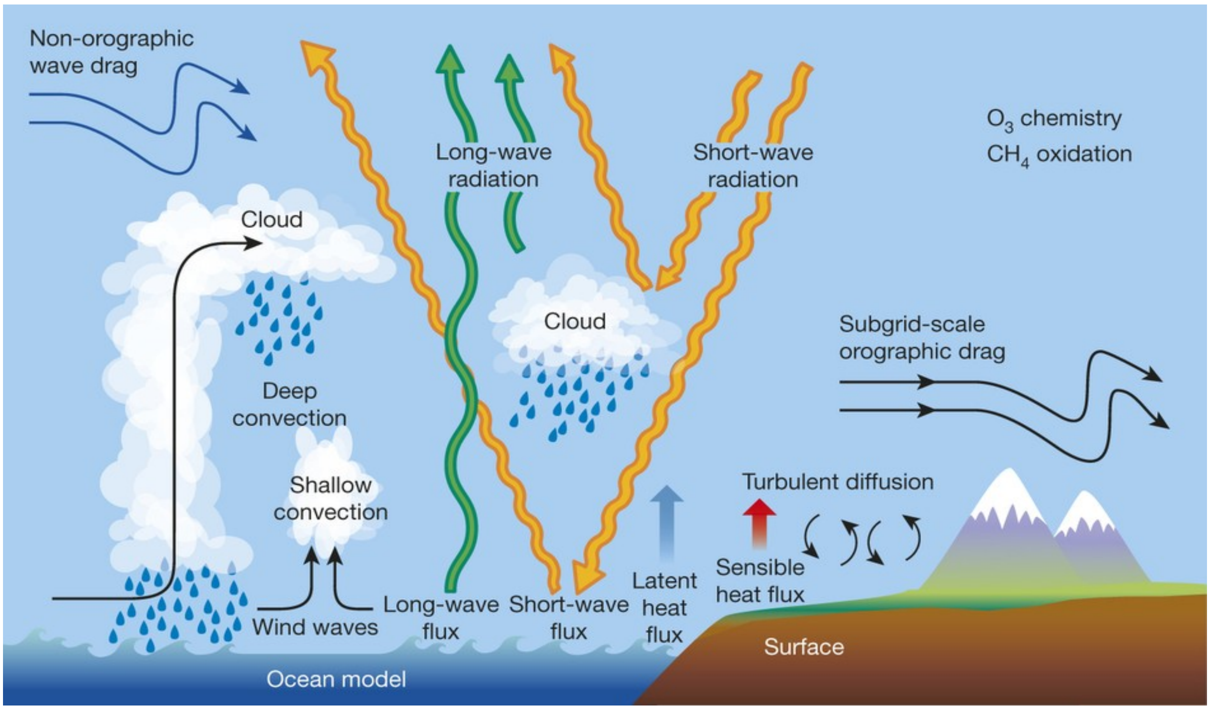

Fig.1 the major factors in weather events [1].

- Climate, examine that change of climates.
- Atmospheric Chemistry and Air Pollution Meteorology,
- Atmospheric Turbulence,
- Bio Meteorology,
- Boundary layer (boundary layer) Meteorology,
- Cloud and precipitation physics,
- Numerical Meteorology,
- Dynamic Meteorology,
- Environmental applications of Meteorology,
- Hydrometeorological,
- Marine Meteorology,
- Meteorological marketing,
- The meteorological measuring instruments,
- Mezo-meteorology,
- Micro-meteorology,
- Numerical Weather Forecast,
- Radar Meteorology,
- Remote Sensing,
- Satellite Meteorology,
- Space weather,
- Tropical Meteorology,
- Urbanization Meteorology,
- Notice of severe weather events,
- Weather Modification.

1.2 Basic Description of the Compounds

The weather conditions also depend on the movement of the atmosphere to warm up and to cool it. In this case weather conditions vary. Warm air can replaced the cold weather, the sun can replaced the rain or snow, light wind can replaced the storm. It is very important to ensure the full and timely meteorological services. Especially the military, civil, agricultural, land, sea and air transportation and other industries to provide meteorological information on the weather forecast is a primary objective. Weather forecast methods, use to learn rain, wind and other events for highways, seafaring and other all areas. Agriculture, forestry, tourism, transport, public works, energy, health, environment, armed forces and other organizations; Providing meteorological support for them [13].

1.2.1 Analysis

Analysis makes observations required by the meteorological services and make weather forecasts for other sectors. Observation stations were spread over large areas and many aspects of the weather in the report may not open. This is especially true for small scale systems. Local and general conditions are difficult to distinguish from each other. Therefore, the first objective is to separate the analysis of the overall impact of local events. After recovering from the wrong details and to eliminate the effects of faulty observation. There is a summary describing the status of the atmosphere and observation of the need to be closer to the ideal situation as possible. Depictions shown on the map is a map or a synoptic weather map. The second purpose of the analysis is to classify basic physics methods by naming the elements of weather.

1.2.2 Research

Studies and researches about Meteorology and also determine that natural disadters, hurricane. Obtained work and studies carried out to determine the region's climate archive and publish information. The aim of the research, the design of satellites and Earth observation systems, integration of existing systems, verification of mutual validity of the data obtained and the model prediction system, the development of early warning systems that use them, is presented to management and users of the data obtained.

1.2.3 Military Services (land, sea and air vehicles) and Civilian

Military and civilian; land, sea and air transport to make weather forecasts for agriculture and other sectors. The organization deem necessary to receiver and transmitter equipment in domestic and international with them to exchange meteorological information to publish in a manner seen to benefit the people need this information. Wavelength, direction, period and wind data, wave forecasts prepared seafood products and reports are offered to usage. Numerical weather forecast model and the wave of products is carried out by special algorithms combining the results and prepared detailed predict of sea and yacht tourism to coastal ports and bays, it offers the service of sailors and fishermen. Reliable search Stations Graphics, Digital Products, flight documents, synoptic maps with satellite and radar products has provided services to the aviation industry.

1.2.4 Agricultural

Agricultural determines appropriate planting time and resistance of plants for farmers. Agricultural Frost Warning System is developed to prevent agricultural frost. The FAO (United Nations Food and Agriculture Organization) by taking advantage of meteorological data with simulation model developed agrometeorologic plant yield estimates it makes. Calculation of the total amount of heat needed for normal plant development it was developed to estimate the harvest time.

1.2.5 Regional Weather forecast Centres

The resulting increase in the number of meteorological disasters in recent years, increasing the spread of the wider area of the point estimates for consistency rate predict has initiated the implementation of regional forecast centers.

1.3 Instruments and Equipments of Meteorology

There are many basic and different instruments and equipments which are used in meteorology.

1.3.1 Pressure Measure Instruments

Pressure is one of the most important meteorological elements. Pressure force is made by the effect of air on the surface per unit area of the surface. There are three main methods for measuring atmospheric pressure and pressure measure instruments are shown in figure2.

a) Column equilibrated with atmospheric is to use a liquid column. The liquid is used with low mercury vapor pressure. The most accurate measurements are made with this method.
b) If the pressure on one side of a metal plate is different than on the other side, the shape of metal will change. Using this method, the aneroid (Metal) Barometer and barograph are made.
c) The boiling point of liquids is due to the pressure on the surfaces. Measuring the liquid's boiling point, the barometric pressure will find.

Fig 2. Pressure Measure Instruments [7].

1.3.2 Duration of the Sunbathing Measure Instruments

The duration of the sun's rays or during the one day, it called heliography the device that saves the time to sunny. Heliography device saves direct sun rays from the sun on a diagram.

1.3.3 Radiation Measure Instruments

Radiation measured for Meteorological measured by Aktinograf device. Aktinograf device is a device that records the total radiation intensity from a horizontal surface on the diagram in terms of calories.

1.3.4 Evaporation Measure Instruments

Evaporation will be described as to become water from liquid to vapor. Evaporation measure tools can examine the two groups.

a) Instruments used to measure evaporation in the shadow (Piche evaporimeter).
b) Instruments used to measure evaporation in open water surface (Round evaporation pools which is shown in figure3.).

Fig 3. Evaporation Pool [7].

1.3.5 Rainfall Measure Instruments

As a result of the gravity of the water vapor in the atmosphere condenses, falling on the earth's surface and earth in various ways to a certain amount of water that is called rain events. Rainfall measure instruments can examine the two groups. As we can see figure 4.

a) **Pluviyometer:** The rainfall measuring device is directly from the atmosphere to the earth.
b) **Pluviyograf:** The device to note of rainfall measuring is directly from the atmosphere to the earth.

Fig 4. Pluviyograf and Pluviyometer [7].

1.3.6 Wind Measure Instruments

Wind is the movement of an air mass is displaced in the direction horizontal or near horizontal. Meteorological wind measurements are made with the following devices.

a) **Fixed Anemometer:** The device measures the speed and direction of the winds.
b) Anemometer of Hand: It is a portable measuring device to measure speed and direction of wind.(shown in figure5)
c) **Anemograph:** Mechanical anemograph, wind direction, average speed per hour and is an instrument that measures fluctuations in wind speed.

Fig 5. Anemometer - Anemometer of Hand [7].

1.3.7 Humidity Measure Instruments

Relative Humidity: The rate of air carried by the water vapor at any given temperature and it can carry the maximum water vapor at the same temperature.

- **Psychometric measures:**
  Simple psychrometers,
  Artificial ventilated psychrometers.

- **Haired hygrometer and similar methods:**
  Relative humidity of air is called a hygrometer to directly indicate the correct device. A hair bundle, called haired hygrometer according to the relative humidity goes on and on shortening the air.

- **Hygrograph:**
  Hygrographs called the place where the relative humidity is constantly recording deviceand it is shown in figure6.

Fig 6. Psychometer - Hygrograph [7].

1.3.8 Temperature Measure Instruments

Temperature is property that describes the status of the heated material. Heat is an energy which from one to another, due to the temperature difference between the two systems. For meteorological purposes, the measurements of temperature are performed.

- **Normal Thermometers:** At any moment, the thermometer shows the temperature of the location.
- **Soil thermometers:** Soil temperature at various depths are measured in special shapes made with mercury thermometers.
- **Marine Thermometer:** The thermometer in the chamber this is as big as earth thermometers, late affected by temperature changes.
- **Max Thermometer:** It measures the maximum temperature of a day.
- **Minimum Thermometer:** It measures the minimum temperature of a day.
- **Thermography:** Temperature is called thermography instruments to record continuously on a diagram.(it is shown in figure7)

Fig 7. Thermography – Max-Min Thermometer [7].

1.4 Automated Observation Stations (Automatic stations)

Automated observation stations, sensitive to changes in meteorological parameters and consists of sensors that measure the amount of these changes as shown in figure8.[19]. Automatic stations, various meteorological parameters measured and calculated to make the process of converting the messages in certain formats. Furthermore, the information are stored in a specific format to be converted into graphics and stored in the printer. Thus, the continuous of meteorological parameters and is provided to obtain the most accurate way. Automatic monitoring station consists of six units [4].

- Sensors and sensor interfaces,
- Data collection unit,
- The central control and processing unit,
- The imaging unit,
- Communication interfaces,
- Power supplies,

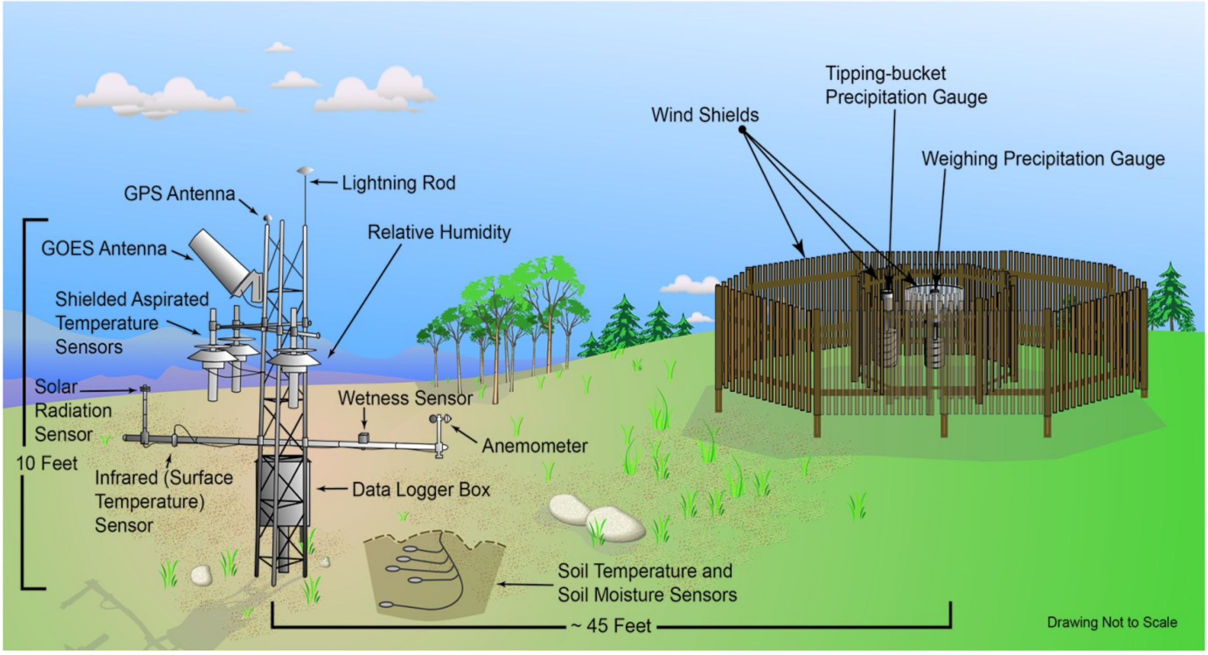

Fig 8. General Parts of an Automated Observation Stations [19].

1.4.1 Advantages of Automated Observing Systems

- Brings a standard to the observations,
- Parameters measured continuously day and night,
- More accuracy,
- More reliability,
- Display of meteorological data,
- Local and remote access to data archives,
- Affected by environmental conditions,

1.4.2 Elements of Automatic Observing Systems

The basic elements of Automated Observing Systems as shown in figure9.

a) Wind Speed and Direction Sensors:

Wind speed sensor is used to measure the wind speed at ten meters high at the top of the pole. Wind speed sensor works with optoelectronic principle and it has three handcuffed. Optical counter in the sensor measures the number of revolutions of the shaft per unit of time. Wind direction sensor is mounted on the part marked to show the north.It is shown in figure9.

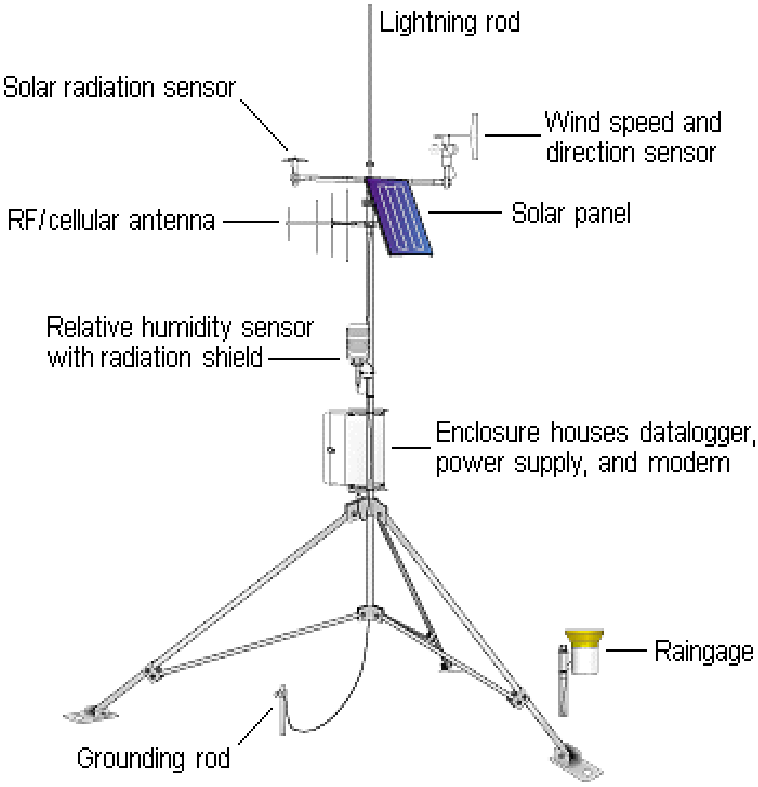

Fig 9. Parts of an Automated System [4].

- **Wind Speed Sensor:**
  Ladle is connected to a disk with a shaft. When disk rotates, photodiodes or magnetic switch pulse (pulse) is produced. The generated blow is by counting wind speed was measured.

- **Wind Direction Sensor:**
  Wind direction is measured with the help of the tail. In the initial position, the tail is exactly north (0 °). The tail turns with the wind. Since the beginning position of the tail's direction by determining the angular position. Used in the determination of angular position, there are three common methods:
  - ✓ Potentiometer Method
  - ✓ Magnetic Switch Method
  - ✓ Photo Diode Method

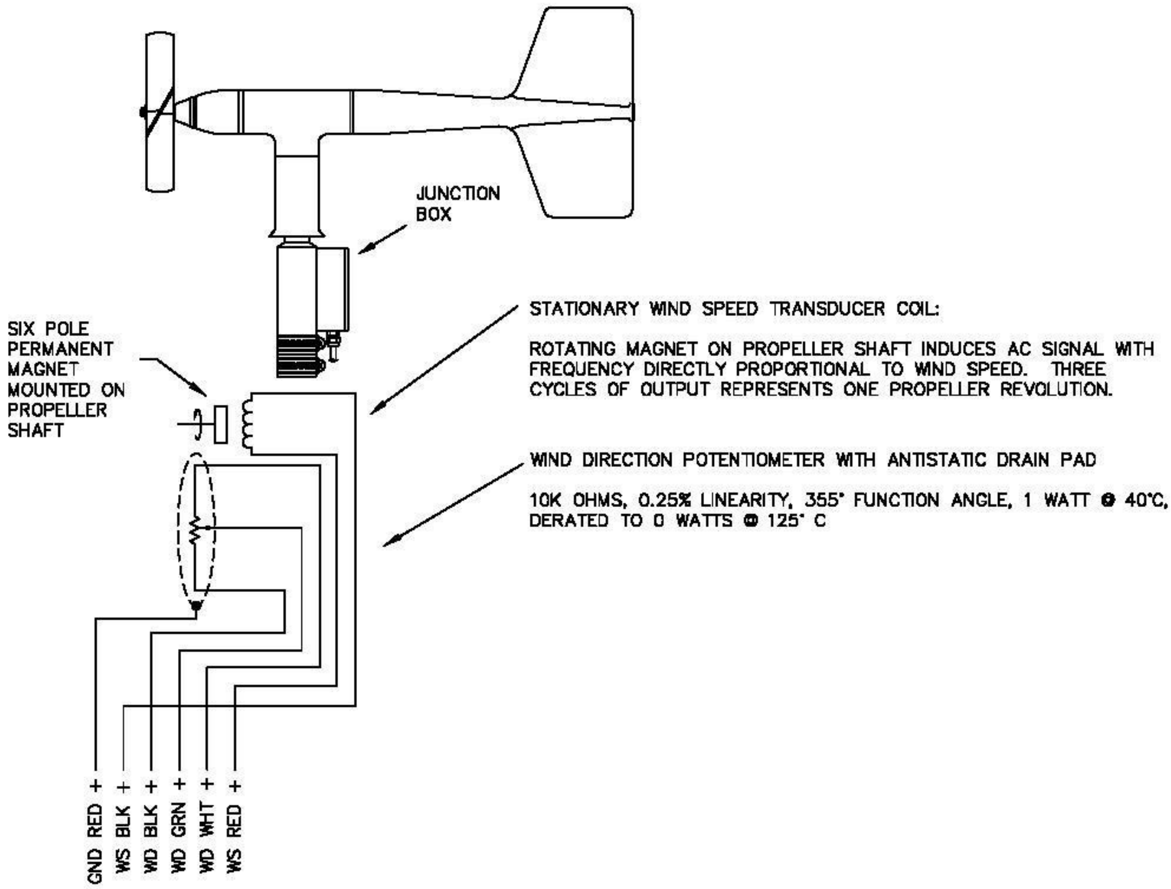

Fig 10.Parts of Wind Speed and Direction Sensors [4].

b) Temperature and Humidity Sensor:

Air temperature and humidity sensors were placed into radiation shield for exposure to direct sunlight.as shown in figure 11.This trench 2 meters in height is mounted on poles.

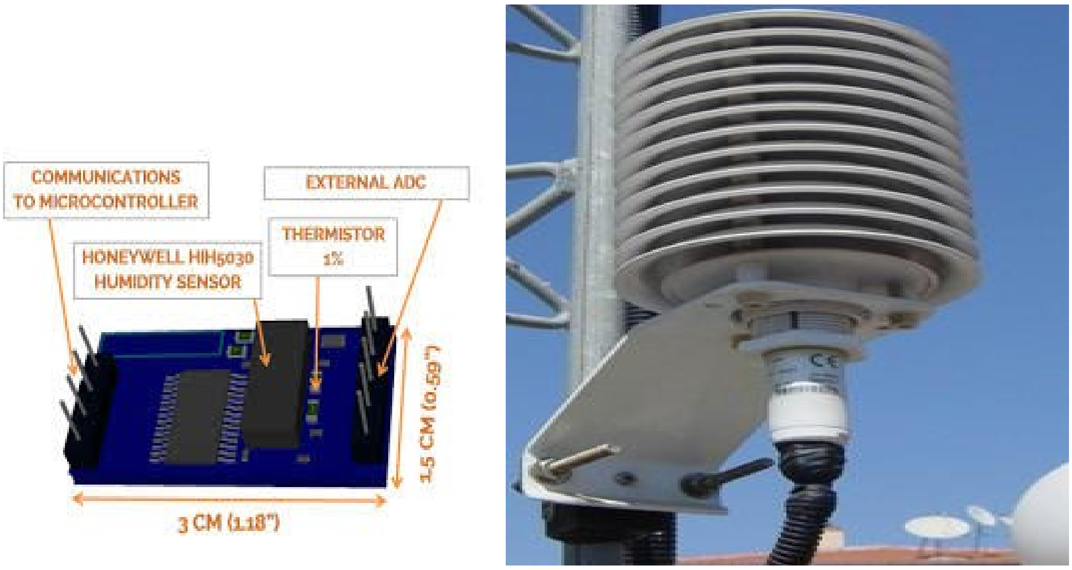

Fig 11. Temperature and Humidity Sensor [4].

- **Temperature Sensor:**
  - ✓ Air temperature near the earth's surface,
  - ✓ High temperature,
  - ✓ Soil temperature,
  - ✓ The minimum temperature over land
  - ✓ Front fender temperature,
  - ✓ Sea water temperature.

- **Humidity Sensor:**
  - ✓ The relative humidity of the air,
  - ✓ Front fender relative humidity,
  - ✓ Soil moisture,

c) Rain Gauge:

Rain sensor is 1 meter in height from the ground to the observation park. Weighbridges and the type of the heater. It works to 0.2 mm precision as shown in figure12.

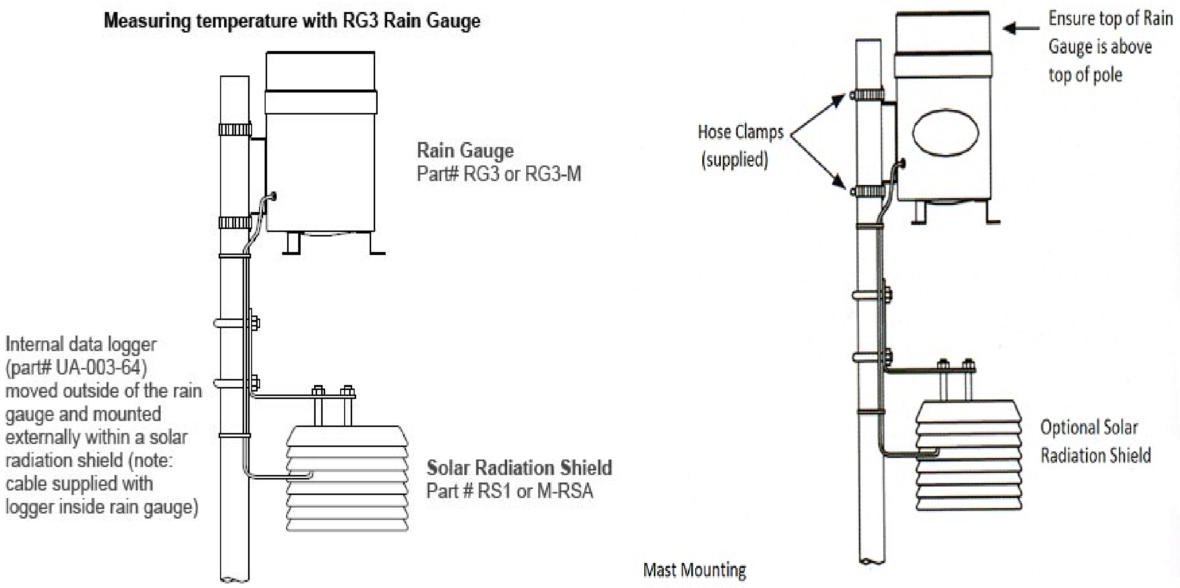

Fig 12.Rain Gauge [4].

d) **Pressure Sensor:**

The pressure sensor measures the actual pressure. Also, temperature and gravity correction will not be made. It has two different type of sensor which are Silicone Pressure Sensor and Aneroid Pressure Sensor.

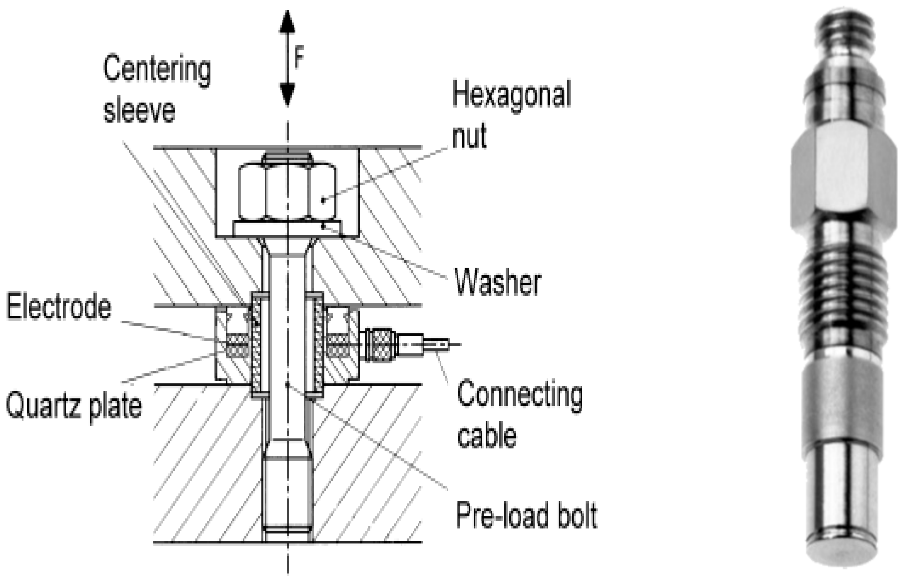

Fig 13. Pressure Sensor [4].

1.5 Objective of the Project

In this Project, mobile weather data collecting laboratory will be designed and constructed. In other words, an automatic weather station will be created. This is an automated type of traditional weather station, either to enable measurements from remote areas or to save human labor. Our system will report as the storage of the information in local data storage such as flash memory for retrieval at a later storage. The automated weather station that will be made has sensors to measure some variables. Thermometer for measuring temperature, anemometer for measuring wind speed, hygrometer for measuring humidity (temperature and humidity will be measured in one sensor), barometer for measuring pressure.

Data acquisition starts with suitable sensor. A sensor is needed for converting physical quantities that are wanted to measure, to electronic signal. These sensors generate voltage that is related with what applied. For this generating, sensors must be fed by electrical source. But also there are kind of passive sensors that do not need any electricity for generating electrical signal. Sensors can be manufactured from some special metals, alloys or materials in simply way or these materials can be together in a mechanism. Sensors should change an electrical parameter and electronic systems sense this changes. Electronic systems that are responsible for measuring or sensing, named as Data Acquisition System/ Data Logger.

In case battery run down to sustain the functioning of the system we also want to add a solar panel system [12].

CHAPTER 2-LİTERATURE REVIEW/BACKGROUND INFORMATION

2.1 History of Meteorology and Data Collecting:

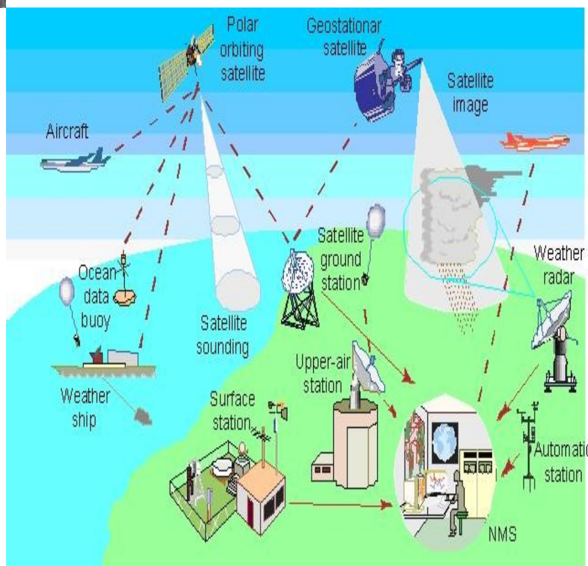

Fig 14. History of Meteorology and Data Collecting [3].

The word 'meteorology' was coined from a research book called 'Meteorologica' which was written by Aristotle, a Greek scientist and philosopher. This early work described the science of earth like its geology, elements, hydrology, seas, wind and weather. In the modern term, the term meteorology explains a complete science. It is for understanding the dynamics of atmosphere and forecasting weather phenomena like hurricanes and thunderstorms. Scientists across the world since ancient times have tried to understand the meteorological phenomena like wind and rain. Many instruments for measuring wind power, humidity and rain were invented in the early 15th century. There are also other methods which have been evolved. Meteorology is a lot related with cycles and their analysis which was what Fernando II de

Medici wanted to prove. He carried out a very determined program in 1654 for recording weather patterns in different European cities with a view to compile data and making their analysis. Other breakthroughs were followed in the 18th century and science was taken to a new level. A modern mercury based thermometer was invented by Gabriel Fahrenheit. Theories about hydrodynamics were devised by Daniel Bernoulli and those theories had helped greatly in understanding the atmospheric changes. When the theory of thermodynamics and atmospheric pressures were adapted, no real changes were important for understanding meteorology. In recent times, focus has been given on meteorological tools for its improvement and attaining better accuracy results. A tremendous boost was given to meteorology because of the technology in two ways. The first is the ability to communicate results and analysis with timing, it was made possible due to the invention of telegraph. The second is the ability of probing skies with using balloons, satellites and radars. Meteorology is a part of our everyday lives. People are kept updated about the changing weather with dedicated channels and mobile devices. The science is still progressing and is an important element of the economy with many industries like agriculture and civil aviation depending on it. Meteorology is a part of our everyday lives. People are kept updated about the changing weather with dedicated channels and mobile devices. The science is still progressing and is an important element of the economy with many industries like agriculture and civil aviation depending on it [3].

Before automated data acquisition systems that is electrical and computer connected became popular, tests were performed and test results were recorded. This process had done by an easy method that is used still. A test coordinator who is experienced about the test, has position for following the flow of testing. Different sensors are connected to the test specimen and they have analogue indications that can be read at some sensitivity. The test coordinator sits a test technician down for each sensor, makes the test and timekeeper start. On each sampling frequency that is determined for that test, the coordinator yells as “READ” or “SAMPLE”. Each sensor readers read the value and record it when they hear the test coordinator. Thus, they write a series of data for each sensor during the test. End of the test, they put together all records and computerized for excel or analyze these records on paper. Data collecting (shortly DAQ) defines that some physical and chemical quantities are detected as electrical, they are converted to numerical values as far as possible high precision, they are sampled and saved. The transfer is a processable data formatted that is opened with Mat lab or

Excel. Then we aim that arriving in certain consequences to apply simple or complicated analysis. Physical quantities of Data Collecting;

- Detect as electrical
- Convert to a numerical value
- Save in digital environment

Last three steps are indispensable 3 main steps of data acquisition. Reporting, online or wirelessly data transfer, detailed charting, calibration, showing with indicators, real-time analysis are other important processes.

2.2 Purpose of Data Collecting

The purpose of Data Collecting which can be automated collects data over a certain period of time and does not require any human intervention. Data logging stands for collection and recording of information. It can be can be manual, where you have to take each reading yourself or automated, where you get a computer or machine to take readings as often as you choose. Data logging normally makes use of sensors. These are devices that take measurements and feed the data back to the computer. Data logging devices are, Temperature sensors, Wind speed sensors, Wind direction sensors, Rainfall detectors, Light detectors, Humidity sensors, Automated Weather Station. There are two types which are Analogue and Digital [17].

a) Analogue :

- Which is continuously variable and do not jump in steps from value to value.
- Analogue need to be converted to digital values using an ADC.
- All quantities measured by the weather reporter.
- A rainfall meter measures rainfall in this system is analogue.
- Temp don’t jump from one degree straight to the next, there are many values in between.

b) Digital :

- That jump from one value to the next.
- It’s a discrete values.
- Can be fed directly into the processor.
- Most computers process only digital values.
- The sensors itself counts the number of buckets that are filled.
- Wind speed anemometer measures wind speed is digital value.

2.2.1 Advantages of data Logging

- Data Logging can be used in remote or dangerous situations.
- Data logging can be carried out 24 hours a day, 365 days of the year.
- Time intervals for collecting data can be very frequent and regular, for example, hundreds of measurements per second.
- It can be set up to start at a time in the future.
- No need to have a person present.
- Data logging is often more accurate because there is no likelihood of human error.
- Data logging devices can be sent to places that humans cannot easily get to.
- Graphs and tables of results can be produced automatically by the data logging software.

2.2.2 Disadvantages of data Logging

- If the data logging equipment breaks down or malfunctions, some data could be lost or not recorded.
- Equipment can be expensive for small tasks.
- The equipment will only take readings at the logging interval which has been set up.
- If something unexpected happens between recordings, the data will not be collected.

2.3 Using Materials in a Weather Station

Scientifically-based weather forecasting was not possible until meteorologists were able to collect data about current weather conditions from a relatively widespread system of observing stations and organize that data in a timely fashion. By the 1930s, these conditions had been met. Wilhelm and Jacob Bjerknes developed a weather station network in the 1920s that allowed for the collection of regional weather data as shown in figure15. The weather data collected by the network could be transmitted nearly instantaneously by use of the telegraph, invented in the 1830s by Samuel F. B. Morse. The age of scientific forecasting, also referred to as synoptic forecasting, was under way [2].

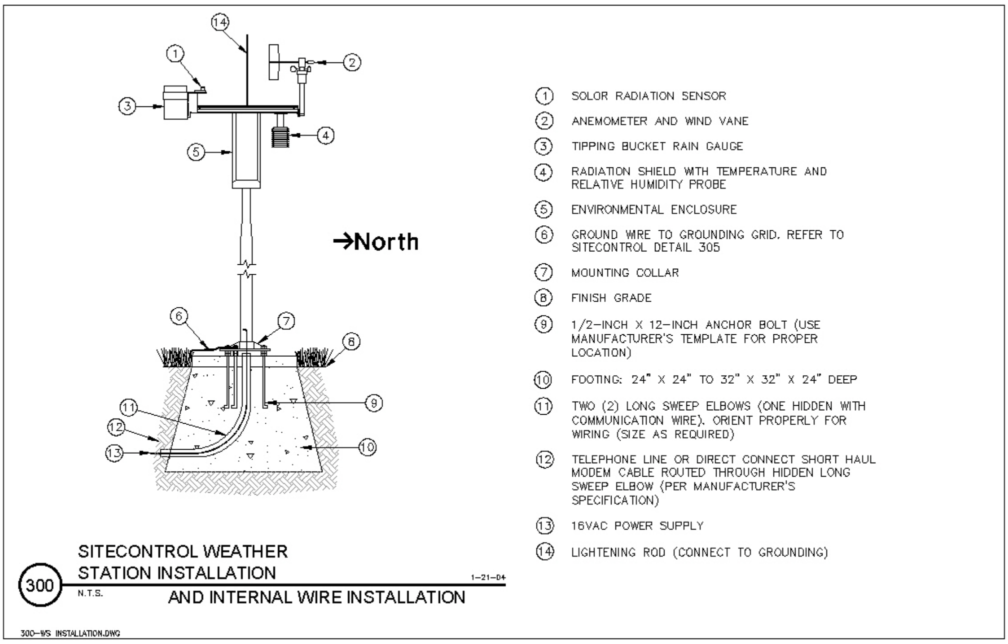

Fig 15. **Using Materials in a Weather Station** [2].

2.3.1 Solar Radiation Sensor

A solar radiation sensor or pyranometer is an instrument that measures total solar radiation (in watts per meter square) both direct and diffuse solar radiation. Determining the solar radiation and its interaction with the atmosphere and the earth's surface is important because atmospheric circulation is driven by solar radiation. Moreover solar radiation can be use to forecast weather and others.

2.3.2 Anemometer and Wind Vane

The speed of the wind strength and direction of the measuring instruments used are called anemometers. Wind sensing can bucket or pressure pipe.

2.3.3 Tipping Bucket Rain Gauge

The days of manually measuring precipitation with a bucket and ruler or with a strip chart weighing gauge are coming to an end. With the introduction of ASOS, came the need for an automated precipitation accumulation gauge, or, at least for the present, an automated rain-only gauge.

2.3.4 Radiation Shield with Temperature and Relative Humidity Probe

Fan aspirated shield draw air across a temperature sensor to improve the accuracy of the air temperature measurements, but these shields increase their systems' power requirements.

2.3.5 Environmental Enclosure

This system project is to protect our external factors.

2.3.6 Ground Wire

Ground Wire used to grounding grid.

2.3.7 Mounting Collar

Ground Wire used to grounding grid. Mounting Collar is a machinable flange collar that can be configured by the user to perform a wide range of applications such as a pulley, cam, or component mounting device. Featuring an integral clamp incorporating a double-split design and relief groove, this clamping flange collar retains its perpendicularity, will not mar expensive shafts, and is easy to adjust. A standard keyway, along with through holes and three tapped holes are incorporated into the design.

2.3.8 Finish Grade

Any surface which has been cut to or built to the elevation indicated for that point. Surface elevation of lawn, driveway or other improved surfaces after completion of grading operations.

2.3.9 Anchor Bolt

Anchor bolts used to manufacturer's template for proper location.

2.3.10 Footing

To make sound measurement system, the system must have good and solid footing.

2.4 Types of Weather Station

Over the years the instruments, number of parameters and the way the data is stored and transmitted has changed considerably. The figures below show the main types of stations used and some of the modifications. They show the stations as operated in accumulation areas. The sonic height ranger is placed on a separate tripod when the station is located in an ablation area. Most of the stations are equipped with Argos transmitters. The latest design is the iWS, a low power system that includes almost all instruments in a single housing.

2.4.1 Type I station

Oldest Weather Station type as shown in figure16, used on Greenland and Antarctica and equipped with Aanderaa sensors(Antarctica, 2003).

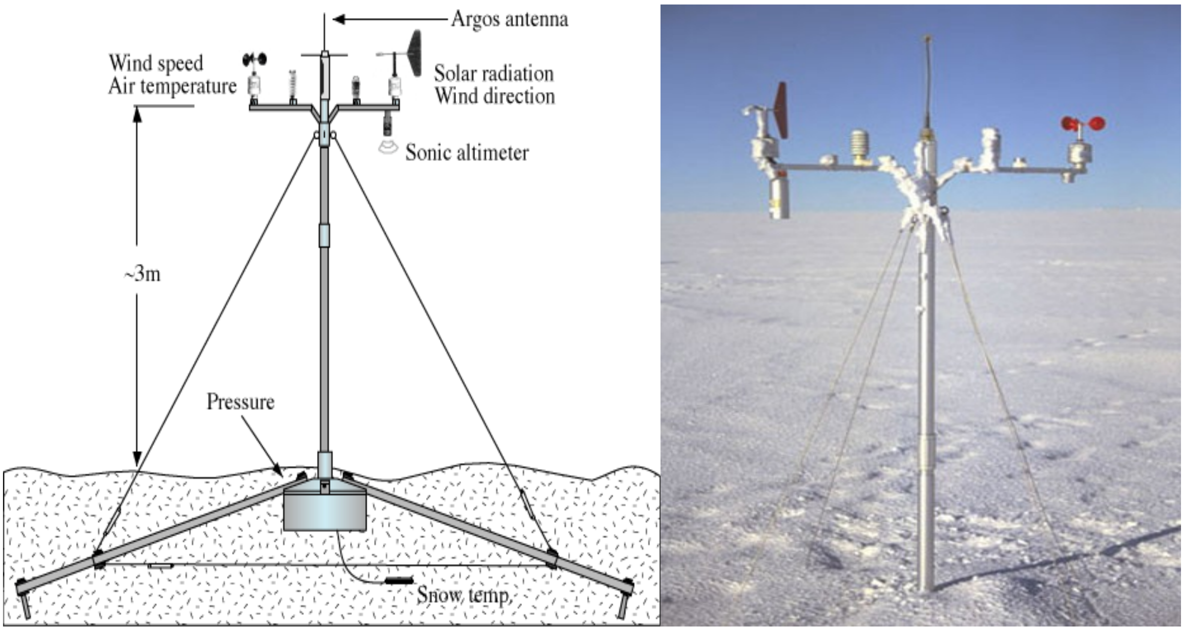

Fig 16. Type I station [3].

2.4.2 Type II station

Standard station for the period 1997-2014 as shown in figure17. Variations on this type include the addition of a second measurement level, a solar panel, a wind generator, extra sensors such as a thermocouple and a version suitable for extreme low temperatures (Antarctica, 2003).

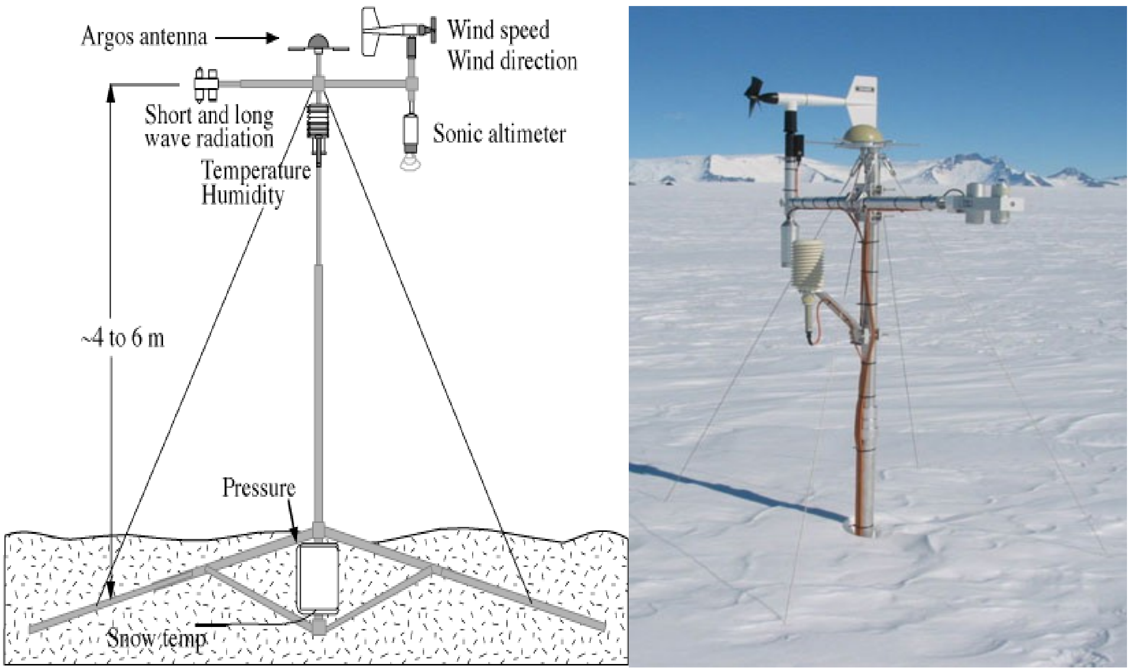

Fig 17. Type II station [3].

2.4.3 Type II with Extra Level and Solar Panel

Type II station but higher and with an extra wind speed and direction sensor as shown in figure18. Used in high accumulation areas (Hardangerjøkulen / Norway, 2005).

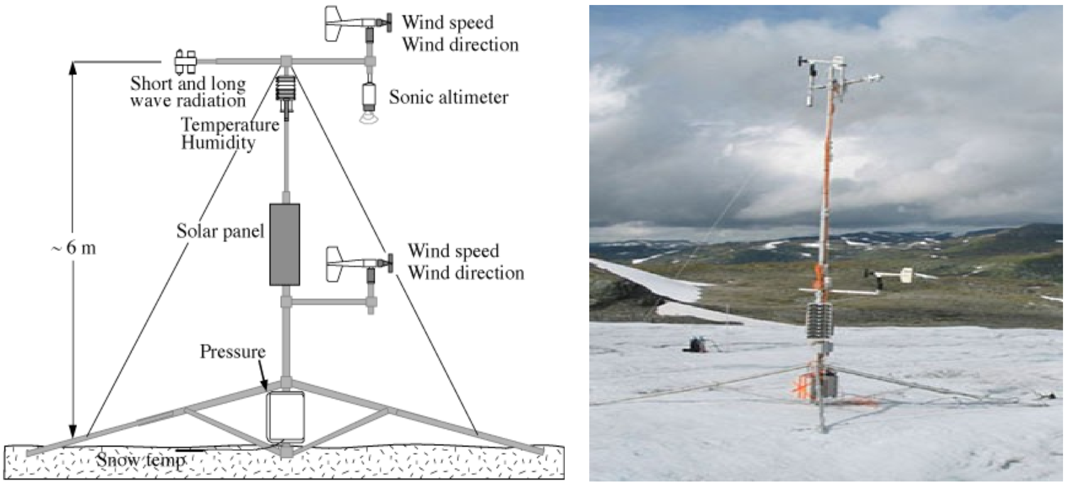

Fig 18. Type II with Extra Level and Solar Panel [3].

CHAPTER 3-DESIGN AND ANALYSIS

3.1 Selecting Appropriate Mechanical Components

Weather data is scientific data and, if you're serious about wanting to collect weather data of good quality, then weather data collecting laboratory and procedures need to conform to the principles of making good scientific measurements. This isn't necessarily difficult, but does mean that you should not just accept the readings of a new weather station at face value.

There are perhaps two guiding principles for collecting good data: firstly, ensuring that the quality of your readings is as good as possible, mainly by sitting your weather sensors with due care; secondly, by being aware of the limitations of your data. Generally this system is fixed to a region or transported on a vehicle. In order to quality materials are used to avoid damage and to make reliable measurements. This situation shows that the system used in fairly thick, big and large equipment. Our project to be portable we chose the same durability and lighter materials. We chose light metal because of that material is strong and flexible and also we used small light metals with screws to assemble and make the base system strong. Especially, the important thing is in the project that swinging of project's mast because of wind speed. If the system does not remain constant, the wind sensor cannot measure as a precisely.

3.2 Robust, Durable Weather Stations for Recording Diverse Meteorological Data

Our Weather Station is made for measuring most basic meteorological parameters. Designed and built for the long-term use under extreme weather conditions without any infrastructure. The Weather Stations can be equipped with diverse sensors according to our requirements [10].

- Air temperature [°C]
- Humidity [% RH]
- Wind speed [m/s] and peak [m/s]
- Air pressure [Pa]

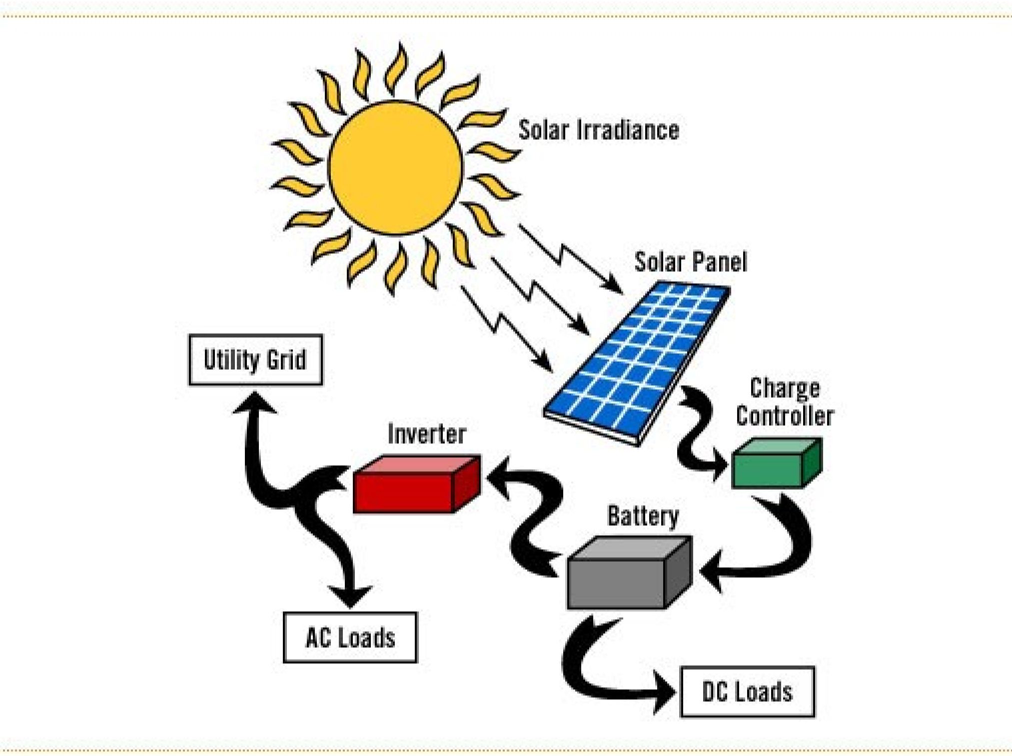

Fig 19. Solar panel system parts [4].

In our weather station we want to use solar panel to produce electricity for nonstop measuring. 12v battery will be used. Solar panel will be connected to a solar panel charge regulator as shown in figure 19 but inverter will not be used. Then we will obtain dc current for measuring.

For our process;

1. Card starts to work.
2. Program checks all sensors.
3. If there is no problem, start to collect data.
4. It records to sd card.
5. 3 and 4. Steps will be loop for desired time invertal.

3.3 Sensor Sitting

Weather data of high precision and accuracy can only be collected if the sensors for the various weather variables are sited and installed with care. Mounting the sensors of a new Weather Station simply at the most convenient location at your observing site will almost certainly lead to significant errors in the data. The sensor locations really do need to be chosen with due scientific consideration for best results. This important topic is covered in detail in its own section.

3.3.1 Anemometer

The anemometer (for measuring wind speed) needs to be mounted high in the air to catch the maximum wind speeds. Typically, for professional measuring, it should be mounted on a pole and projecting 3-4 m above the apex of a roof for best results but in our project this weather system will not use for professional measuring so the anemometer is mounted on a nearly 2 meter pole.

3.3.2 Temperature

Air temperature can vary with height above the ground under certain weather conditions and therefore a standard height for measuring air temperature has been set at 4 feet above the ground. The sensor must also be protected from both direct sunlight and rainfall. The sensor should also be positioned away from any nearby potential sources of heat such as buildings and brick walls. The air temperature sensor should be mounted in an open space to allow good air circulation and over natural ground (i.e. not concrete or asphalt).In this system, protective radiation shield is not available, so the temperature sensor must be mounted in the shade for accurate results.

3.3.3 Humidity

The humidity sensor is usually mounted alongside the temperature sensor in most commercial Weather Station systems and does not therefore have its own independent siting criteria. Where a separate sensor is used, the same guidelines as for temperature sensor siting are recommended. Humidity is not measurable to high accuracy (typically ± 3-5%) by standard electronic sensors and may not always quite reach 100% as a maximum reading because of sensor limitations.

3.3.4 Barometric Pressure

Since barometric pressure does not vary across a local area at uniform altitude, pressure is generally measured as shown in figure 20 by a sensor inside the weather station console and not by an external sensor. Consequently, there are no major concerns about siting the pressure sensor, other than to be aware that its accuracy is only specified over a limited temperature range. Note that pressure reduces by about 1mb for every additional 32 feet of elevation and it is therefore essential to know the altitude accurately of the weather laboratory base location. Pressure is also relatively easy to check and to calibrate [14].

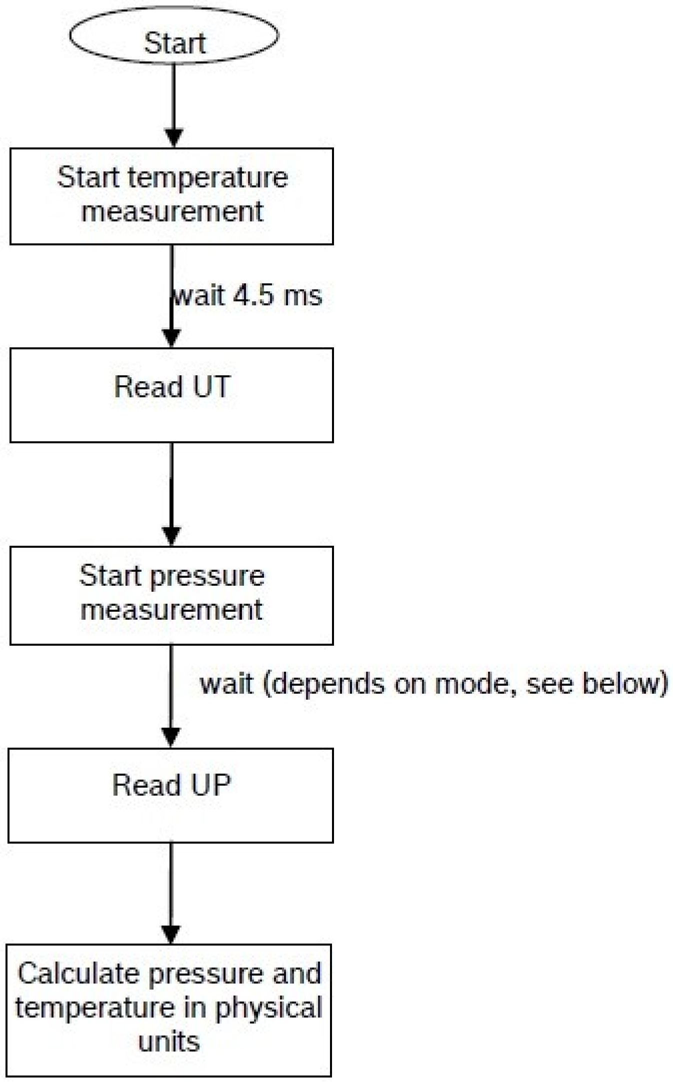

Figure 20. Air pressure sensor measuring chart [14].

3.4 Cost Analysis of Project

Other material costs will be added. The materials calculated and then choosen from different cites. We don’t have more calculation but some special part like Battery voltage, sensors and panel.

TABLE1. Cost Table

Parts	Cost
Temperature and Humidity Sensor	12.74 TL
Wind Speed Sensor	170 TL
Pressure Sensor	13.99 TL
Solar Panel	38.99 TL
Breadboard	8.43 TL
12V 12ah Battery	It is used from workshop
SD Card Module	5.85 TL
Solar Panel Charge Regulator	55 TL
Arduino UNO R3	69.77 TL
Circuit materials	35 TL
Spray paint	8 TL
Clock modeule	20 TL
Main structure	It is used from workshop
TOTAL COST	**437,77 TL**

3.5 Design Calculations

3.5.1 Pressure calculation

Patm = ρgh …………………………..(Equation 1)

where ρ is the density of mercury, g is the gravitational acceleration, and h is the height of the mercury column above the free surface area.

In thermodynamic calculations, a commonly used pressure unit is the "standard atmosphere". This is the pressure resulting from a column of mercury of 760 mm in height at 0 °C. For the density of mercury, use ρHg = 13,595 kg/ m^3 and for gravitational acceleration use g = 9.807 m/ s^2

If water were used (instead of mercury) to meet the standard atmospheric pressure, a water column of roughly 10.3 m (33.8 ft) would be needed.

Standard atmospheric pressure as a function of elevation:

Note: 1 torr = 133.3 Pa = 0.03937 In Hg

TABLE 2. Atmospheric pressure related altitude [14].

P_{atm}	Altitude		P_{atm}	Altitude
101.325 kPa	Sea Level (0m)		29.92 In Hg	Sea Level (0 ft)
97.71 kPa	305 m		28.86 In Hg	**1,000 ft**
94.21 kPa	610 m		27.82 In Hg	**2,000 ft**
89.88 kPa	**1,000 m**		26.55 In Hg	3,281 ft
84.31 kPa	1,524 m		24.90 In Hg	**5,000 ft**
79.50 kPa	**2,000 m**		23.48 In Hg	6,562 ft
69.68 kPa	3,048 m		20.58 In Hg	**10,000 ft**
54.05 kPa	**5,000 m**		15.96 In Hg	16,404 ft
46.56 kPa	6,096 m		13.75 In Hg	**20,000 ft**
37.65 kPa	7,620 m		11.12 In Hg	25,000 ft
26.44 kPa	**10,000 m**		7.81 In Hg	32,808 ft
11.65 kPa	15,240 m		3.44 In Hg	**50,000 ft**
5.53 kPa	**20,000 m**		1.63 In Hg	65,617 ft

3.5.2 Humidity Calculation

Absolute humidity is defined as the ratio of the mass of water vapor contained per volume of moist air. Relative humidity, technically, is the ratio between the partial pressure of water in the air and the maximum possible vapor pressure of water at a particular temperature.

Relative Humidity (%) RH;

The relative Humidity is the ratio of water vapor pressure (Pw) and saturation vapor pressure (Pwa) at the present temperature (Pwa(t))

Relative humidity formula;

RH= Pw / Pws(t) ………………………………………..(Equation 2)

%RH = 100 * (Pw / Pws(t))

Humidity formula related temperature and pressure:

$$Phumid\,air = \frac{Pd}{Rd\,.\,T} + \frac{Pv}{Rv\,.\,T}$$ ……………………………(Equation 3)

Where;

Phumid air = Density of humid air (kg/ m^3)

Pd = Partial pressure of dry air (Pa)

Rd = Specific gas constant for dry air, 287.05 J/ (Kg.K)

T = Temperature (ºK)

Pv= Partial pressure of water vapour (Pa)

Rv= Specific gas constant for water vapour, 461.495 J/ (Kg.K) v_z

3.5.2 Wind Speed Calculation

Wind speed changes according to altitude as well, increasing where temperature increases. However, it does it not linearly but according the power law wind speed function:

$$v\,z = vg\left(\frac{z}{zg}\right)^{1/a}, 0 < z < zg$$

Where vz=speed of the wind at height z, Vg= gradient wind at gradient height zg, α=exponential coefficient

This is due to greater boundary friction with the earth which diminishes gradually as altitude increases. At elevations close to the earth, such as the levels that wind turbines operate at, a modified formula is used which includes an exponent which varies depending on the type of surface, the Hellman exponent.

$$v\,w(h) = v\,10.\left(\frac{h}{h10}\right)^{a}$$

Where vw(h)= velocity of the wind at height h, V10= velocity of the wind at height h10=10 meters, α= hellman exponent

3.5.4 Battery Calculation

In this project Arduino and anemometer require electricity. For nonstop measuring, system needs a battery. DC input is between 7 – 24 v for anemometer. For Arduino it is about 7-12 Dc v but its limitations are 6-20V. Because of this technical conditions, 12v 10 W battery was chosen for this project.

Power = voltage x current (P = U x I) where power unit =Watt W , voltage unit =Volt V (U) , current unit = Amper I

For arduino, P=12V x 40 mA =0,48 W

P=0,48 x 24=11,52 Wh is our total AC power

For weekly battery capacitance (AC_t x 1,2 + DC_t) / Battery Voltage = AH / Week

(11,52 x 1,2)/12V =1,15 AH/weekly

Battery size in Ah is multiplied by battery voltage then power available in watt hours is obtained

X (Battery size in AH) x Y (Battery Voltage) = Z (Power available in watt hours)

Here is the formula of Charging Time of a Lead acid battery.

Charging Time of battery ="Battery Ah" /"Charging Current" = (T =" Ah" /"A")

3.5.5 Solar Panel Calculation

In this project, polycyristal solar panel was chosen because it is cheaper than monocyristal solar panel and also polycyristal is enough for our system. For our system,12V solar panel was chosen because the battery of the system was chosen as 12 volt and solar panel voltage at maximum power should be around 5 or 6 volt bigger than battery voltage.In this situation 12v solar panel is available for our design.

In Cyprus yearly hours of sunshine is 12 hours in summer and 5 hour in winter. We want to use this system along yaerly and average hours of sunshine is 8,5 hour. Our solar panel produces 0,718 mA current. In 8,5 hours it produces 8,5 x 0,718 = 6,1 Ah current.

3.5.5.1 Solar Panel Electricity Calculation

The global formula to estimate the electricity generated in output of a photovoltaic system is [14];

$$E = A * r * H * PR \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Equation 4)}$$

Where;

E = Energy (kWh)

A = Total solar panel Area (m^2)

r = solar panel yield (%)

H = Annual average solar radiation on tilted panels (shadings not included)

PR = Performance ratio, coefficient for losses (range between 0.5 and 0.9, default value = 0.75)

r is the yield of the solar panel given by the ratio : electrical power (in kWp) of one solar panel divided by the area of one panel

Be aware that this nominal ratio is given for standard test conditions (STC) : radiation=1000 W/m^2, cell temperature=25 °C, Wind speed=1 m/s, AM=1.5 The unit of the nominal power of the photovoltaic panel in these conditions is called "Watt-peak" (Wp or kWp=1000 Wp or MWp=1000000 Wp).

H Betwenn 200 kWh/m^2.y (Norway) and 2600 kWh/m^2.y (Saudi Arabia). You can find this global radiation value here : solar radiation data

You have to find the global annual irradiation incident on your PV panels with your specific inclination (slope, tilt) and orientation (azimut).

PR : PR (Performance Ratio) is a very important value to evaluate the quality of a photovoltaic installation because it gives the performance of the installation independently of the orientation, inclination of the panel. It includes all losses.

3.5.5.2 Solar Panel Angle Settings

While a solar panel system is constructed, panel stand should be set the way that it receives sunlight as much as 90 degree. If the system will be used in both winter and summer, panel stand angle should be same with latitude angle of the place where system will be constructed in. If it will be used in just summer, stand angle should be 15 degree less than latitude angle because of vertical sunlight in summer. In winter, it should be opposite , panel stand angle should be 15 degree more than latitude angle because of horizontal sunlight in winter.

In this project, panel should be set 35 degree because latitude angle of Famagusta is 35 degree. But in winter angle should be 50 degree and in summer, angle should be 20 degree.

For yearly optimum efficiency S = Latitude angle x 0,9

For winter about 7 month S = Latitude angle + 15^o

For coldest 3 month in winter S = Latitude angle + 25^o

For summer S = Latitude angle – 25^o

where S is optimum slope angle.

3.5.5.3 Solar Panel Efficiency

For measuring the efficiency ratio of solar modele, this formula will be applied:

$$efficiency\ ratio = \frac{Maximum\ output\ power\ of\ module\ (W)\ x\ 100}{Module\ area\ (m^2)\ x\ 1000\ W/m^2} \quad \text{.........(Equation 5)}$$

$$efficiency\ ratio\ of\ our\ system = \frac{10\ (W)\ x\ 100}{3{,}1\ x\ 3{,}6\ (m^2)\ x\ 1000\ W/m^2} = 0{,}089$$

3.5.6 Charge Regulator Calculation

In this project , it needs a charge regulator circuit. Because of conditions, charge regulator was bought. The battery of the system is 12 volt we have only 1 solar panel so 12v charge regulator should be chosen. From solar panel 0,718 mA current comes. Thus 5 A charge regulator is enough for this system. Charge regulator is also organizes charge controlling.

Electrical parameters	LS0512R
Nominal system voltage	12 VDC
Max. battery voltage	16V
Rated battery current	5A
Charge circuit voltage drop	≤0.26V
Decharge circuit voltage drop	≤0.15V
Own consumption	≤6mA

Environmental parameters		Mechanical parameters	
Working temp.	-35℃ - +55℃	Sizes	97x66x25mm
Storage temp.	-35℃ - +80℃	Montage holes	86x44mm
Humidity	10%-90% NC	Terminal	2.5mm²
Protection	IP30	Net weight	0.05kg

Figure 21. Regulator details

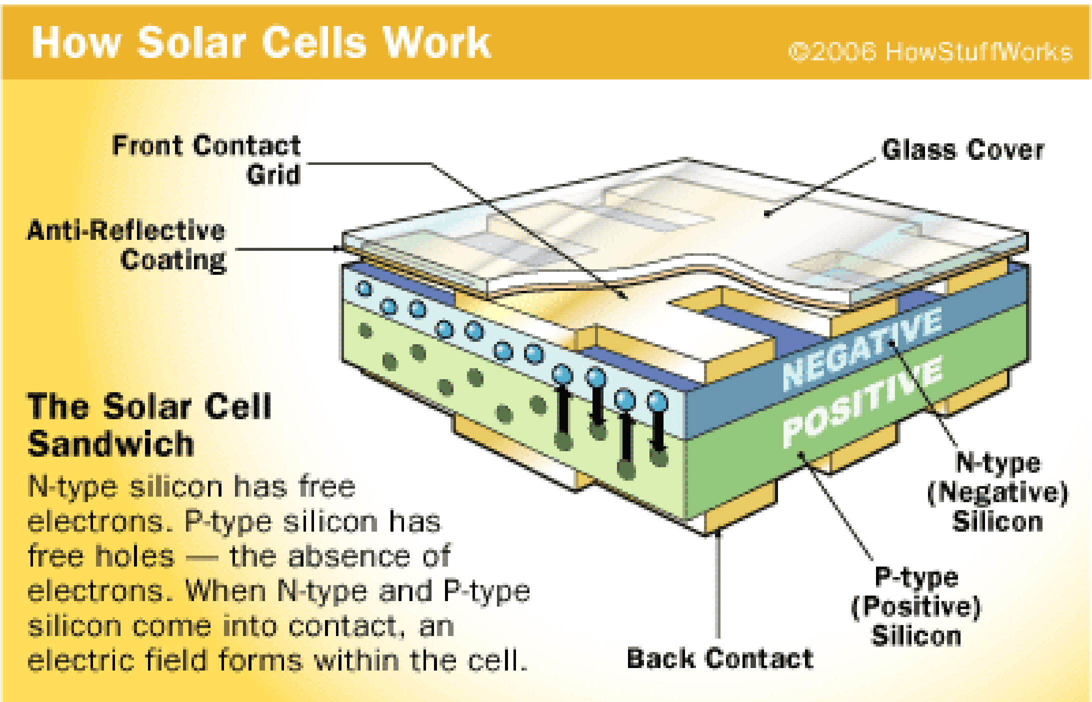

Figure 22. How solar cells works [5].

CHAPTER 4-MANUFACTURING,ASSEMBLY AND TESTING

4.1 Anemometer

Anemometer is used for measuring wind speed and properties of our anemometer is given below.

4.1.1 Dimensions

- Height (from bottom to center): 105mm / 4.1"
- Distance from center to wing: 102mm / 4"
- Arm length: 70mm / 2.8"
- Weight: 111.8g

4.1.2 Properties

- Output: 0.4V to 2V
- Test range: 0.5m/s to 50m/s
- Measured minimum wind speed: 0.2 m/s
- Resolution: 0.1m/s
- Accuracy: In worst situation 1 m/s
- Max Wind speed: 70m/s
- Connector details: Pin 1 - Power (brown), Pin 2 - Sachet (black), Pin 3 - Signal (blue), Pin 4 free
- Anemometer is used for measuring wind speed.

4.1.3 Usage

Brown cables for 7-24V DC input. Blue cable is for analog voltage output.

Output voltage is between 0.4 v (0 m/s) and 2.0 v (32.4 m/s).

4.2 Arduino UNO R3

The Arduino UNO R3 is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable (not included) or power it with an AC-to-DC adapter or battery to get started. Arduino UNO differs from all preceding boards because it does not use the FTDI USB-to-serial driver chip [9].

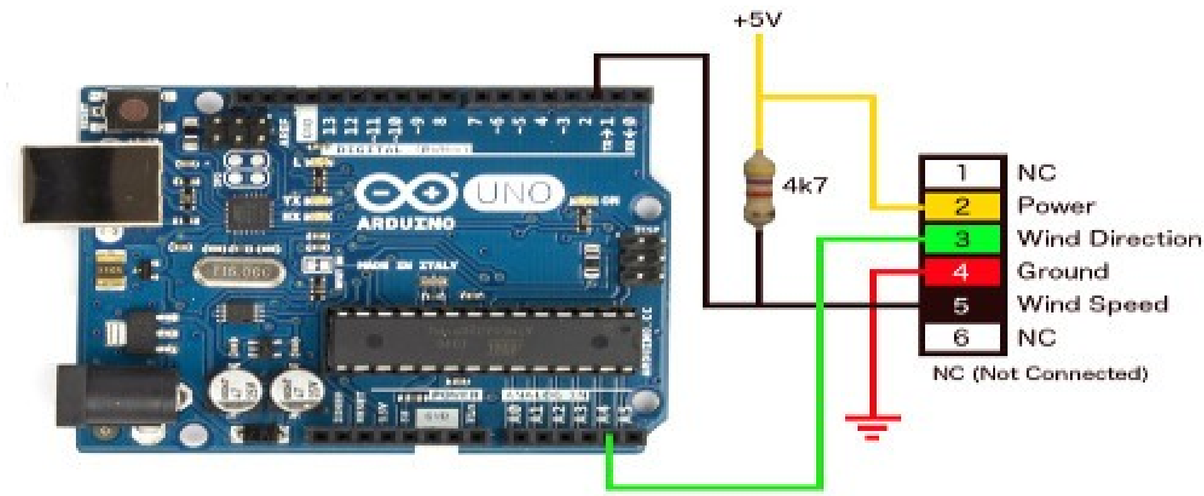

Figure 25. ARDUINO UNO R3 [9].

4.3 DHT11

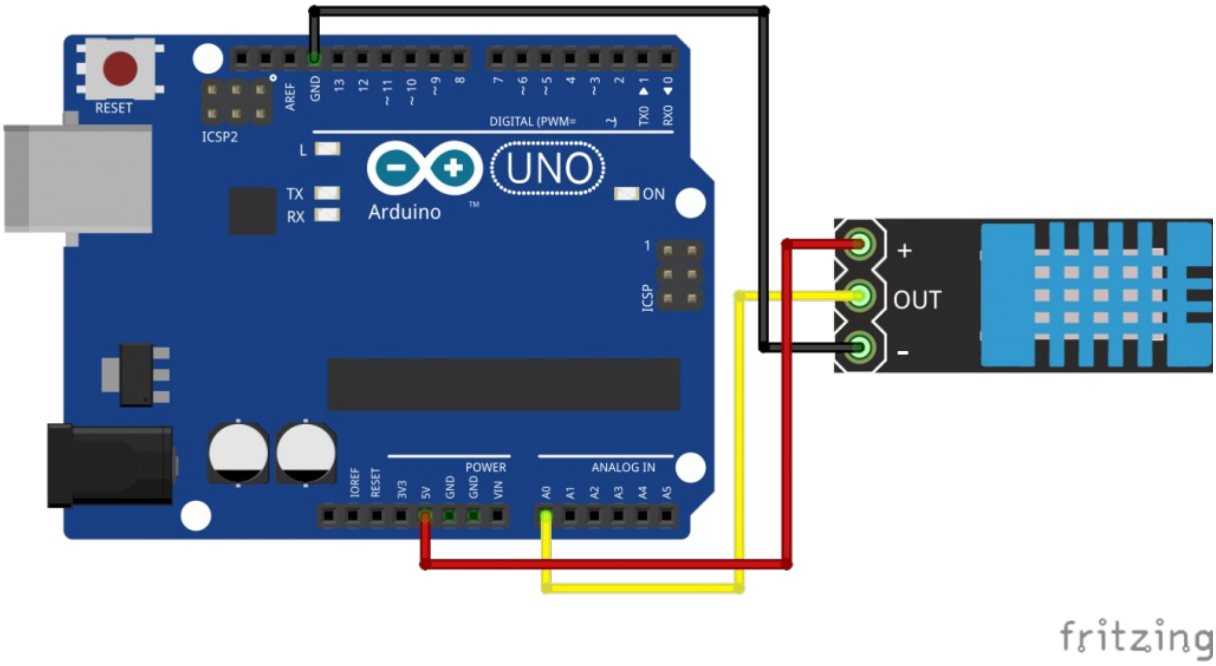

Figure 26. Connection of DHT11 Tmperature sensor [9].

Can detect surrounding environment of the humidity and temperature

DHT11 sensor adopts

Humidity measurement range: 20%-95%, humidity measurement error: +-5%

Temperature measurement range: 0 -50 ?, measurement error: +-2 degrees

Working voltage 3.3 V-5 V

Output form digital output

Has fixed bolt hole and easy installation

PCB size: 3.1 cm * 1.4 cm

4.4 BMP 180

This sensor is used for measuring barometric pressure and its connection is shown in figure27.

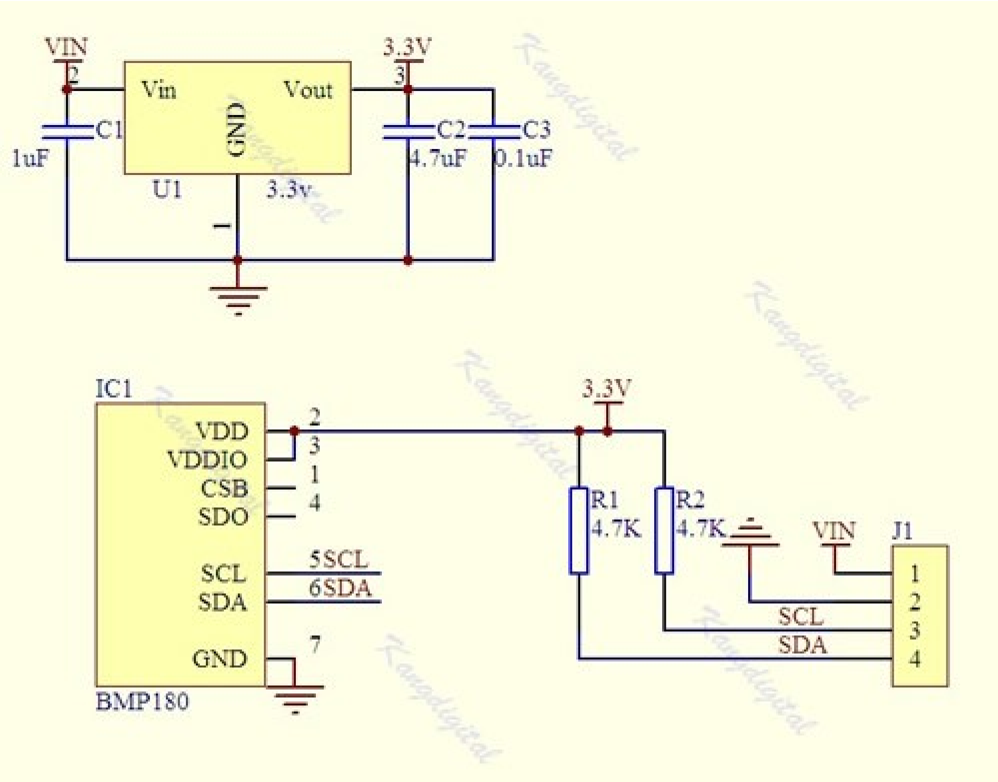

Figure 27. Connection of BMP180 pressure sensor [9].

4.4.1 Description

- Size: 21mm x 18mm
- 1.8V to 3.6V Supply Voltage
- Max I2C Speed: 3.5Mhz
- Low power consumption - 0.5uA at 1Hz
  I2C interface
- Very low noise - up to 0.02 kPa (17cm)
- Full calibrated

Pressure Range: 300 kPa to 1100 kPa (+9000m to -500m)

4.5 SD Card Module

The Arduino SD Card Shield as shown in figure 28 is a simple solution for transferring data to and from a standard SD card. The pinout is directly compatible with Arduino, but can also be used with other microcontrollers. It allows you to add mass storage and data logging to our project.

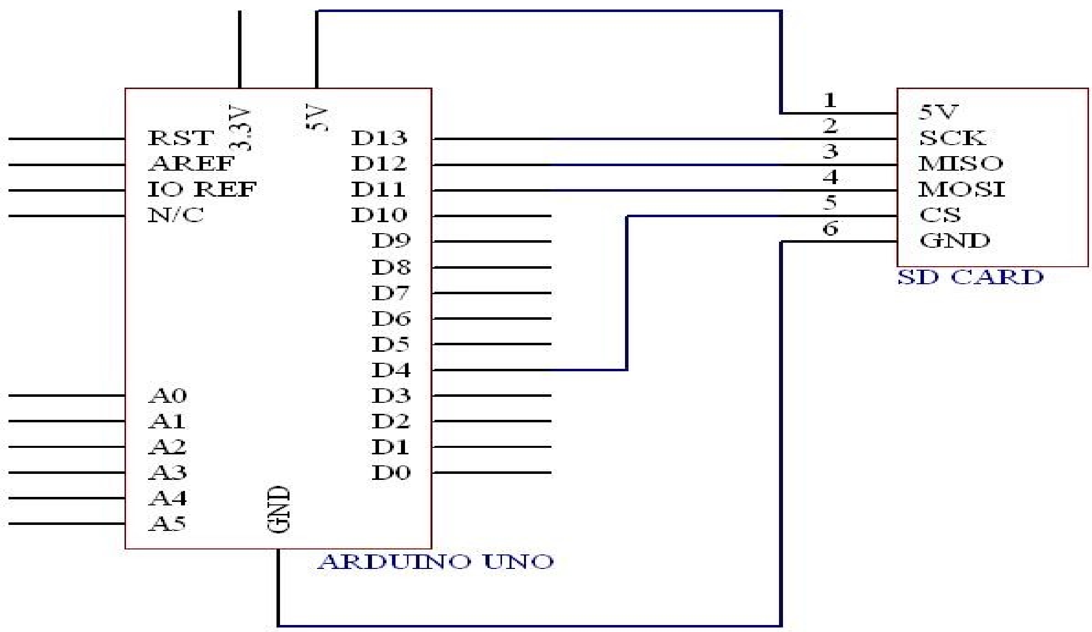

Figure 28. SD CARD MODULE [9].

4.6 Clock Chip

This device is used for setting time interval in arduino.and its connection is shown below:

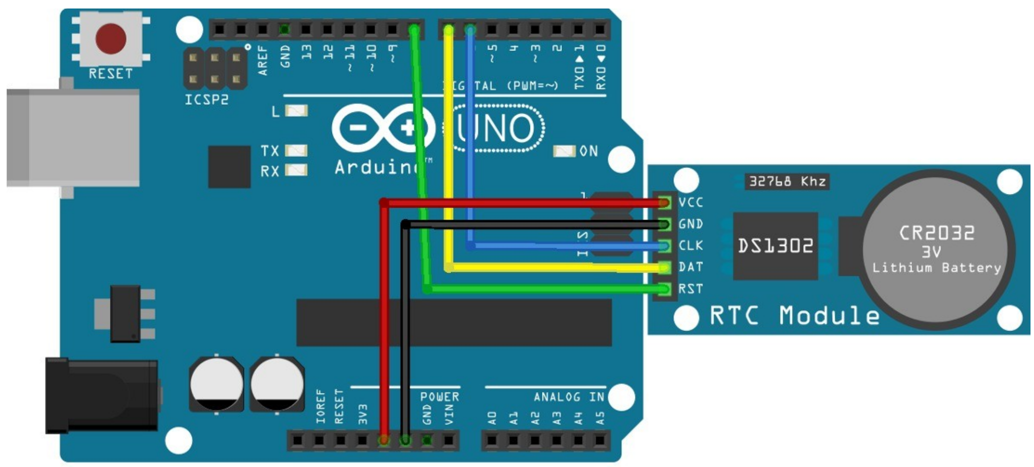

Figure 29. Clock Chip

Figure 30. General View of the main structer

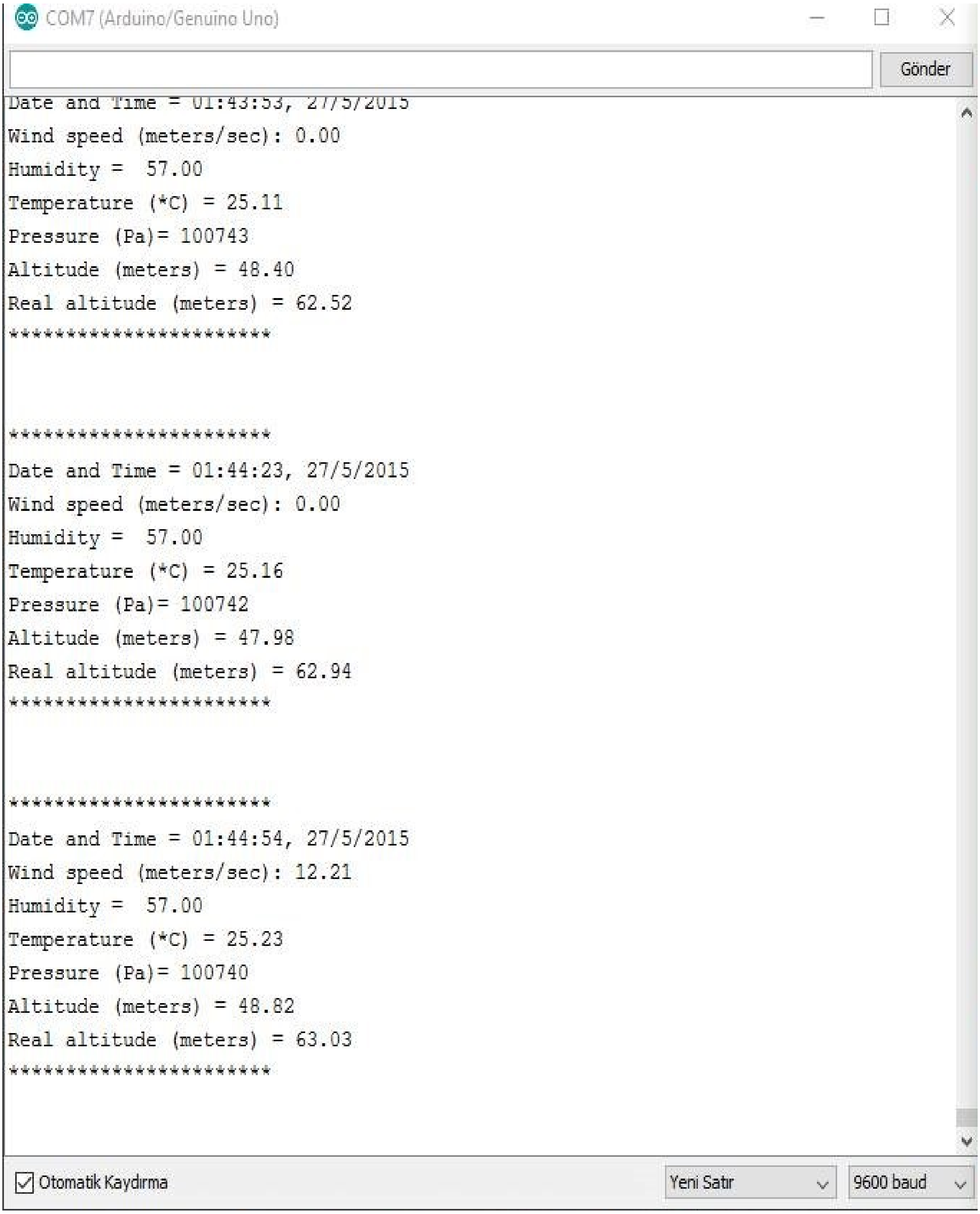

Figure 31. Some results of our measurements

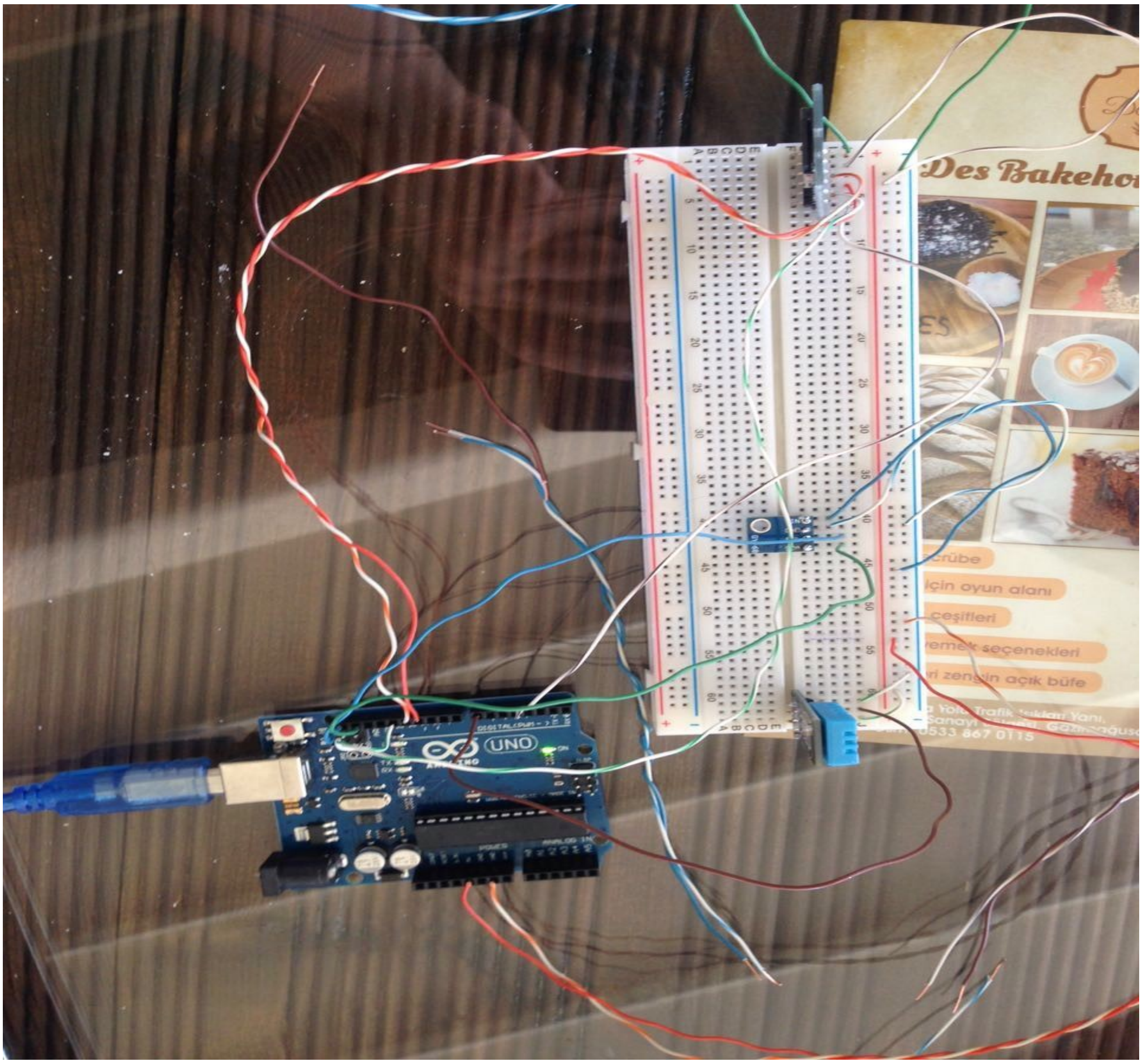

Figure 32. Arduino connection

Figure 33. Metal Box

Figure 34. Solar PV Panel

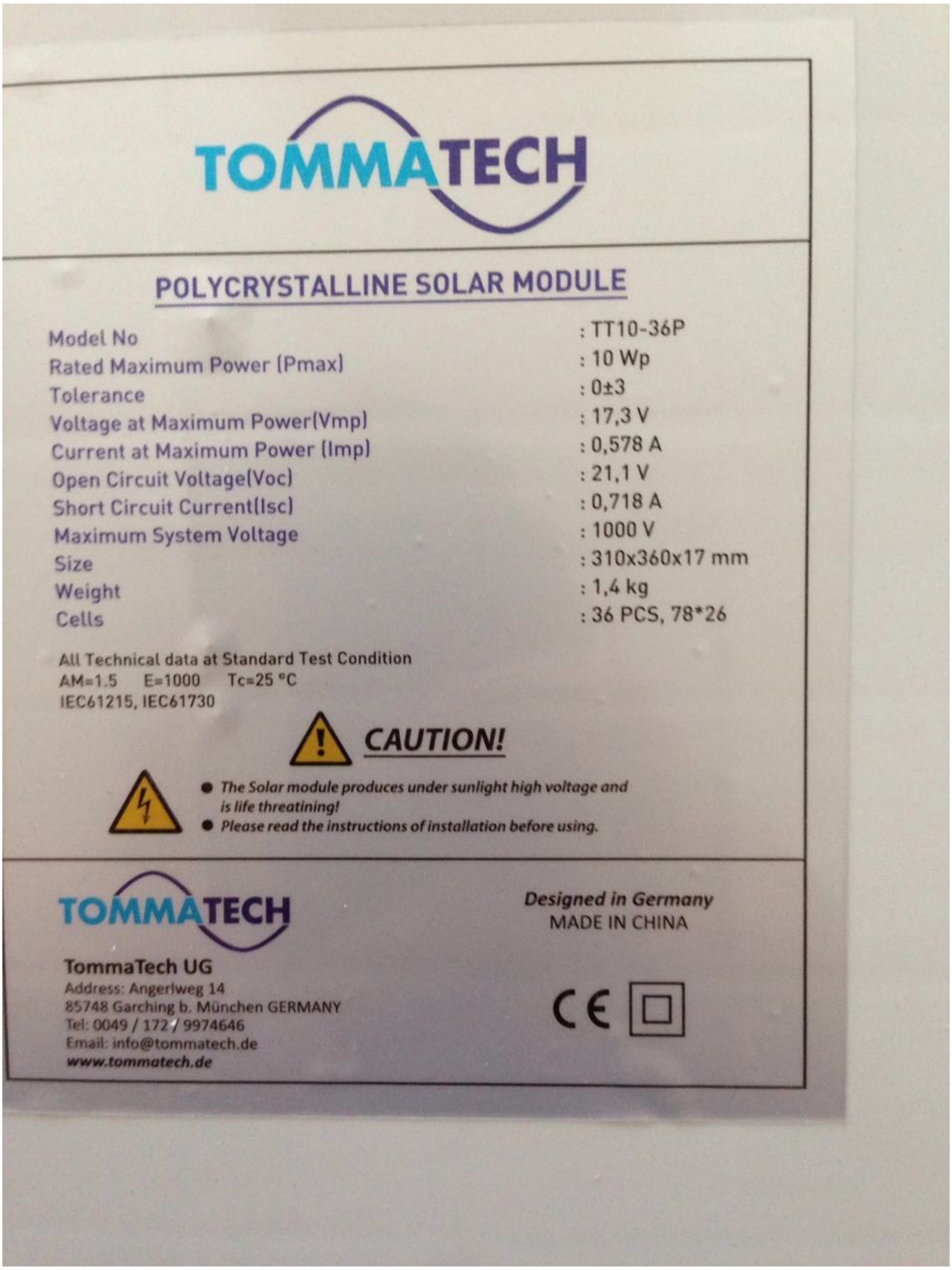

Figure 35. Information of Solar Panel

Figure 36. Base of project

CHAPTER 5-RESULT AND DISCUSSION

5.1 Results and Discussion

The project started by choosing sensors. According to sensors, softwares were found from arduino library. They were assemblied for final software and checked. After that, their connections were made on the breadboard. Without using battery, Arduino was checked and software worked out. We measured wind speed, pressure, humidity and temperature on per hour and datas were saved to SD card. In the project, there was no time controller. Clock module was added later to make measuring each 1 hour data [15].

To constract main structure, material research was done for selecting suitable material. Because to fix its balance, it needs light and strong material. We used another capstone project's structure from last semesters. It was a wind turbine structure but it was covered for portable weather station project. It was constructed as more steable and it was painted for better look. Metal bars were assemblied such as 3 arms and montaged to main structure. It was done for that sensors can measure data the way the best. Also covering system was added to protect sensors from bad weather situations and sunlight. A box was provided for fixing our devices. Battery, electrical circuits were put to box to protect. The box was fixed such as its cover open and close easily.

The biggest problem was on solar panel part. Because of we don't want to buy regulator directly. We waste time a lot on constructing circuit. Because there was a problem between solar panel and battery charge connection. In Northern Cyprus, there is always problem about finding devices. Finally a circuit was found and its all devices were ordered. Asst. Prof. Dr. Davut SOLYALI advices many thing about solar panel charge regulator circuit. The final version of the system is shown in f1illlolo0lçgure [21].

CHAPTER 6 CONCLUSIONS AND FUTURE WORK

6.1 Conclusion

The project shows us that when technology is developing, the electric and electronic systems are developing with technology like our project system. New requirements gives birth new systems or new equipment to improve the systems. Our project measures 4 different variables such that wind speed, temperature, humidity and pressure and the system saves the input variables a microchip. Also the system work by solar panel so, it does not need any other electric energy. In general systems do not have solar panel but we add that at this system. We work to improve our project like that. Our project must be portable so it must produce from solar panel the electric power which will need to work. We made a program to work sensors and also we have another program to produce power from solar panel. This system is very useful and it has green energy.

This system must be long for measuring data. Specially, wind sensor must at the high point of the system. We build a system and we add extra rods at top of the system. Our system must be portable so it cannot be heavy. We use sturdy and light metal when we build the system. Finally, the system can transport everywhere easily and it can work the energy which is producing by itself for using solar panel.

6.2 Future Work

A mobile weather data collecting laboratory or known another name as digital weather station is an electronic device that receives and digitally displays weather information, often through a wireless connection to a monitoring device. The information displayed by this system is usually gathered by a separate device, which is installed in an outdoor location, and then transmitted through a connection or wirelessly to the display device. A digital weather station can also connect to an Internet connection instead, and display information obtained by a separate weather service. There are a number of different devices that can function as a digital weather station, though in general they consist of a display device and some way to gather information about the weather. This display device is usually similar to a handheld smartphone or a digital tablet, and features a screen or readout that displays weather information. This is the future work because of mobile phones or laptops are in everywhere and we cannot live without them. Also we do not use the mobile just for talking nowadays we want to do it our own mobiles. A digital weather station usually functions through a connection to a gathering device, which is installed outside of a location. The gathering device then actually determines information about the local weather, such as temperature, atmospheric or barometric pressure, and humidity, and can even gather rain to produce information regarding accumulated rainfall. This information is then sent by the gathering device to the digital weather station, usually through a cable connection, though wireless devices have become increasingly common and popular. This step can send by directly wireless devices in the future.

Firstly military and later other sectors use that system and in the future automated system will use all the sectors.

REFERENCES

1 http://www.koreaittimes.com/story/32262/kes-2013-korea%E2%80%99s-first-educational-automatic-weather-system

2 http://www.tradeindia.com/fp667839/Compact-Automatic-Weather-Station.html
3 http://www.coastalenvironmental.com/scientific-weather-stations.shtml
4 http://www.sutron.com/system
5 http://www.solarpaneltilt.com/
6 http://stacorp.kr/product/product_view.html?prdcode=1305270002
7 http://www.columbiaweather.com/resources/industrial-automation/
8 https://en.wikipedia.org/wiki/Barometer
9 http://photovoltaic-software.com/PV-solar-energy-calculation.php
10 https://www.arduino.cc/
11 http://www.robotistan.com/
12 http://www.ansolab.com/#!daq-tasarim/c1h2d
13 http://www.ni.com/white-paper/3536/en/
14 http://www.mgm.gov.tr/
15 https://www.adafruit.com/datasheets/BST-BMP180-DS000-09.pdf
16 http://arduinoturkiye.com/arduino-temel-baglantilar-arduino-basic-connections/
17 http://www.renewableenergyst.org/wind.htm
18 Campbell Scientific, Data loggers, Sensors and Weather stations, http://www.campbellsci.co.uk.
19 Visala, Automatic weather stations, http://www.vaisala.com/en/products.
20 Prodata, Affordable automatic weather stations, http://www.weatherstations.co.uk.
21 Hettiarachchi H.A.P.K. & Fernando I.M.K., "USB Based High Speed Data Acquisition System for an Unmanned Weather Station", *2nd Int. Conf. on e-governance*, 2004
22 http://www.wxforum.net/index.php?topic=22428.0
23 http://www.iso.org/iso/catalogue_detail.htm?csnumber=31497
24 http://www.iso.org/iso/catalogue_detail.htm?csnumber=29291
25 https://www.asme.org/products/codes-standards/b40200-2008-thermometers-direct-reading-remote
26 https://www.asme.org/products/codes-standards/pcc2-2015-repair-pressure-equipment-piping-(1)
27 http://www.iso.org/iso/home/store/catalogue_ics/catalogue_detail_ics.htm?ics1=13&ics2=040&ics3=99&csnumber=45022
28 https://www.ashrae.org/resources--publications/bookstore/climate-data-center#iwec

APENDIX A - LOG BOOKS

Beste Özdilli 110745

DATES	COMMENTS
20.10.15	First of all I visited Assoc. Prof. Dr. Hasan Hacışevki to know his capstone topics.
24.10.15	We search the some Project and we discuss together with Assoc. Prof. Dr. Hasan Hacışevki, also we learned other topics which are giving by Assoc. Prof. Dr. Hasan Hacışevki.
26.10.15	We cannot understand the giving topics so, we had research some more topics.
06.11.15	We continued to search topics and using materials.
13.11.15	We decided to this topic to approval of Assoc. Prof. Dr. Hasan Hacışevki to upgrade the project and add more functions to the system.
20.11.15	Group members meeting, we distribute the work and did some researches, for me, I took the researching and the 1st chapter which include installation.
28.11.15	I started to search this project and I understand the topic is too important for many areas.
29.11.15	Group members meeting, we distribute the work and did some researches, for me, I took the researching and the 2nd chapter which include installation.
04.12.15	Start working on my duties. I started to write Chapter 2 Back Ground.
05.12.15	I meeting with Assoc. Prof. Dr. Davut Solyalı for getting some information about project. Later we met and discussing with Neriman hoca and Hasan hoca.
06.12.15	I finished Chapter 2 Literature Review.
11.12.15	We meet and discussed about our researches (using sensors, main details, etc..). Than during the meeting all 3 chapters were combined.
12.12.15	We finished the Chapter 3. Later we went our advisor.
13.12.15	Group meeting to combine each chapters to finish the project report and starting for drive the project in SolidWorks.
21.12.15	We visited Assoc. Prof. Dr. Hasan Hacışevki to show our report to finalize it.
25.12.15	We meeting last time and I prepared appendix, ganttchart and my logbooks for the final report.
15.04.2016	I meet with Faruk and We determined materials to order.
18.04.2016	We meet with Mr. Hasan Hacışevki and Mr. Davut Solyalı for learning sensor types for our project.
20.04.2016	We order some materials from Internet sites and some others from Mağusa.
22.04.2016	We talk to Mr. Hasan Hacışevki and Mr. Davut Solyalı about program software of ardunio and sensors.
25.04.2016	We order other material from internet sites.
06.05.2016	Our materials arrived which is we ordered. We start to make the program.
13.05.2016	We meet a friend and his boss for exchange ideas. He is an electric engineer.
20.05.2016	We meet with Mr. Mostafa Ranjbar and then Mr. Hasan Hacışevki for learning report writing.
21.05.2016	We search software to work the sensor.

23.05.2016	We work to run the program. Finally, we success that.
24.05.2016	We build a system and painted that.
26.05.2016	We meet Mr. Davut Solyalı and he advice about program of solar panel at workshop.
28.05.2016	Solar panel arrived today and we work to run the program.
29.05.2016	I write some part at the report.
30.05.2016	We meet at workshop to add all part on the system.
31.05.2016	We test the system and we take a note those values.

Faruk Ateş 112276

DATES	COMMENTS
20.10.15	I registered for MENG 410 with my advisor and after that I created a group with my friend. My group member is Beste ÖZDİLLİ.
24.10.15	Meeting with Assoc. Prof. Dr. Hasan Hacışevki to show and explain the projects topics.
26.10.15	We did not understand fully the existing topics and we started to search some other topics with Beste.
06.11.15	Second meeting about researching about topics from books, journals and researches that is done.
13.11.15	I decided to this topic to approval of Assoc. Prof. Dr. Hasan Hacışevki to upgrade the project and add more functions to the system.
20.11.15	Discussion meeting about our project and how can we benefit from this project and talked about previous experiences.
27.11.15	I started to search this project and I understand the topic is too important for many areas.
29.11.15	Group members meeting, we distribute the work and did some researches, for me, I took the researching and the 1st chapter which include installation.
04.12.15	We visit Assoc. Prof. Dr. Hasan Hacışevki and discussed about the project. He offered to add solar panel system the system and we accepted that.
05.12.15	Start working on my duties. I started to write Chapter 1 Introduction.
06.12.15	I continued to writing Introduction and I finished that. I started to search about Chapter 3 Design.
11.12.15	We meet and discussed about our researches (using sensors, main details, etc..). Than during the meeting all 3 chapters were combined.

12.12.15	Chapter 3 Finished. Later we went to discuss with our advisor.
13.12.15	I started to drive the system by using Solid Works with Beste.
21.12.15	Meeting with Assoc. Prof. Dr. Hasan Hacışevki, through the meeting Assoc. Prof. Dr. Hasan Hacışevki gave us some comments and notices to avoid them in our report.
25.12.15	We finalized our report, appendix and references.
15.04.2016	I meet with Beste and We determined materials to order.
18.04.2016	We meet with Mr. Hasan Hacışevki and Mr. Davut Solyalı for learning sensor types for our project.
20.04.2016	I search the some useful material for our project. We meet with Beste to order materials.
22.04.2016	We talk to Mr. Hasan Hacışevki and Mr. Davut Solyalı about program software of arduino and sensors.
25.04.2016	We order other material from internet sites.
06.05.2016	Our materials arrived which is we ordered. We start to make the program.
13.05.2016	We meet a friend and his boss for exchange ideas. He is an electric engineer.
20.05.2016	We meet with Mr. Mostafa Ranjbar and then Mr. Hasan Hacışevki for learning report writing.
21.05.2016	We search software to work the sensor.
23.05.2016	We work to run the program. Finally, we success that.
24.05.2016	We build a system and painted that at workshop.
26.05.2016	We meet Mr. Davut Solyalı and he advice about program of solar panel at workshop.
28.05.2016	Solar panel arrived today and we work to run the program.
29.05.2016	I write some part at the report.
30.05.2016	We meet at workshop to add all part on the system.
31.05.2016	We test the system and we take a note those values.

APENDIX B – GANTT CHART

	20.10.2015	24.10.2015	26.10.2015	06.11.2015	13.11.2015	20.11.2015	27.11.2015	29.11.2015	04.12.2015	05.12.2015	06.12.2015	11.12.2015	12.12.2015	13.12.2015	21.12.2015	25.12.2015
Selecting project																
Start to prepearing ganchart																
Searching information abaut the project																
Learning to ASRS system																
Distribution of duty																
Design and calculation																
Collecting information																
Preparing to proposal																
Prepearing to report writing																
Writing chapter 1, 2 and 3																
Writing formula and calculation																
Resulting the final report																

	15.04.2016	18.04.2016	20.04.2016	22.04.2016	25.04.2016	06.05.2016	13.05.2016	20.05.2016	21.05.2016	23.05.2016	24.05.2016	26.05.2016	28.05.2016	29.05.2016	30.05.2016	31.05.2016
Selecting sensors	■	■	■	■						■	■	■	■			
Start to prepearing ganchart	■	■										■	■			
Searching information about the project		■	■	■	■	■										
Learning to Arduino		■	■			■										
Distribution of duty					■	■	■	■	■	■	■	■				
Design and calculation			■	■	■	■	■	■			■	■	■	■	■	■
Collecting information	■	■	■	■	■	■										
Preparing to proposal					■	■	■	■	■	■						
Prepearing to report writing										■	■	■	■	■	■	■
Writing chapter 4, 5 and 6								■	■	■	■	■	■	■	■	■
Writing formula and calculation				■	■	■	■			■	■	■	■	■		
Resulting the final report												■	■	■	■	■

TABLE 3. Distribution of tasks

DISTRIBUTION OF TASKS	BESTE	FARUK
SENSOR SELECTION	X	X
SOLAR PANEL SELECTION	X	X
BATTERY SELECTION	X	X
MATERIAL SELECTION	X	X
MATERIAL ASSEMBLY		X
ARDUINO	X	
SOLIDWORK DESIGN	X	X
AUTOCAD DESIGN		X
ELECTRONICS CIRCUIT SELECTION	X	X
ELECTRONICS CONNECTION	X	
WEBSITE	X	
POSTER		X
TRANSPORTATION	X	X
REPORT WRITING	X	X
SOLVING PROBLEMS	X	X

APENDIX C -TECHNICAL DRAWINGS

<table>
<tr><td></td><td>NAME</td><td>DATE</td><td>SIGN</td><td rowspan="3">E.M.U</td></tr>
<tr><td>DRW.BY</td><td>Machine Humans</td><td></td><td></td></tr>
<tr><td>CHK.BY</td><td></td><td></td><td></td></tr>
<tr><td>SCALE</td><td colspan="3"></td><td>DRW NO:</td></tr>
</table>

*All technical drawings are drawing in cm.

APENDIX D – ENGINEERING STANDARDS

ISO 17713 – 1 : 2007 : Meteorology - Wind measurements - Part 1: Wind tunnel test methods for rotating anemometer performance

ISO 17713-1:2007 describes wind tunnel test methods for determining performance characteristics of rotating anemometers, specifically cup anemometers and propeller anemometers. It also describes an acceptance test and unambiguous methods for measuring the starting threshold, distance constant, transfer function and off-axis response of a rotating anemometer in a wind tunnel [23].

ISO 16622:2002 : Meteorology – Sonic anemometers/thermometers – Acceptence test methods for mean wind measurements

ISO 16622:2002 defines test methods of the performance of sonic anemometers / thermometers which employ the inverse time measurement for velocity of sound along differently oriented paths. It is applicable to designs measuring two or three components of the wind vector within an unlimited (360°) azimuthal acceptance angle [24].

ASME B40.200 – 2008 : Thermometers, Direct Reading and Remote Reading

This Standard provides definitions, testing and conctruction and safety issues of Bimetallic actuated, Filled System and Liquid –in –Gas Thermometers and Thermowells and Elastic Temperature Sensors [25].

ASME PCC-2 : Pressure Equipment and Piping

This provides methods for repair of equipment and piping within the scope of ASME Pressure Technology Codes and Standards after it has been placed in service. These inspection and flaw evaluation methods are not covered in this document, but are covered in other post-construction codes and standards. Only technical procedures and information are provided; administrative or policy requirements are outside of the scope of this Standard [26].

ISO 28902-1:2012 : Air quality -- Environmental meteorology -- Part 1: Ground-based remote sensing of visual range by lidar [27].

Standard 169-2013 : Climatic Data for Building Design Standards

ANSI/ASHRAE Standard 169-2013, Climatic Data for Building Design Standards, serves as a comprehensive source of climate data for those involved in building design, and provides a variety of climatic information for designing, planning, and sizing building energy systems and equipment [28].

APENDIX E - Website of Project

http://students.emu.edu.tr/112276/

Poster

PICTURES, TABLES AND GRAPHS OF SENSORS AND COMPONENTS

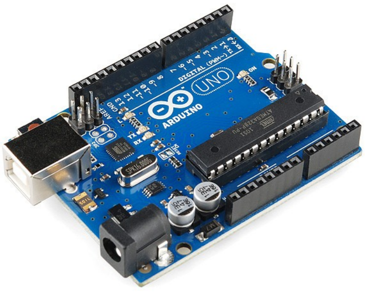

Figure 37. Arduino UNO R3

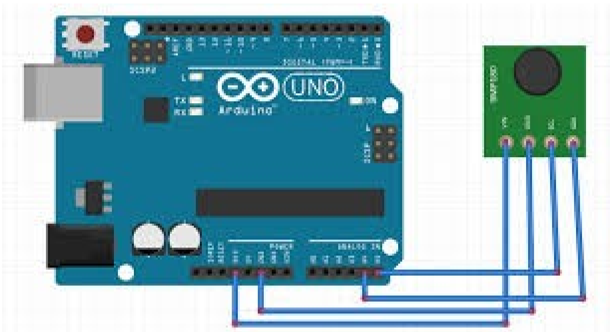

Figure 38. Connection of BMP180 pressure sensor

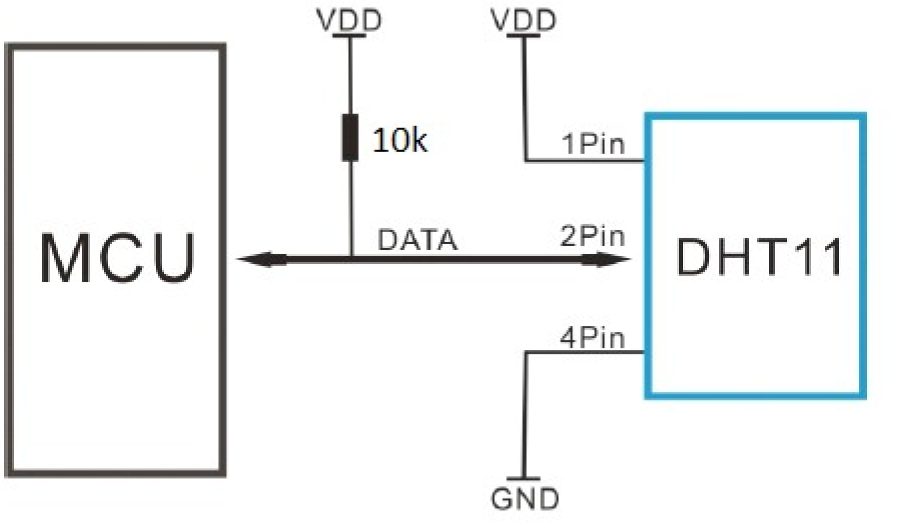

Figure 39. Connection of DHT11 Tmperature sensor

Figure 40. Wind speed sensor, anemometer

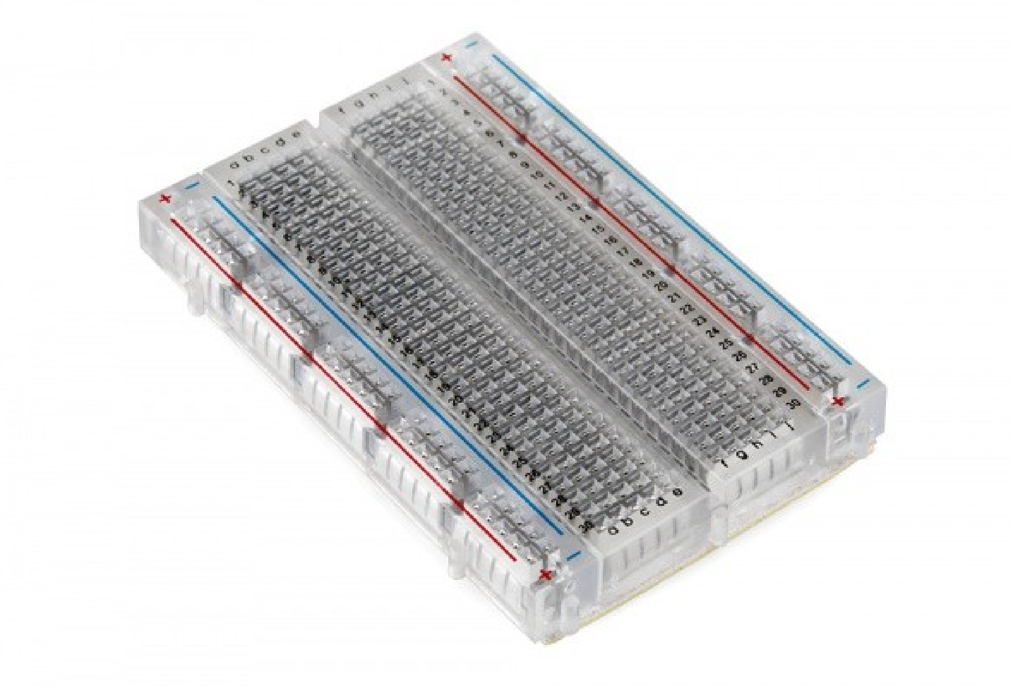

Figure 41. Breadboard

Figure 42. 12V Battery

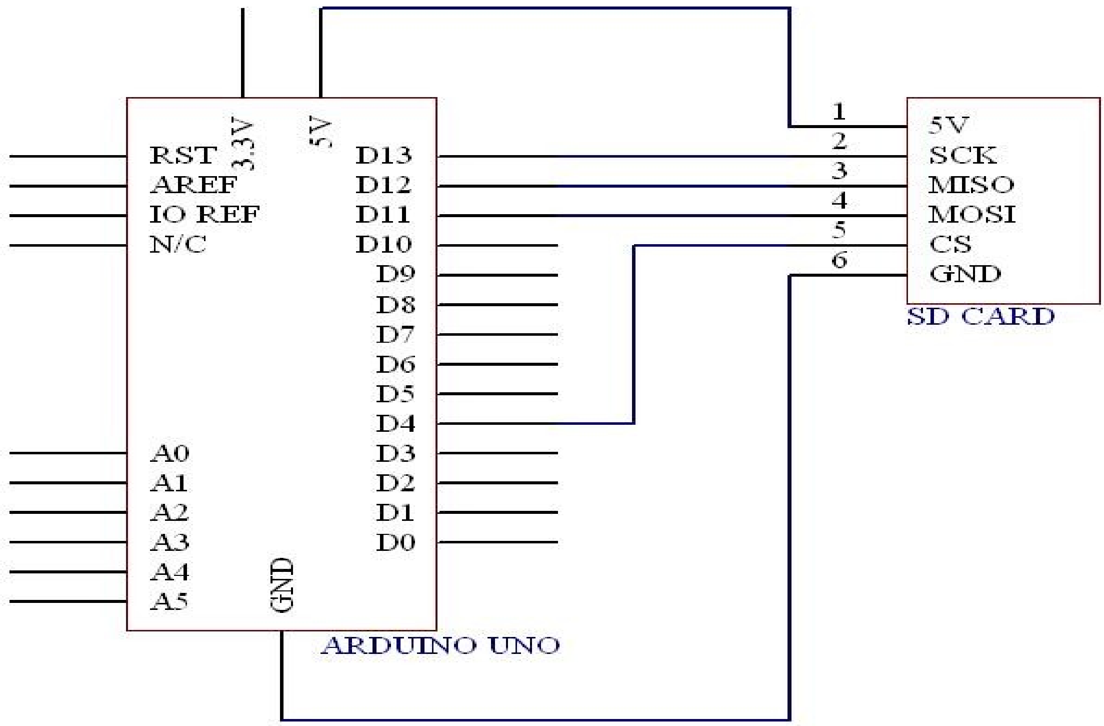

Figure 43. SD Card Module

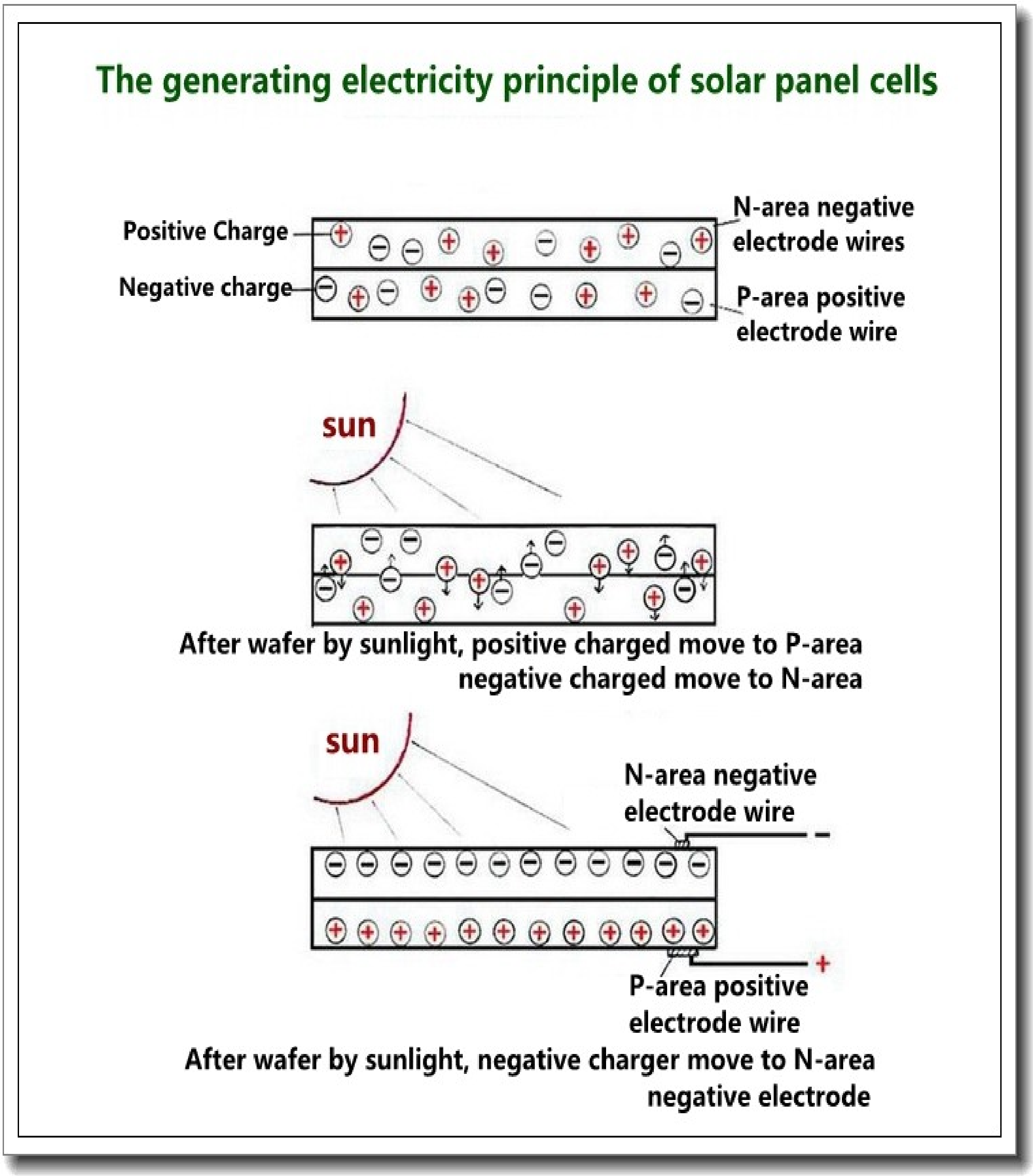

Figure 44. Electriciy principles of solar cels

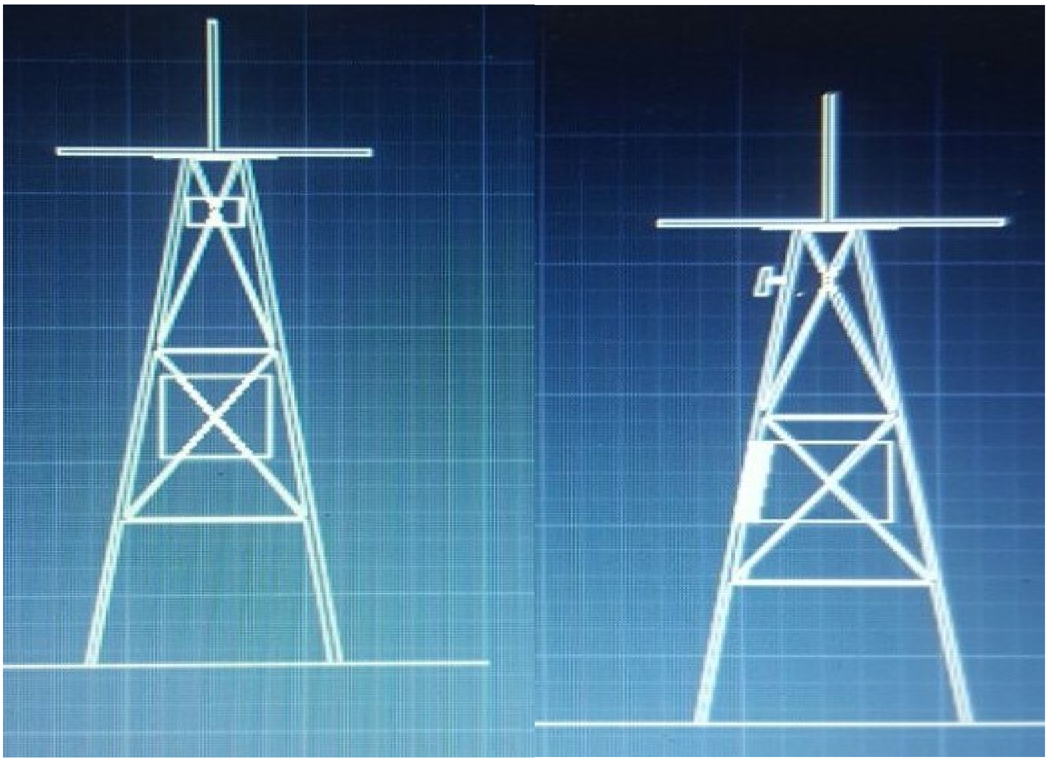

Figure 45. PART1 (front, right side. top)

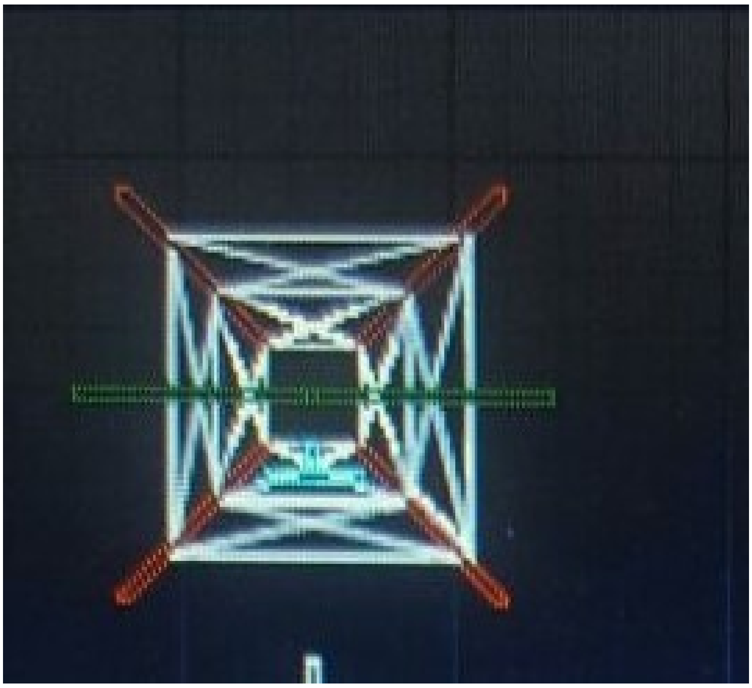

Figure 46. Assembly

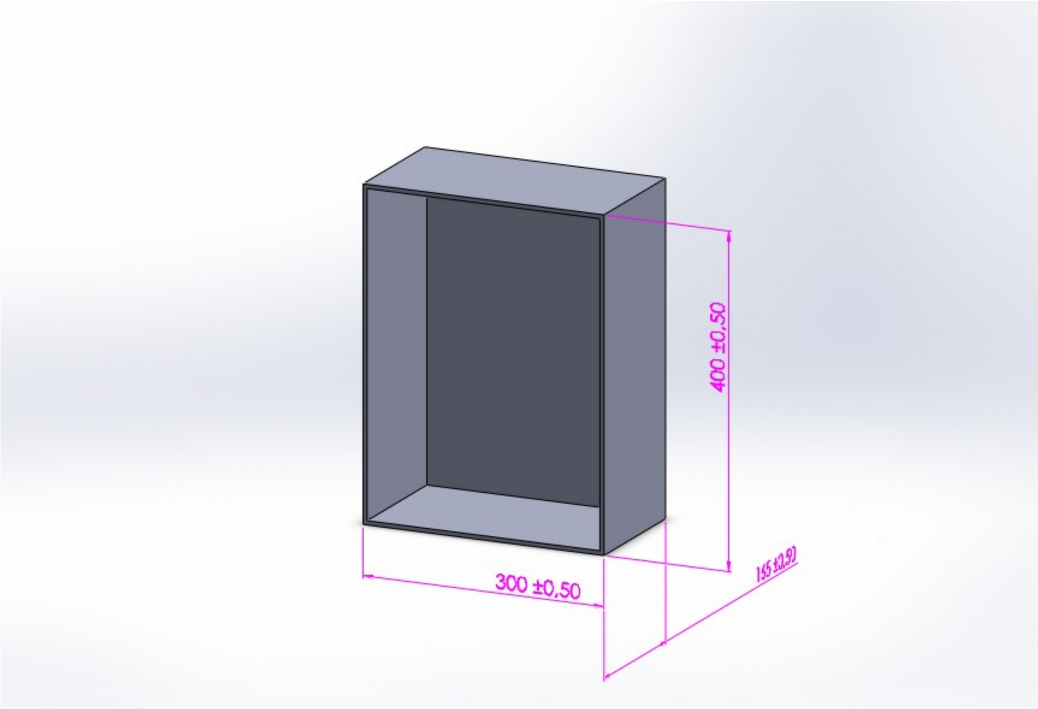

Figure 47. PART2

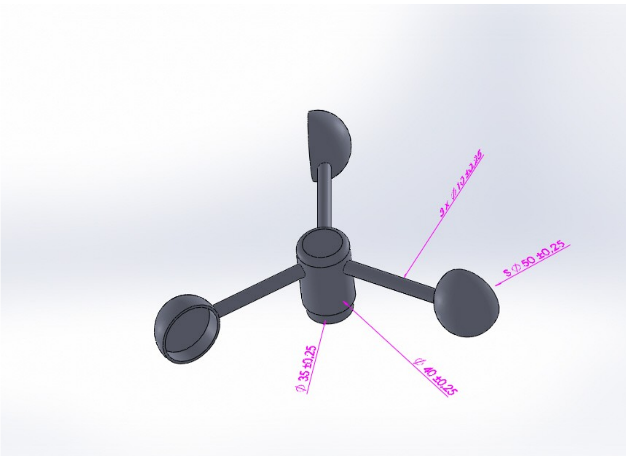

Figure 48. PART3

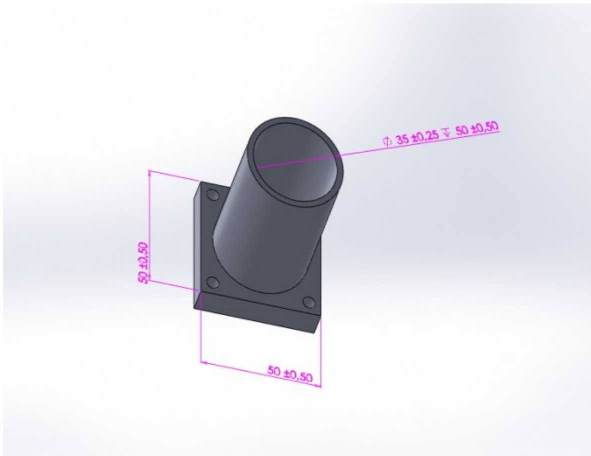

Figure 49. PART4

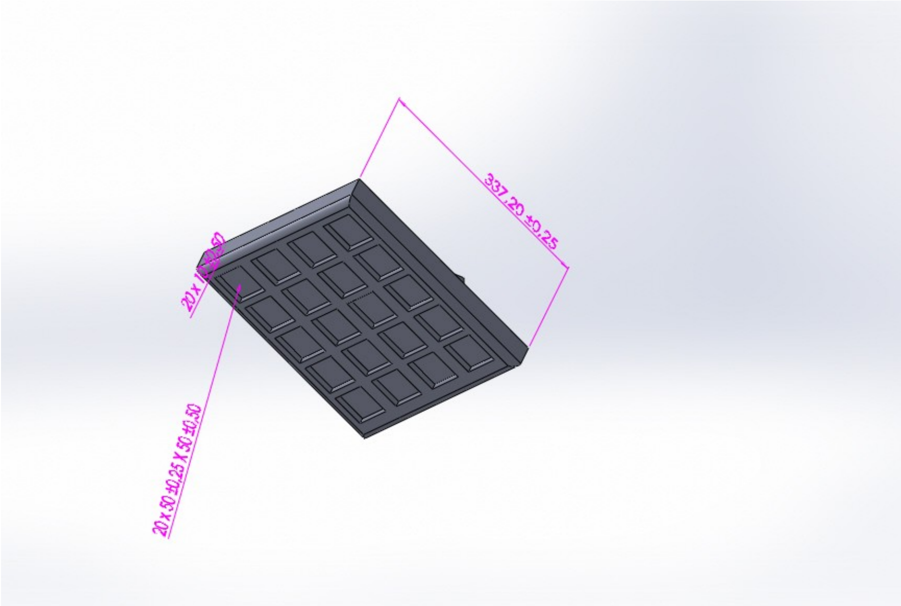

Figure 50. PART5

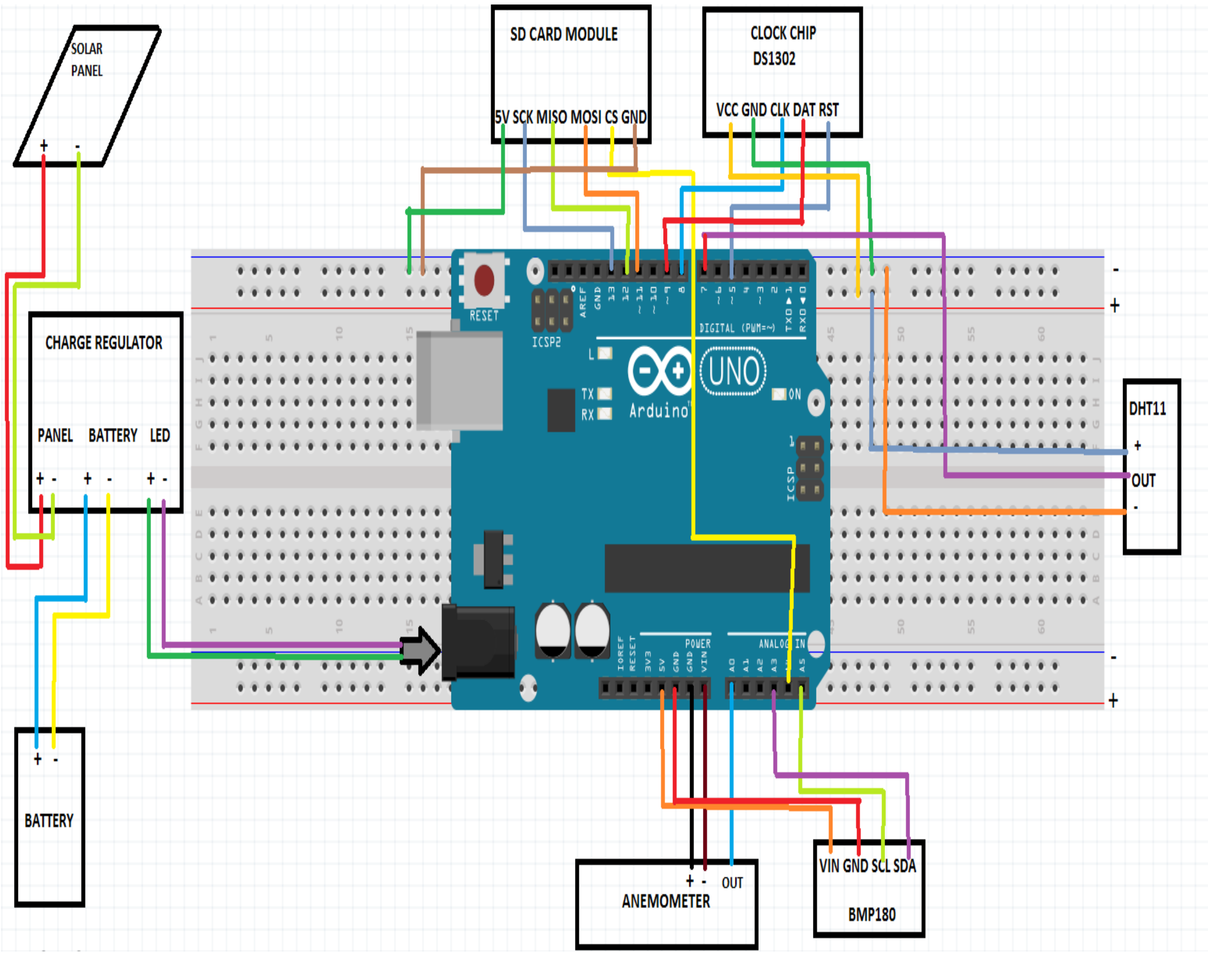

Figure 51. Wiring diagram of electrical components

LIST OF FIGURES

LIST OF TABLES