CHAPTER ONE

INTRODUCTION

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1.1Preface

As the demand grows for communication services, wireless solutions are becoming increasingly important, wireless can offer high-bandwidth service provision without reliance on fixed infrastructure. One of the innovative wireless services is high altitude balloon(HABs).

HABs when fully deployed will have the capability of providing services and applications ranging from broadband wireless access, navigation and positioning system, remote sensing and weather observation/monitoring systems. These balloon are filled with hydrogen or helium and expands as they ascend through earth's atmosphere, the objects are attached to a HABs is often referred to as the payload train and each payload services a particular purpose[1].

Habing provides an opportunity to explore a place from which new perspectives of the world are still possible, but returning with pictures that do it justice does present some technical and artistic challenges.

The most common type of HABs are weather balloons, other purpose include use as a platform for experiments in the upper atmosphere, modern balloon contains electronic equipment such as radio transmitter, cameras as the fan additions or satellite navigation system, such as GPS receivers.

1.2 Problem statement

The difficulties and complexity of data gathering for weather station operating on high altitude. There is a difficulty of those station maintenance because it depend on integrated circuits(IC).

There is no prototype of such system and no detailed information about design of high altitude balloon systems.

1.3 proposed solution

The solution to the previous mentioned problems is to design a high altitude balloon system with an excellent hardware and software design with low cost and low transmission power as possible. To achieve these solutions.

1.4 Aim and Objectives

Aim

Design and implementation of high altitude balloon system.

Objectives

The effectiveness of the scheme is simulated using Arduino code with C++ programming code to verify the following objectives:

- To build a simple HABs system and easy to maintenance.
- To measure the temperature and humidity.
- To take photographs.
- To track the balloon position.
- To implement and test the system.
- To create a prototype for HABs design as a reference for students in university.

1.5 methodology

The realization of this project was achieved in four major steps which presented by flow diagram in figure (1.1).

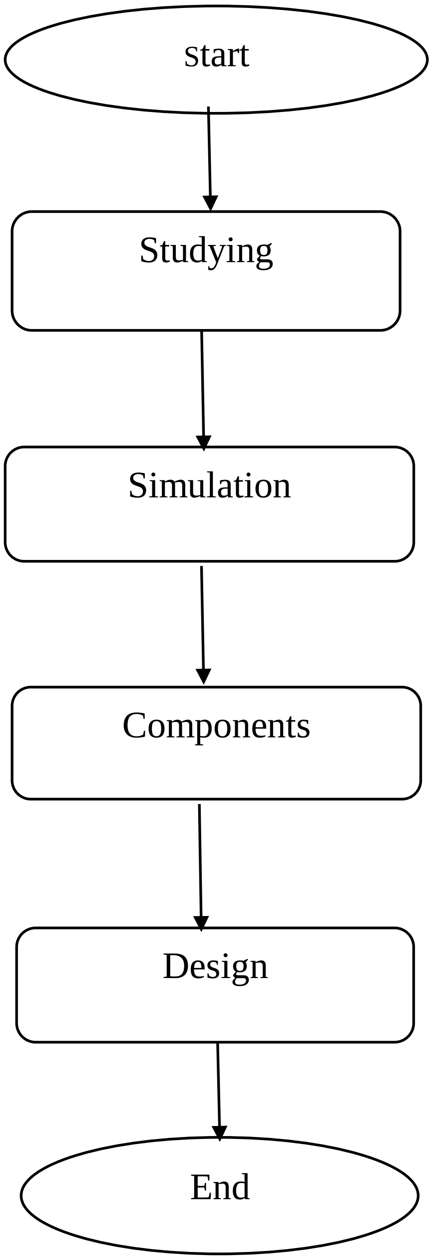

Figure (1.1) flow diagram of the implementation process

- **Studying**

enriched our knowledge by studying a general background related to our proposed problems, which contains design of high altitude balloon system to carry a small payload.

- **Simulation**

simulating the high altitude balloon circuit by using proteus IS-IS professional to ensure the working of our circuit before starting on the hardware circuit.

- **components**

collecting our project components which include: Arduino Uno, breadboard, DHT11, LM35, XBEE module, XBEE shield, wires, resistances, LEDs, TTL USB serial and battery**.**

- **Designing**

Design HABs hardware circuit using available components.

1.6 Research Outlines

Chapter one: An introduction that gives a feedback about project, problem statement, proposed solution including the aim and objectives of the project. It also gives a brief description on how to achieve these goals in the methodology and research outlines**.**

Chapter two: A first part of this chapter gives a background about a high altitude balloon design, the second part is analysis of papers that were in the field of High altitude balloon design**.**

Chapter three: shows the system methodology, which contain the design requirements and the components complete definitions and the HABs block diagram.

Chapter four: The hardware implementation, the first part of this chapter shows all design steps in great details were undertaken to achieve the project objectives. The second part of this chapter is the project results include simulation results and hardware results.

Chapter five: Conclusion and recommendation are achieved from the project and recommendation for the future studies.

CHAPTER TWO

LITERATURE REVIEW

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LITERATURE REVIEW

2.1. Background

2.1.1 Overview

High altitude ballooning has been an important platform for astrophysicists and earth scientific for observations and measurements. High altitude balloons have evolved over time to increase payload and mission endurance. The first weather balloons came into existence in France in 1892. Devices a board measured barometric pressure, temperature and humidity but had to be retrieval in order to collect the data. These large balloons inflated with gas and remained open at the bottom like a hot air balloon. When the temperature cooled in the evening, the gasses cooled and then the balloon deflated and descended. However, no control over the balloon descending back to earth existed. Sometimes they would drift hundreds of miles making data gathering difficult.

In 1912 Victor Hess conducted experiments to understand the radiation changes with altitude. These lead to the discovery of cosmic rays. In 1930 vastly improved the data gathering capabilities of weather balloons. In 1985 another development allowed meteorologists height and leaves them there to gatherer data over a period of time. Zero pressure balloons and later super-pressure Mylar balloons invented by a research branch of the air force could reach greater altitude and based on the gas inside be calculated to remain at that altitude for a period of weeks or months where they record and transmit data. These could also be launched over water which increased the amount of data that could be collected. These balloons transmitted data to satellite. In 1997 the BOOMERanG (Balloon Observation of Millimetric Extragalatic Radiation and

Geophysics). Experiment measured the cosmic microwave background radiation of small part of the sky using a high altitude balloon flown over Antarctica. In 2001 Science New Metrics,8.3 percent of the world’s discoveries and technologies were attributed to NASA and 83 percent of these discoveries were space related. In December 2008,NASA successfully launched Ultra-Long-Duration balloon (ULDB).with an approximate volume of 200,000 m^3 [2].

In 2008 Google contracting with or acquiring space data crop. A company that sends balloons carrying small base station about 20 miles (32km). On June 2013 Google began a pilot experiment in New Zealand where about 30 balloons were launched. In May-June 2014 Google tested its balloon powered internet access venture in Piaui Brazil making it is first LTE experiments and launch near the equator in2014 Google partnered with France’s center national etudes spatial (CNES) on the project. In February 2014 the record streak for a balloon lasting in the stratosphere was 50 days ,in November 2014 the record 130 days and in March 2015 the record for a continuous balloon flight is 187 days (over 6 months) on 28 July 2015 Google signed an agreement with officials information and communication technology Agency Sri- Lanka To launch the technology on a mass scale As a result by March 2016 Sri-Lanka will be the second in the world to get full coverage of internet using LTE after Vatican city on 29 October 2015 Google agreed to partner with Indonesia’s XL Axiata, Indosat and Telkomsel to bring technology to the country in hopes of connecting its 17000 islands[5].

2.1.2 The High altitude balloon

Weather balloon has been used for many years by meteorologists to study weather pattern in the upper atmosphere. Recently there has been increasing interest in other studies that could be performed using weather balloons in near space environmental. It consists of two systems; the balloon provides the necessary lift using the buoyancy force of hydrogen or helium. The payload tied below the balloon, and contains the electronics necessary for tracking measurements and communicating with users on the ground.

There are several areas of interest in light altitude balloon experiments, these include radiation effects on solar cells wireless communication, guidance, and detailed maps of atmosphere condition in relation to altitude. This wide span of information could be used in many areas such as for military aircraft and for natural disaster rescue teams.

High bandwidth wireless communication between the ground and the balloon, as well as between multiple balloons could be used to design communication methods and systems between high altitude unmanned air vehicles (UAV). The balloons could be used in natural disaster situations as temporary communication towers for cell phones.

Figure (2.1) shows the high altitude balloon system.

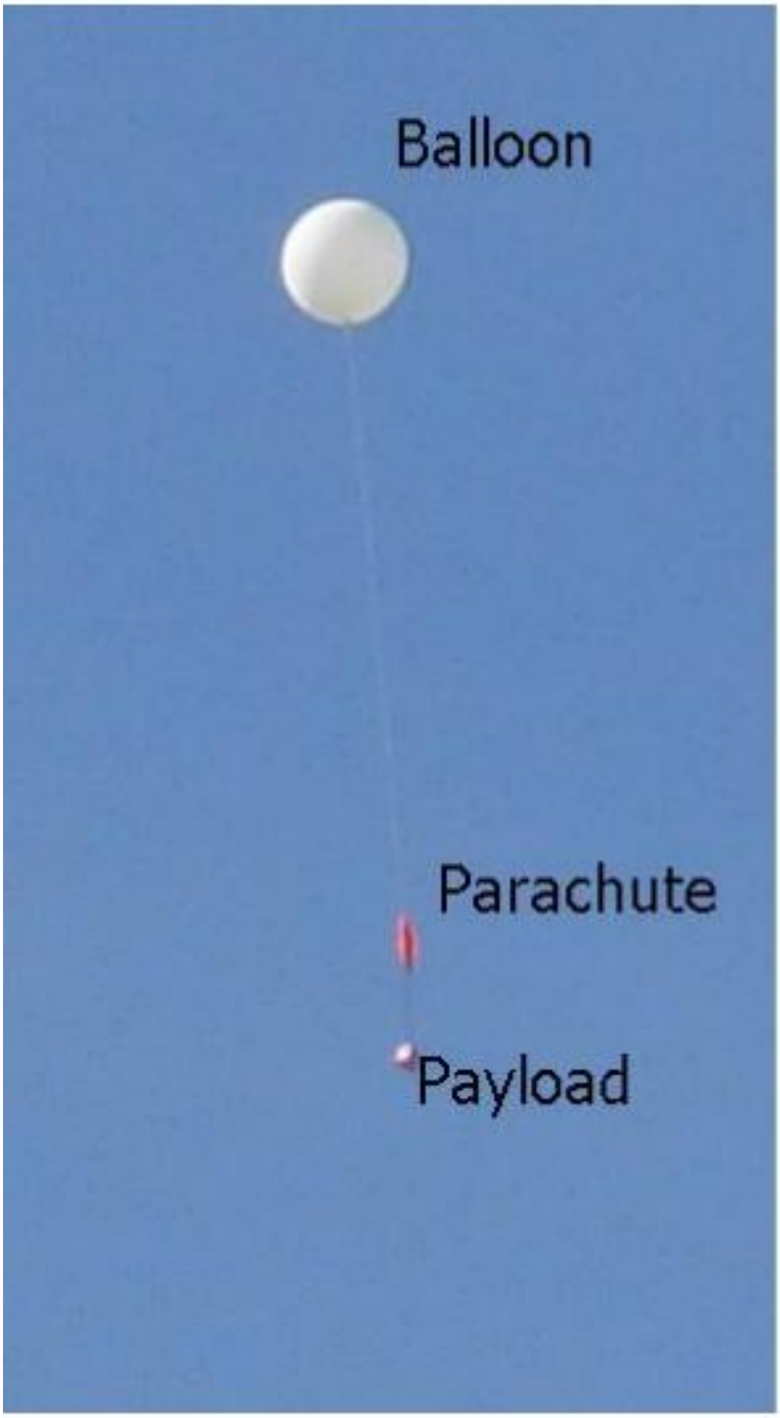

Figure 2.1 High altitude balloon system

2.1.3 HABs Advantages

- High altitude balloons have significant advantage over satellite, cheaper cost than satellite.
- The balloons payload can be recovered and used for repeat flight several times. Under the current NASA program, the payloads are recovered, refurbished and reflows several times with successive flights providing higher quality measurements.
- The low cost of the balloon missions offers realistic opportunities to involve researchers from across the world.
- The evolution of high altitude balloon has allowed improvements in observational capabilities large balloon capable of reaching high altitude as 20Km in the atmosphere.

2.1.4 Application of HABs

1- High altitude balloon photography

There are many platforms for aerial photography kites, hot air balloons, helicopters, drones, jets and spy planes, But high altitude balloons(HABs) stand out on the way up a balloon visits the altitudes home to all of these platforms then surpasses them achieving truly unique views of the planet that bridge the gap between conventional aerial photography and satellite imagery HAB provides an opportunity to explore a place from which new perspectives of the world are still possible but returning with pictures that do it justice does present some technical and artistic challenges[2].

2- High altitude balloons for weather

HAPs are conventionally used to collect weather data including pressure, temperature, humidity and wind speeds up to an altitude of at least 100,000 feed. The HABs create and launch an electronics system for real time tracking and data monitoring for a HABs. GPS data temperature and pressure are published to an on board SD card and sent via SMS to a cell phone on the ground thus users are able to track the position for balloon recovery. Two on board cameras capture still images throughout the two-hour flight[3].

3-**HAB Surveillance**

An altitude of 65,000 feet he set the world record for the greatest high ever reached by a human in a hot air balloon his flight also piqued the interest of military and intelligence officials near space technology solutions that could provide persistent surveillance in an operational theater. The military could deploy unmanned lighter above an air craft's upper limit of 60,000 feet and well below the greater than 100,000,000 feet orbits of geosynchronous satellites [6].

4- HAB for determining exchange of carbon dioxide over agricultural and scopes

The exchange of carbon dioxide between the terrestrial biosphere and the atmosphere is a key process in the global carbon cycle. Given emissions from fossil fuel combustion and the appropriation of net primary productivity by human activities, Understanding the carbon dioxide exchange of cropland agro-ecosystems is critical for evaluating future trajectories of climate change in addition human manipulation of agro-ecosystems has been proposed as a technique of removing carbon dioxide from the atmosphere via practices such as no .tillage and cover crops Propose a navel method of measuring the exchange of carbon dioxide over croplands using a high altitude balloon the HAB methodology measure two sequential vertical profiles of carbon dioxide concentration and using a mass[7].

5-**Balloon Navigation facility**

To support the balloon flight operations during the DTFT missions a real time online balloon navigation facility was also developed the system for augmented navigation of balloon (SANBA) is a real time navigation on facility that integrates several prediction and decision making tools extremely use full during balloon missions it is able to acquire the GPS data coming from the gondola and display the trajectory and the current position on a map.

2.2 Literature Review

Website [5] describes the project loon which is a research and development project begin developed by formerly Google with mission of providing internet access to rural and remote area. The project uses high altitude balloons placed in the stratosphere an altitude of about 18km (11mi) to create an aerial wireless network with up to 4G-LTE speeds it was named project loon since even Google itself foun

d the idea of providing internet access to the remaining 5 billon population unprecedented and crazy. The balloons are maneuvered by adjusting their altitude in the stratosphere to float to a wind layer after identifying the wind layer with the desired speed and direction using wind data from the national oceanic and atmospheric administration (NOAA) users of the service connect to the balloon network using a special internet antenna attached to their building. The signal travels through the balloon network from balloon to balloon then to ground base station connected to an internet service provider (ISP) then onto global internet. The system aims to bring internet access to remote rural areas poorly served by existing provision and to improve communication during natural disaster to affected regions. The balloon use patch antennas to transmit the signal to ground station or LTE user some smart phone with Google SIM cards can use Google internet services that whole infrastructure is based on LTE the e-node b component the equivalent of the base station that talks directly to hand set is carried in the balloon.

This paper [3] describe design and build a payload to be attached to a weather balloon that would reach an altitude of 100,000 feet and return safely to the earth. The payload contained both experiments and tracking equipment such as GPS receiver and amateur (HAM) radio. The payload was first launched to test the communication and tracking equipment and to define the launch procedures. The remaining launches were to contain the experiment and improved command module that implemented redundant tracking system.it included a solar cell study at high altitude profiling of temperature, pressure and humidity.

This paper [4] outlines an analytical model to predict the temperature of fully-inflated balloon on float at high altitude in stratosphere. Simplified radiative and convective heat transfer models are developed to estimate absorption and emission heat of balloon film and lifting gas within balloon. Thermal equilibrium equation for the balloon system in the day time and night time are derived by incorporating radiative and convective heat transfer models. The new model is applied to calculate the day and night temperatures of the balloon system on float at a high altitude in stratosphere and reasonable correlation is achieved between the predication obtained from new models and form prior flight testing data, demonstrating the effective use of the proposed models.

Paper [14] provides a reference for the historical behavior of wind direction, speed and air temperature between 10k and 100k at Reno Nevada the nearest reporting site at Black Rock Desert in Northwestern Nevada. Depend on analyzes the (NOAA) National Oceanic and Atmospheric Administration’s radiosonde data. Accurate prediction of launch profile and recovery location requires near real-time wind data from either Reno National Oceanic and Atmospheric Administration’s radiosonde or a local radiosonde launch.

CHAPTER THREE

System model

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System model

The High Altitude Balloon Design Decompose into Three Main systems:

3.1 Payload System

Payload include two Components; Microcontroller, Image Collection.

Microcontroller

An Arduino Uno Microcontroller as The" brain" of the Data Acquisition and Communication System, this model is available at no cost, and also provide an excellent balance between weight and features (Number of I/O Pins). Arduino Requirements for the HAB Decomposed into four Tasks: Communication, Localization, Sensors and power supply. The Microcontroller in C++ to record GPS position data every second and to store it in an onboard SD memory card that gives us a very detailed plot of the path of the balloon traveled.

Figure 3.1 Arduino uno

3.**1.1. Communication**

GSM Module

A GSM Module used as a back-up tracking. It can be used to communicate with base station as well as to determine coordinate of balloon. It is allowing an Arduino board to connect to the internet, send and receive SMS, and make voice calls us ing the GSM library.

XBEE MODULE

The XBee module is the popular wireless transceiver. This module uses the IEEE802.15.4 networking protocol for fast point-to- multipoint or peer-to-peer networking, also XBee use Zigbee standard and add to it and wraps it up in their own neat little package.it is flexible, it can send and receive data over a serial port, which mean is compatible with both computers and microcontrollers (Arduino). XBee provide two friendly modes of communication –a simple serial method of transmit/receiver or a formed mode providing advanced features.

XBee are ready to use out the package, or they can be configured through the x-CTU utility or from microcontroller. The X-CTU is a free multi-platform application includes new tools that make easy to set-up, configure and test XBee modules RF. XBees can communicate wirelessly with each other [8].

The figures (3.2), (3.3) Xbee module

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Figure 3.2 the Xbee module

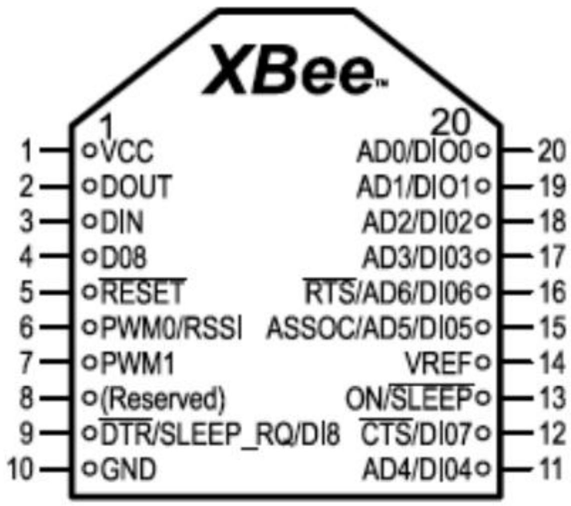

figure 3.3 Xbee module pins

3.1.2 LOCALIZATION:

GPS Module

The GPS feeds the location and altitude into the terminal node controller (TNC) which is device that can translate the text strings received from the GPS into a signal that could be transmitted over the national ARPS frequency (44.39MHZ).

The 3 segments of GPS

The Space segment

The space segment consists of 24 satellites circling the earth at 12,000 miles in altitude. The high altitude allows the signals to cover a greater area. The satellites are arranged in their orbit so a GPS receiver on the earth can always receive a signal from at least four satellites at any given time. Each satellite transmits low radio signals with a unique code on different frequencies, allowing the GPS receiver to identify the signals.

The control segment

The control segment tracks the satellites and then provides them with corrected orbital and time information. Also consists of four unmanned control station and one master control station. It receives data from the satellites and then sends that information to the master control station where it is corrected and sent back to the GPS satellites

The user segment

The user segment consists of the users and their GPS receiver.

The number of users is limitless.

Figure (3.4) show the GPS module.

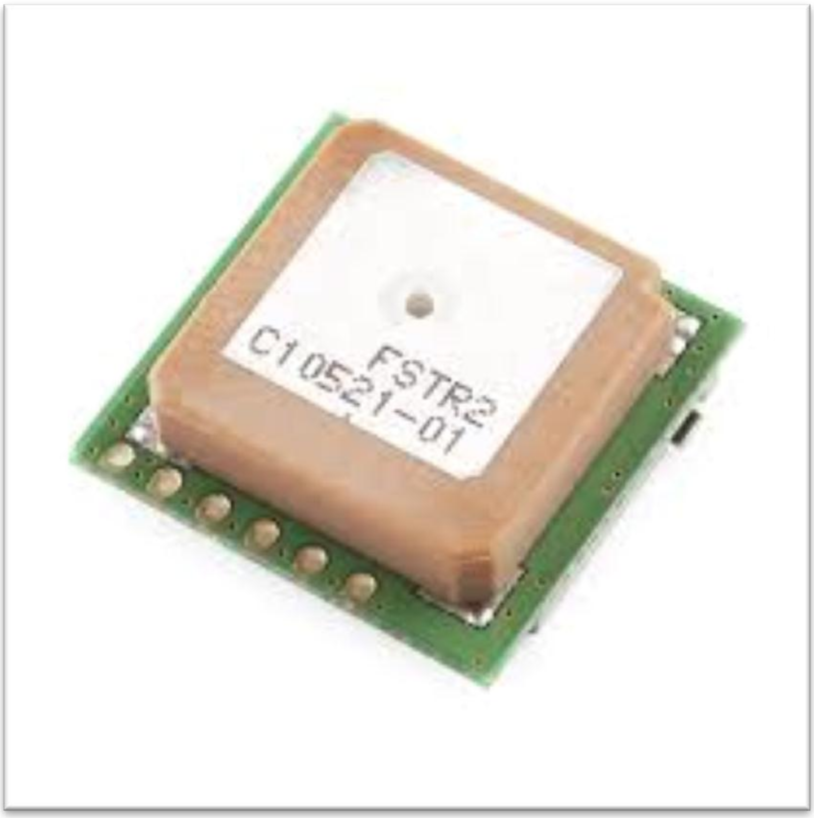

Figure 3.4 GPS module

3.1.3 Sensors System

DHT11 (Temperature & Humidity Sensor)

The DHT11 Sensor include a resistive – type humidity measurement components and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness [9].

The features

• Full range temperature compensated.

• Relative humidity and temperature measurement.

•Calibrated digital signal.

• Outstanding long-term stability.

•Long transmission distance.

• Low power consumption.

Figure3.5 the DHT11 sensor

Table 3.1 DHT11 Technical Specification:

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 ℃	±5%RH	±2℃	1	4 Pin Single Row

LM35

The LM35 series are precision integrated – circuit temperature sensor, whose output voltage is linearly proportional to the Celsius (centigrade) temperature. It Thus has An Advantages over linear temperature sensor calibrated in Kelvin , as the user is not required to subtract a large constant voltage from it is output to obtained convenient centigrade scaling .It does not require any external calibration or trimming to provide typical accuracies of (+1/4) or (-1/4) centigrade at room temperature and (+3/4) or (-3/4) centigrade over a full -55 to +150 centigrade temperature range .low cost is assured by trimming and calibration at the wafer level .The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy[10].

The features

- Calibrated directly in Celsius (centigrade).
- Linear + 10.0 mv/c scale factor.
- 0.5 ºC accuracy guarantee able (at+25ºC).
- Rated for full -35 to +150C range.
- Suitable for remote applications.
- Operates from 4 to 30 volts.
- Less than 60 µA current drain.
- Low self-heating 0.08ºC in still air.
- Low cost due to wafer-level trimming.
- Non linearity only±1/4ºC typical.
- Low impedance output, 0.1Ω for 1mA load.

Figure 3.6 the LM35 sensor

3.1.4 Power Supply

The Arduino can accept a range of voltage inputs (6-20 v), and regulates this to desired level internally on board. Not only that, the boards themselves have different power input ports, and some can be powered at multiple point on the board. For an Arduino a 9-volt battery used as power

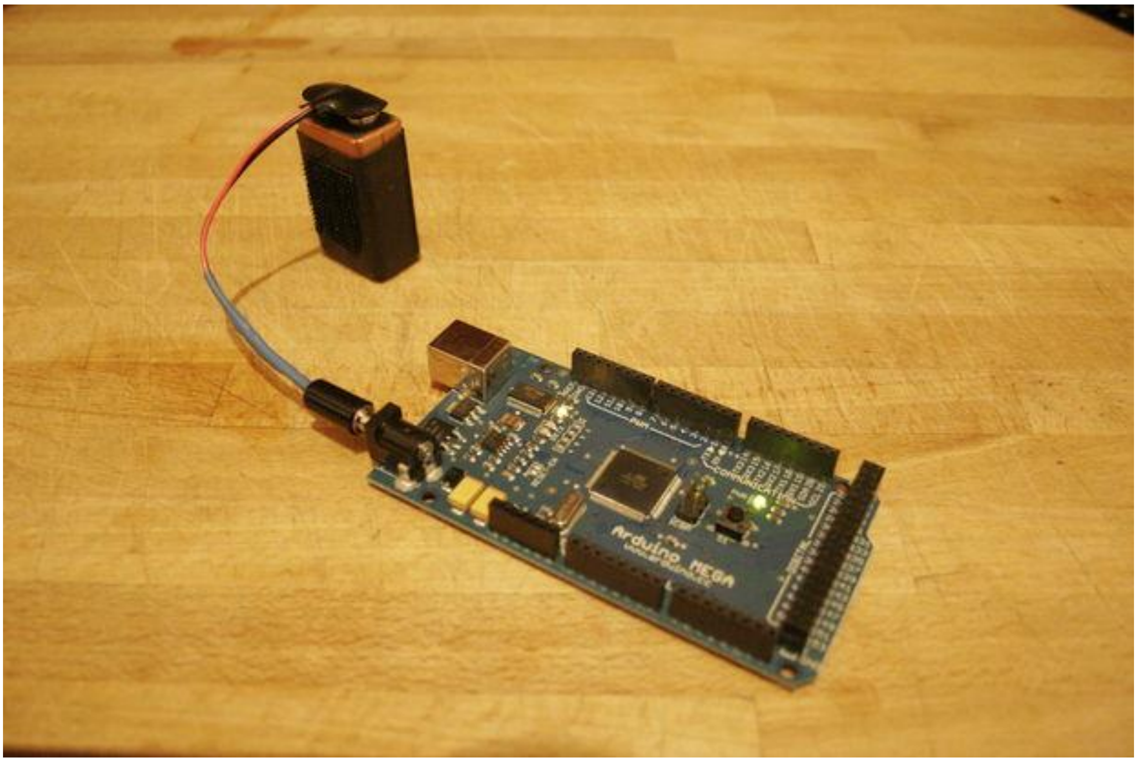

Figure 3.7 the battery of Arduino

A Power supply for all components (DHT11, LM35, TTL camera, GPS module and SD card) which connected with an Arduino feed by 5-V from an Arduino, but XBee module feed by 3.3 V from an Arduino via XBee shield at the payload. At the ground station XBee module feed by 3.3 V from the pc via TTL serial USB.

3.2 Image collection

TTL camera module

TTL serial camera module is a nice addition to a microcontroller to take a photo or control a video stream. The modules have a few features built in, such as the ability to change the brightness/saturation/hue of images, auto-contrast and auto- brightness adjustment, and motion detection. The module was initially design for surveillance purposes. It’s meant to constantly stream TV-resolution video out of the pin and also take commands from the serial port. The serial port commands can request that the module freeze video and then download a JPEG color image.

The maximum size it can take is 640×480 pixels. And it is sensitive to infrared light, which alters the color rendition somewhat.as shown below

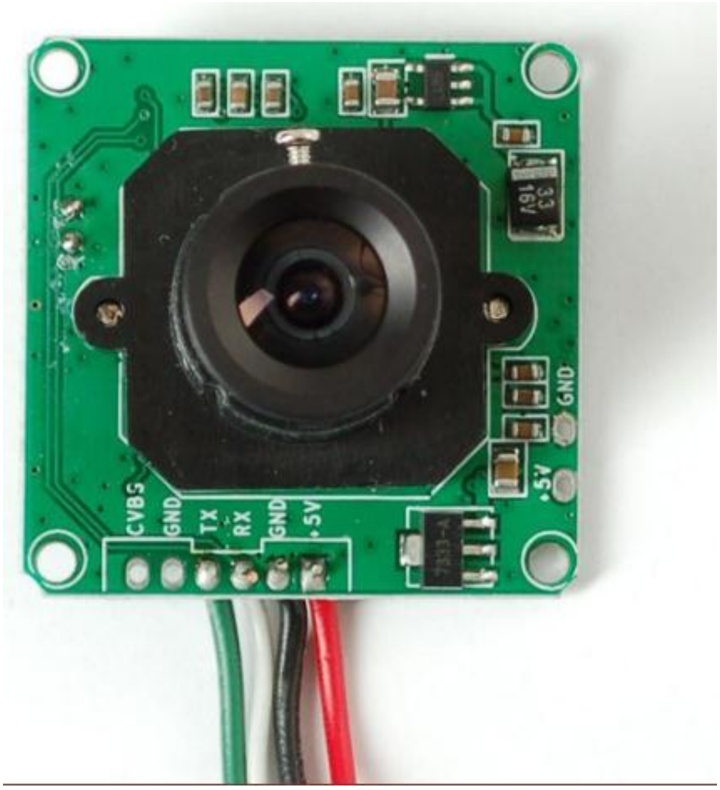

Figure 3.8 TTL camera

Features

- Module size: 32mm x 32mm
- Image sensor: CMOS 1/4 inch
- CMOS Pixels: 0.3M
- Pixel size: 5.6um*5.6um
- Output format: Standard JPEG/M-JPEG
- White balance: Automatic
- Exposure: Automatic
- Gain: Automatic
- Shutter: Electronic rolling shutter
- SNR: 45dB
- Dynamic Range: 60dB
- Max analog gain: 16dB
- Frame speed: 640*480 30fps
- Scan mode: Progressive scan
- Viewing angle: 60 degrees
- Monitoring distance: 10 meters, maximum 15meters (adjustable)
- Baud rate: Default 38400
- Current draw: 75mA
- Operating voltage: DC +5V
- Communication: 3.3V TTL (Three wire TX, RX, GND)

Secure digital (SD)card

Is a non-volatile memory card format developed by the SD Card association for used in portable devices. It used to store the photos which taken by a TTL camera module.

3.3 Balloon System

3.3.1 Balloon

The balloon is made of latex. Latex is a natural substance find in many plants. Which is extracted from maple trees The weight of balloon should just be enough to meet the demand, this way can save on cost and get the most out of the high altitude balloons. As the balloon climbs to the edge of space it eventually expands to the point where it bursts, the payload then fall back to earth under parachute.

Figure 3.9 The balloon

3.3.2 Helium

Helium has lees density than air and will rise to the surface of the earth's atmosphere. By trapping the helium inside balloon to attack a line to the balloon called flight train. Most weather balloon are filled with hydrogen due to the lower cost and higher buoyancy force but also hydrogen is far more dangerous to work with it, then for safety reason a helium is used as safety option for balloon filling.

The figure below shows the helium tanks

Figure 3.10 helium tank

3.3.3 Parachute

The parachute in a position where it opens immediately upon balloon burst. A length of load line (about 30 feet long) separates the parachute from the balloon.

There are several requirements for a parachute. First, the parachute must be large enough to slow down the descending capsule to a safe landing speed. Second the parachute must be constructed of materials that are not porous to the wind or stiff in the very cold temperate of near space. Three the parachute must be made of materials that are insensitive to UV exposure. Finally, it should be constructed of bright colors that can be seen from the ground. There are two opposing forces on a descending near spacecraft, weight pulling down and drag pulling up. When the force is equal the spacecraft falls at a constant speed.

The force of weight is given by the equation:

$$W = m * g \qquad (1)$$

Where m is the total mass of descending equipment (balloon, capsules and parachute) and g is the acceleration due to gravity (which changes by 1% in middle near space, but can be treated as a constant in this case).

The drag created by a parachute is given by the equation:

$$F_d = c_d * A * d_m * (v^2/2) \qquad (2)$$

Where c_d is the coefficient of drag of the parachute, A is the area of the parachute exposed perpendicularly to the air during descent, d_m is the density of the air the parachute is traveling through, and v the velocity the parachute is moving through the air. Of these factors, the coefficient of drag and area of the parachute are constants for a given parachute [3]

Figure 3.11 the parachute

3.4 The block digram of high altitude balloon

The high altitude balloon system(HABs) block diagram consists of two parts, the first part of the block diagram is the payload consists of GPS module to track the balloon on the flight mode using the satallites, DHT11 humidity sensor to measure humidity and temperature, LM35 sensor to measure temperature, TTL camera module with SD Card memory to take photos and to store it in SD Card, all of this components are controlled by an Arduino microcontroller as The" brain" of the Data Acquisition and Communication System. An arduino powered with 9V battery as power supply and the transmitter which transmit the data via XBee module which adjust as the router .

The second part of the block diagram is the ground station for data receiving by XBee module as the coordinator which connected to pc via TTL serial USB which receiving data from XBee module .

The block diagram shown in figure 3.12

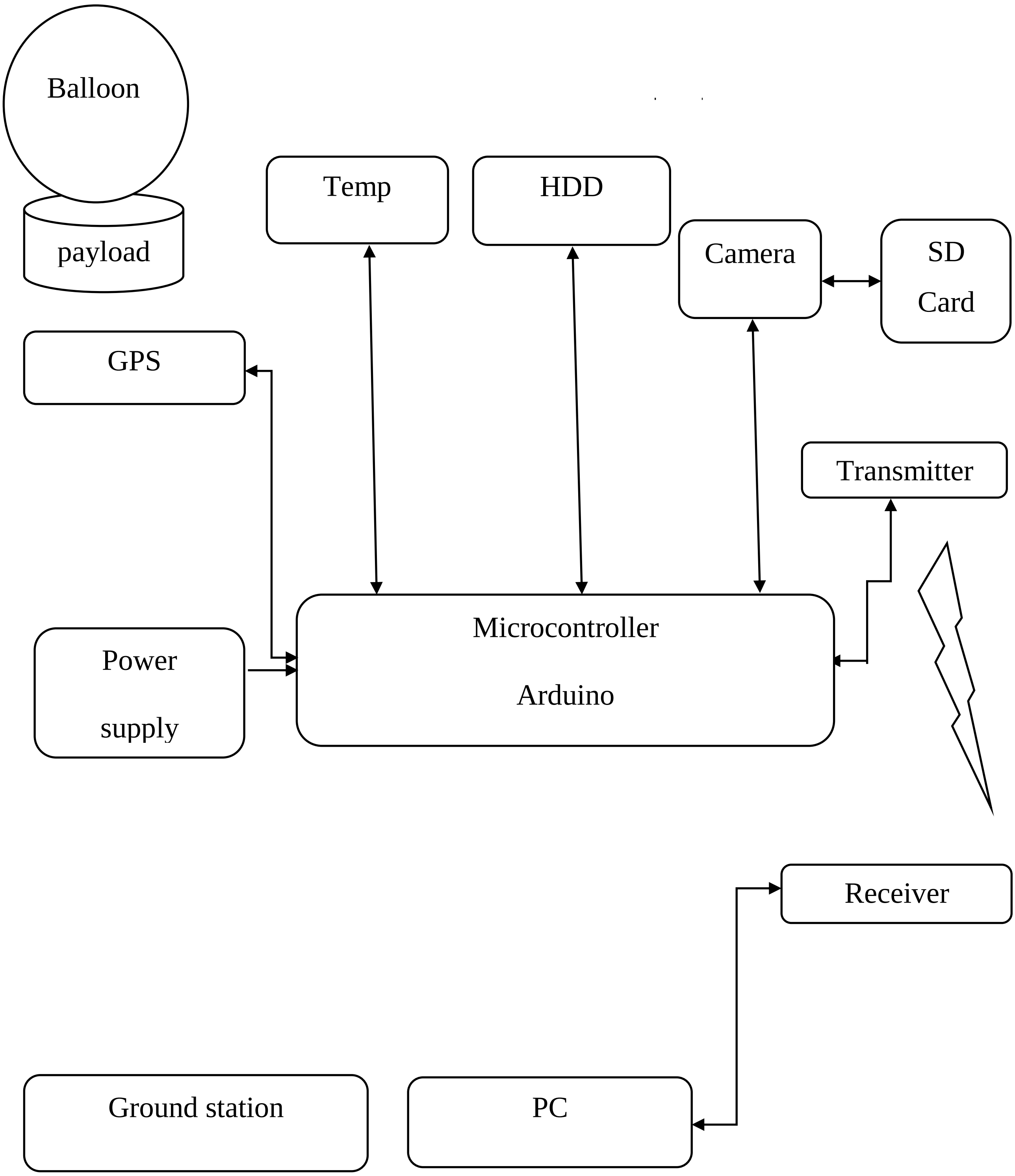

Figure 3.12 the block diagram of the high altitude balloon

CHAPTER FOUR

HARDWARE IMPLEMENTATION

CHAPTER FOUR

Hardware implementation

4.1 The connection of HABs system components

1. Microcontroller(Arduino)

an Arduino microcontroller which programmed with C++ language has been used in design of high altitude balloon(HABs) system, data gathering from the sensors such as temperature data from LM35 sensor and humidity data from DHT11 sensor and images receiving from the camera module which positioned inside the payload.

-Ardino Uno

It used in the payload for data transmitting from the balloon through Xbee module.

-TTL serial USB

It used in the ground station for data receiving from the balloon through Xbee module and displaying it at the pc screen.

2. DHT11 Sensor

It used for temperature and humidity measuring by using the exclusive digital-signal-acquisition technique and temperature and humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bits microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effective.

Table 4.1 DHT11 Specification

VCC	5V
Data	Digital pin 2
GND	GND

- VCC (DHT11) connected with 5v (Arduino).

- Data (DHT11) connected with Digital pin 2(Arduino).

- GND(DHT11) connected with GND(Arduino).

3. LM35 Sensor

It is an analog sensor consists 3 pins, which used to convert the surrounding temperature to analog voltage. The sensor output is connected to Arduino analog input 0 to extract the temperature in digital value, and then the value of voltage increase linearly by temperature increasing.

Table 4.2 LM35 Specification

VCC	5V
Data	Analog input A0
GND	GND

- VCC(LM35) connected with 5v(Arduino).

- Data(LM35) connected with analog input A0 (Arduino).

- GND(LM35) connected with GND(Arduino).

4. GPS Module

It used to specify the HABs location and then sending the location data to the ground station. A GPS system consists of 24 satellites around the earth at 20200 Km. A satellite radiates his location signal which also carry the timing of signal radiating in high accuracy and then the receiving device at the balloon payload receive the coming signal from a satellite. By comparing the timing of a signal radiation and signal arriving we can know the time of signals transferring and then calculating the distance between a satellite and HABs receiving device. By receiving three crossing signals from three different satellites we can specify the HABs location.

Increasing the number of satellites allow for HABs receiver with correcting the calculation errors, and then increasing the HABs location accuracy.

5. XBEE Module

A pair of xbee modules were been used programmed by X-CTU program. The first one adjust as a router at the HABs payload and used for wireless data sending from the balloon. The second one adjust as a coordinator and used for data receiving at the ground station and then displayed on a pc.

6. XBEE shield

A xbee shield was been used to connected between an Arduino and the xbee module coordinator.

7. Balloon

We used latex balloon for carrying payload. As a balloon climbs higher the pressure in the atmosphere decreases and then the balloon expands.

As the balloon climbs to the edge of space it eventually expands to the point where it bursts, our payload then fall back to earth under parachute.

8. payload

Is a Flynn box which consists:

- Arduino.

-LM35.

-DHT11.

-TTL Camera.

-GPS Module.

-XBEE Router.

-XBEE Coordinator.

-Bread board.

-Wires.

-GSM or IPhone.

-TTL serial USB.

9. Parachute

Is a plastic trash bag and nylon rope deployed to fall back the payload to the earth when balloon bursts.

4.2 simulation of the circuit

Proteus

Proteus is a virtual system modeling and circuit simulation application. The suite combines mixed mode SPIC circuit simulation, animated components and microprocessor models to facilitate co-simulation of complete microcontroller based design. Proteus also has ability to simulated the interaction between software running on a microcontroller and any analog or digital electronics connected to it. It simulates input/output ports interrupts, timers, USART and all other peripherals present on each supported processors. By using proteus program for design the electronic circuit of high altitude balloon that contains of the following components:

- **DHT11 Circuit**

  The first thing, including the DHT11 library and read DHT11 data sheet in order to understand how this device work and also to understand the programming code. The DHT11 use one-wire protocol to communicate with master device(Microcontroller), first the master device sends a star signal and then when this star signal detected by the sensor it sends a response signal to the master device, after that the sensor start sending data which has 40-bit long, first 16 bits for humidity (byte 1 and byte 2) and the second 16 bits for temperature (byte 1 and byte 2) and the last bit is a check-sum to know whether the data has been send correctly or not. The data send byte by byte and for DHT11 humidity byte 2 and temperature byte 2 are both zeros.

- **LM35 Circuit**

The first thing, finding LM35 library in Arduino library for proteus, the only addition is virtual terminal which used to check the values. The virtual terminal simply like the serial monitor that used in an Arduino software.

- **GPS Circuit**

First, including GPS library for proteus which adds GPS module to our components library and allows us to use GPS module in our proteus simulation. GPS module has been designed to output some fake NMEA data. NMEA is just a format in which GPS devices output data; the NMEA data from the GPS module is received by the Arduino through it is hardware serial port. The TinyGPS library parses the data received and “translates” it into understandable GPS data such as longitude and altitude and the data display on a virtual terminal inside proteus.

- **Xbee module circuit**

First, including xbee library and can quit easily using Xbee module in proteus software. Xbee has two pins TX and RX and we can easily have communicated with them. Each Xbee module has virtual terminal connected with it, also we can change the properties of one of these Xbee so double click on any one of these XBees, after it is seeming simply to change physical port of this module to COM 2 while the other module at COM, then Xbee start sending and receiving data on their respective COM ports. Finally, whatever type in the virtual terminal of first Xbee will appear in the virtual terminal of second xbee.

For this project the simulation has been done by three steps: first, write a code of each system circuit in an Arduino programming environment, second, collection of the sub codes which consists DHT11 code, LM35 code and GPS code in one code then verified and uploaded in an Arduino, finally, arraigning the code to proteus circuit and then execution of the circuit simulation to achieve the complete circuit simulation for our high altitude balloon system(HABs).

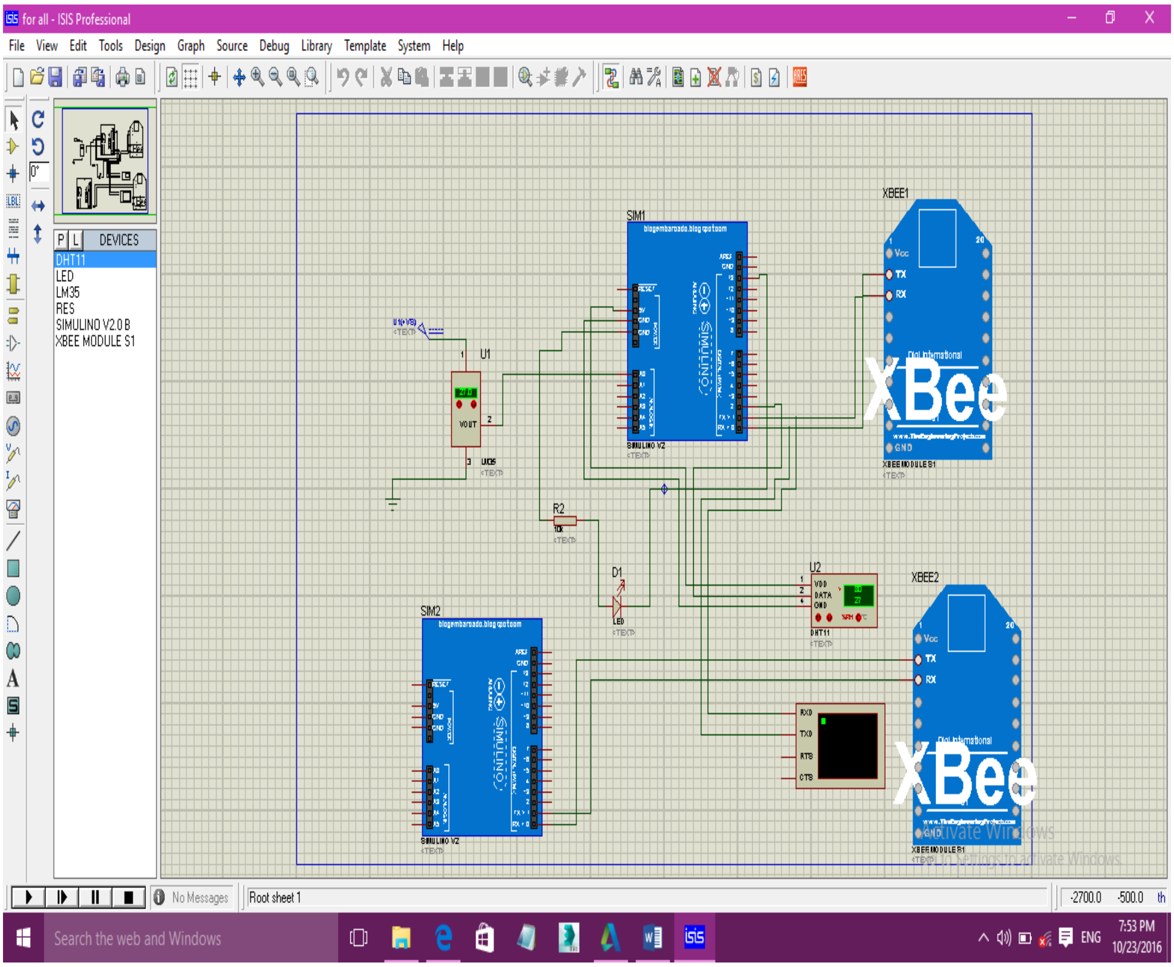

Figure 4 .1 simulation of HAB system

4.3 The results of the project

We design a flexible design of high altitude balloon system which capable to measure the humidity and temperature, and collect photos. Also we used xbee module for wireless communication between the balloon system and ground station. The hardware circuit of HAB.

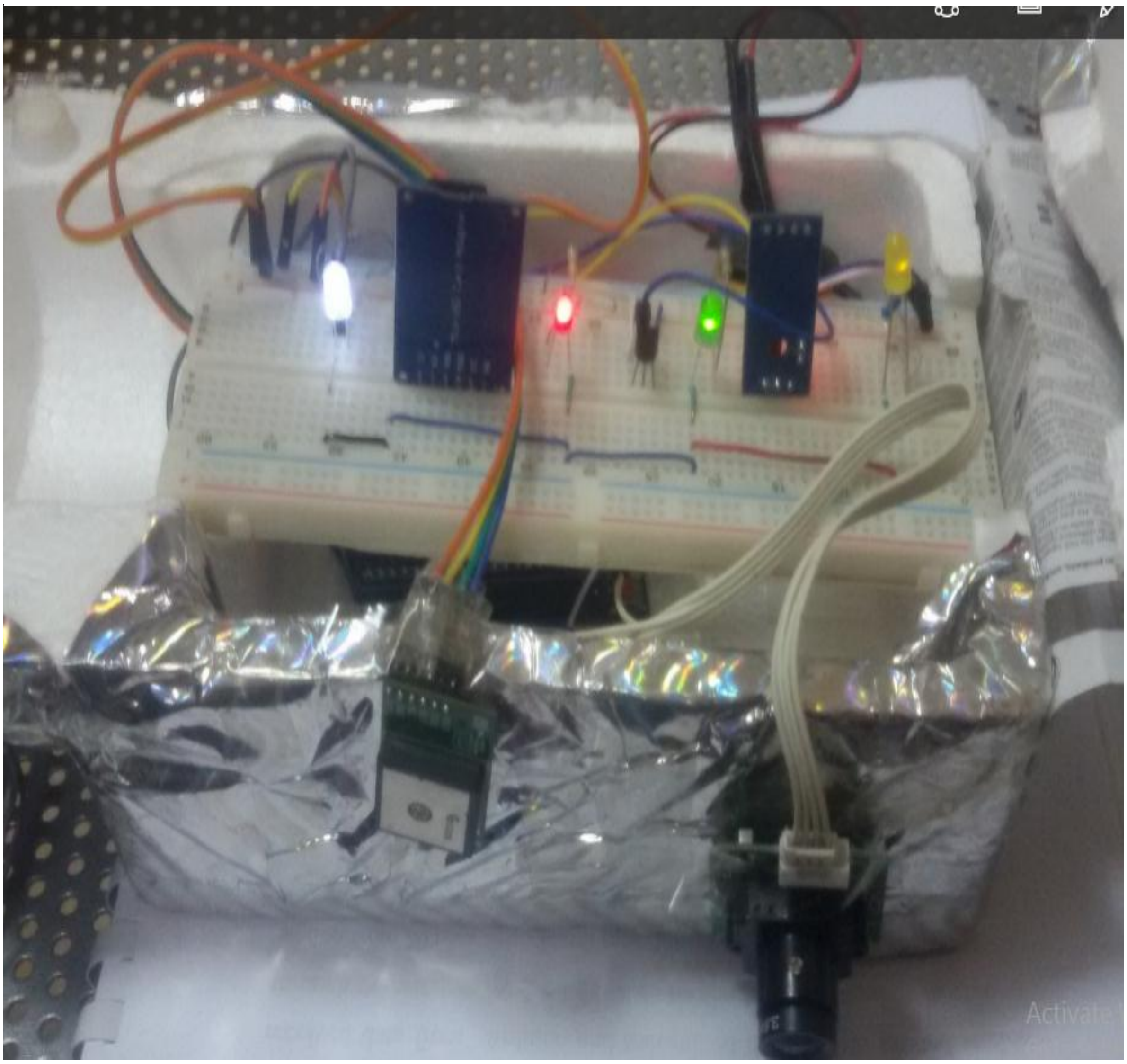

Figure 4.2 the hardware circuit of HAB

Table 4.3 The relationship between temperature and voltage for LM35 sensor

Temperature(c)	Voltage(v)
32	1.05
32	1.05
31	0.89
33	1.53
33	1.06
32	1

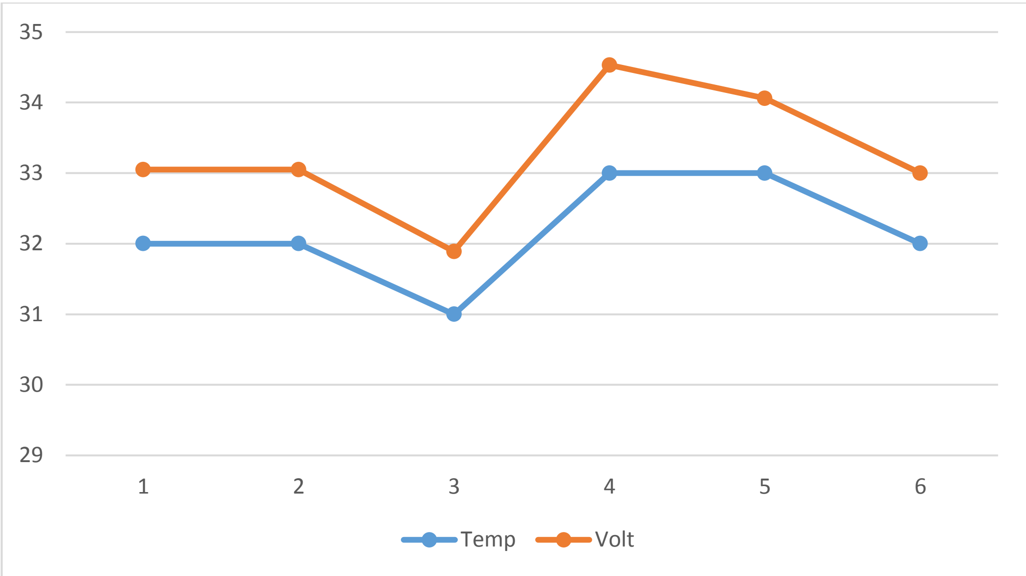

Figure 4.3LM35 sensor relationship

The relationship between temperature and voltage for LM35 sensor is linear relationship which the voltage increase at the output of LM35 sensor by increase the temperature this measurement shown on table (4,3) that take at ground station.

For the DHT11 the humidity was been measured in the Sudan university at 11:10 am 20/10/2016 is 14 RH at the ground station.

4.4 Table of Cost:

Components	**Cost by SDG**
Arduino	250
Breadboard	100
LM35 Sensor	35
DHT-11 Sensor	180
Xbee Module (Two pair)	800
Xbee Shield	250
Wires	20
Camera Module	850
GPS Module	550
Battery	40
TTL	150
LEDs and Resistors	25
Total Cost	3,250

CHAPTER FIVE

CONCLUSION AND RECOMENDATIONS

5.1 Conclusion

As a result of this project, a deep understand for high altitude balloon system design had been achieved with some help from institutes space research and aerospace (ISRA), learning how to simplify and maintain the payload components and how to cope with stabilization and weight limitations after that the system has been tested to ensure its capability to measure humidity, temperature, altitude and capture photographs.

Finally, from this design experiment release that, the high altitude balloon system(HABs) development limitation by two major factors, first, the cost of the system, second, the power of the system; these factors lead to system complexity, then it is important to care about them in HABs design.

5.2 Recommendations

From this experience in HABs project, a lot of recommendations were being laid on high altitude balloon (HABs) design especially on developing countries such as our country “Sudan”, which on it there is a big potentials problem on coverage infrastructure, so that the HABs with a varies economical and innovative applications to give coverage in developing countries for large number of services including, Internet, weather measurements and forecasting, and image capturing.

Also it is important to lay advice for the researchers in this field to concentrate in the stability of HABs systems at atmosphere layer to rich exactly the desire altitude and developing the wireless connection between the balloon system and ground station.

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Appendix’s

Appendix (A)

The Code

```
#include   "DHT.H"

 #define   DHTPIN

# define   DHTTYPE  DHT11

# define   dht_apin  A0

 DHT  dht (DHTPIN, DHTTYPE) ;

Const  int  sensorPin = A0;

int reading;

float voltage;

float temperature;

int ledPin =13;

int value;

String input String =" ";

Boolean string Complete = false ;

void setup( )  {

Serial.begin(9600);

PinMode (ledPin,OUTPUT);

Serial.println("DHTxx test"!);

dht.begin ( );

input String .reserve(200) ;

void loop (){
```

```
Reading=analogRead(sensorPin);

Voltage=reading*5.0/1024;

Serial.print(voltage);

serial.println("volts");

temperatureC=(voltage-0.5)*100;

//  Serial.println ("temperature is:");

// Serial.print("temperature C ");

Serial.println("degrees C");

value =Serial.read( );

if (value=='1') {digitalWrite(ledPin,HIGH ); }

else if (value =='0') {digitalWrite(ledPin,LOW  );}

// Wait a few seconds between measurement .

delay(2000) ;

float h = dht.read Humidity( );

//Read temperature as Celsius (the default  )

float t = dht.read Temperature  ( );

//Read temperature as Fahrenheit (is Fahrenheit = true )

float f = dht.read Temperature(true)  ;

//Check if any reads failed and exit early (to try again);

if (isnan(h) || isnan(t) || isnan(f) )

{

Serial.println("Failed to read from DHT sensor !");
```

```
return ;
}
//Compute heat index in Fahrenheit (the default)
float hif = dht. compute HeatIndex(f, h ) ;
//Compute heat index in Celsius (is Fahreheit = false)
float hic = dht.compute HeatIndex(t, h, false );
Serial.print("Humidity:");
Serial.print(h);
Serial.print(" %\t ") ;
Serial .print("Temperature :");
Serial.print(t );
Serial.print(" *C ") ;
Serial.print(f  );
Serial.print(" *F\t" ) ;
Serial.print("Heat index: " );
Serial. print(hic)  ;
Serial. print(" *C ") ;
Serial. print(hif)  ;
Serial. println(" *F") ;
} (if (string Complete
Serial. println (input String ) ;
//clear the string:
```

```
input String =" " ;

String Complete = false ;

}

}

void serial Event () {

while (Serial. available ( ) )

{

char in Char = (char)Serial. read ( );

input String += inChar  ;

if (in Char == '\ n')   ;

string Complete = true  ;

}

}

}
```

Appendix (B)

Troubleshooting

- DHT 11

Consist of three pins, the first pin is VCC feed to 5Vfrom Arduino by using red wire and the second pin is data connected to the pin 2 on the Arduino by using blue wire and the third pin is ground connected to the ground in the Arduino. If any of the three pins reverse, this is connection problem and therefore the DHT11 cannot work.

- LM35

Consist of the three pins, the first pin is VCC feed to 5V from Arduino by using red wire and the second pin is data connected to the analog input pin (A0) on the Arduino by using white wire and the third pin is the ground connected to the ground Arduino by using green wire this pins a to the status of the LM35 in the circuit. If any of the three pins reverse, this is connection problem and therefor the LM35 cannot work.

- LED

Consist of two pin the first it is longer than the second, the first connected to pin 13 in Arduino by using yellow wire and the second pin connected to the resistor 10kΩ. If the two pin reverse, LED cannot emit light.

- Xbee module

Consist of 20 pins connected to the Arduino by the Xbee shield received data from Arduino and transmitted data to the ground station through the wireless received this data by another Xbee module in ground station from 20 pins ,used fourth pins the pin number one is VCC connected to the TTL module by white wire and the pin number two is transmitter connected to the TTL receiver by violet wire and pin number three is receiver connected to the transmitter of TTL by white wire and the pin number ten is the ground of the Xbee connected to the TLL module ground . If any of the pins reverse, this is connection problem and therefor the Xbee cannot worked.

- TTL module

Consist of five pin and USB connection with the PC, the first pins the VCC 3.3V connect to the VCC pin one from Xbee module by violet and the second pin is the transmitter (TX) connected to the receiver of the Xbee module by using white wire and the third pin is receiver (RX) connected to the receiver of the Xbee module by using gray wire and the four pin is the ground connected to the ground of the Xbee module in pin 10 by the white wire and four pin is VCC5V which is not used. If any of the three pins reverse, that is connection problem and therefor the TTL module cannot work.

- TTL camera module

Consist of the four pins, the first is the VCC (5V) connected to the VCC power supply and the second pin is ground connected to the ground connected to the ground of the circuit, the third pin is the transmitter (TX) connected to the receiver (RX) of the Arduino and the four pin is the RX connected to the TX of the Arduino. If the any four pins reverse this is connection problem and therefor the TLL camera cannot work.

- After the test of the all components connection is properly work.
- Other problem

  Any problem appear after that test this is software problem, it can troubleshooting by modification of the software code for (C++ codes for Arduino, DHT11, LM35, GPS, LED, and XCTU for TTL, TTL camera and Xbee module).