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**A Project Report**

**On**

**“Pico Sat”**

**[Course Code: COMP 303]**

**(For partial fulfillment of III Year/ I Semester in Computer Engineering)**

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**Bonafide Certificate**

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Any suggestions for the improvement of the project will be highly appreciated.

Sincerely,

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# Abstract

Pico Sat is a simulation of a real satellite with mass less than thousand grams and integrated with subsystems such as on-board computer, microcontrollers, sensors and communication systems. Climate change presents the single biggest threat to sustainable development everywhere. So, we have created a prototype of a Pico Sat as a research project to monitor the different aspects of environment. The main objectives include measurement of environmental parameters as temperature, pressure, altitude, dust, humidity and pollution. The collected data by sensors is transmitted on real time through wireless channels, retrieved and processed on ground station. This data is stored in our database and represented graphically in the GUI. The data from our device is also analyzed and compared with data from standard API. Since, research on this kind of technology is in growing phase in Nepal, this project could be a great milestone and foundation for development on space research projects.

**Keywords:** *Pico Sat, Climate change, Environmental parameters, Ground station, Sensors, API*

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# Abbreviations

|  |  |
| --- | --- |
| **Short form** | **Full form** |
| PCB | Printed Circuit Board |
| DHT | Digital Humidity Temperature |
| BMP | Barometric Pressure |
| JS | JavaScript |
| SQL | Structured Query Language |
| HTML | Hypertext Markup Language |
| CSS | Cascading Style Sheets |
| UI | User Interface |
| WWW | World Wide Web |
| JSON | JavaScript Object Notation |
| API | Application Program Interface |
| IDE | Integrated Development Environment |
| Ghz | Gigahertz |
| ISM | Industrial Scientific and Medical |
| ML | Machine Learning |

# Introduction

## Background

Pico Sat is a simulation of a real satellite with mass less than thousand grams and integrated with subsystems such as on-board computer, microcontrollers, sensors and communication systems [10]. The system consists of a ground station for receiving the real time data from the Pico Sat and the data is projected in GUI. This project offers a unique opportunity for us to have a first practical experience of real space project.

Climate change presents the single biggest threat to sustainable development everywhere. This has inspired many scientists studying about weather impacts in living as well as non-living beings. Previously, there were simple and inaccurate instruments, which were inadequate for easy reading and storing data. Nowadays, there are many advanced observatories and labs collecting the environmental parameters continuously for different applications. However, these come at the high cost of time, money and human resources. In this scenario, miniaturized satellites can play an important role not only in the academics, but also in scientific projects for observing, monitoring and analyzing the environmental data. Even though, the cost for constructing small satellites is very low compared with those of the standard sizes designed for science and communication missions, the data provided by these satellites are found to be highly reliable [6]. So, with the help of this Pico Sat we can study the real time data of lower level atmosphere and represent the data visually for easy analysis.

In the context of our country, our government has set up pollution measuring stations at 19 different places in our country as shown in the website [*www.pollution.gov.np*](http://www.pollution.gov.np)*.* On one hand while this number is too low, on the other hand, the reliability of the data can be questioned because when we go the ‘Research & Data Analysis’ page of the website, we are welcomed with a blank page [4]. While every developed city has a well-planned pollution monitoring system, we are lagging behind in every single sector. Environmental data analysis is an utmost necessity in our country.

This is our research-based project where we have developed a prototype for measuring environmental parameters using relatively inexpensive components. We have collected environmental data from our university location and create a system for visually monitoring the data from ground station. By collecting the data from different sensors and analyzing various data we can study about the current climatic conditions of our location. Pollution can also be monitored, and alerts can be generated. By comparing our data with the data from pre-existing sources we are able to know about usefulness and status of our system.

## Objectives

The primary objective of this project is to measure the environmental parameters and develop a system for monitoring the changes in those parameters. We initiated this project with following objectives:

1. To retrieve real time data of pressure, temperature, altitude and humidity.
2. To detect dust level in atmosphere to analyze about pollution.
3. To alert and help coping about climate change.
4. To measure the weather statics of specific area, room, lab or industry.

## Motivation and Significance

Recently, Nepal launched its first satellite NepaliSat-1 successfully [13]. With this humble beginning Nepal has entered the Space-Era and the success of this project means we are now technically capable of preparing such satellites in future. New paths have opened for space engineering in our country [9]. Also, last semester Kathmandu University Robotics Club (KURC) conducted a two-day workshop on Can Sat, which is a simulation of a real satellite, integrated within the volume and shape of a soft drink can [1].

The pollution monitoring system used in our country is not satisfactory and a lot of changes are yet to be made. Data is an important aspect of smart city. Proper analysis of data can be used to infer a lot of things. Further, analyzed data is used by policy makers to come up with plans and policies for development of certain state. Hence, in the light of aforementioned motivation and issues, we have developed this system.

The significance of our project are:

1. We can study about our atmosphere from local level using our own technology.
2. We can compare our data with standard API data to know status of our system.
3. Real-time data can be obtained from difficult terrain and high altitude.
4. Use our data for research and analysis purposes.

# Related Works

The concept of this type of Pico Sat is relatively new in our country. However, there have been a lot of Pico Sat related experiments and competition in other countries. Competitions for these kinds of satellites have taken place in many countries around the world since the late 1990s. This kind of system has been mostly used for educational purposes, but inclusions in scientific projects demonstrates that it can be used for both scientific and technological applications. Some of the related works are:

## 2.1. Pollution.gov.np

Our government has set up pollution measuring stations in different places in our country. Data from 19 such stations as shown in the website [*www.pollution.gov.np*](http://www.pollution.gov.np)*.* The site is named Air Quality Monitoring and it is under Department of Environment, Ministry of Forests and Environment, Government of Nepal. These kinds of stations are expensive and have been setup only in cities, seven of them being in Kathmandu Valley only. These kinds of stations are placed in Lumbini, Ratnapark, Shankapark, Bhaisipati, Dhulikhel, Sauraha, Bhaktapur, Jhumka, Pulchok, Nepalgunj, GBS-Pokhara, DHM-Pokhara, Dang, Phora Durbar, Simara, Damak, US Embassy, Dhankuta and PU-Pokhara [4].

On one hand while this number is too low, on the other hand, the reliability of the data can be questioned because when we go the ‘Research & Data Analysis’ page of the website, we are welcomed with a blank page. The site also has News and Event section which shows nothing and a tweets section where latest tweets by @DoEnv\_Nepal are shown.

According to the site, air pollution has become a serious environmental concern and a public health risk in Nepal [11]. Government of Nepal has taken various initiatives for the control of air pollution. Air quality monitoring program is one of the initiatives of the Department of Environment. Department of Environment is planning to set a network of air quality monitoring network throughout the country. The data from air quality monitoring can be accessed through this website.

Under the Stations page we can get environmental data for individual cities. The data related to air temperature, pollution, wind speed, wind direction, ozone concentration, etc are given in table along with visual graph.

A screenshot of a computer screen

Description automatically generated

Figure 1 Air Quality Index in Nepal [4]

## 2.2. European Space Agency (ESA)

The European Space Agency (ESA) [3] is Europe’s gateway to space. Its mission is to shape the development of Europe’s space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world. ESA organizes different Pico Sat related competitions in Europe to increase support for space activities in Europe. Simulation of a real satellite integrated within the volume and shape of a soft drink can. The challenge for the students is to fit all the major subsystems found in a satellite, such as power, sensors and a communication system, into this minimal volume. The Satellite is then launched to an altitude of a few hundred meters by a rocket or dropped from a platform or captive balloon and its mission begins: to carry out a scientific experiment and achieve a safe landing.

## 2.3. Defense Advanced Research Projects Agency (DARPA)

DARPA [2] initiated a microsatellite program featuring extremely small microelectromechanical systems (MEMS) radio frequency (RF) switches. The first picosat mission, launched on January 26, 2000, demonstrated MEMS RF switches operating on a pair of tethered satellites, each one weighing just over one pound. The program demonstrated how constellations of small satellites could work together in the future with dramatically reduced size and power requirements.

## 2.4. Dyacon

Dyacon, Inc. [7] was established in October 2007 in beautiful northern Utah, USA, to build commercial vehicle tracking computers. In 2012, Dyacon began development of a line of weather instruments. These products benefit from the Dyacon team’s extensive experience in rugged electronic design and cost-effective value. The features that Dyacon weather stations provide are unique to the industry. Dyacon focuses on weather satellites. Satellite stations are shipped pre-configured, allowing new stations to be up and operational in less time. These satellites have plug-and-play capability with industrial flexibility; the embedded cell phone in the satellite or WiFi capability and Modbus port eliminate expensive satellite links, server programs, and minimizes IT support.

A picture containing text, map

Description automatically generated

Figure 2 Dyacon Equipment [7]

## 2.5. Acurite

Acurite is a weather product selling brand in North America. They offer the technology for personal weather stations builders. However, they are expensive and cost hundreds of dollars. Acurite focuses on building personal weather stations called My Acurite, which is small enough to be carried by general people. My Acurite has smartphone app, tablet, and browser-based interface lets user view home conditions from work, or vacation. They allow user to know their environment in and around the living space and keep tabs on all places. My Acurite can be programmed to alert user to hazardous outdoor conditions like high wind gusts and excessive rainfall. It can also notify about dangers inside the home, like a leaking appliance or potential conditions for mold through personal satellite. The system supports Google Assistant.

A screenshot of a cell phone

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Figure 3 Acurite Equipment [5]

## 2.5. KAIST

KAIST (KAIST, n.d.) or Korea Advanced Institute of Science and Technology [8] is a national research university located in Daedoek Innopolis, Daejeon, South Korea. Seven KAIST Institutes(KIs) have been set up among which Korea Aerospace Research Institute Goheung Aviation Center have developed this technology. There satellite is wings or rotors based, which are mechanically more complex and less vulnerable to weather conditions. These are much harsher to govern and require an electronic system able to perform many more corrections per second due to its higher rate of descent.

## 2.6. ACEMA

ACEMA (Argentina, n.d.) OR Association of Experimental Rocketry and Space Modeling of Argentina [5] provides program to students to develop Pico Sat.  This program is released for free and provides students satisfaction, involving them in the entire life cycle of a complex engineering project, ranging from conceptual design, integration, testing, and actual system operations, concluding with a meeting of post-mission summary. The program was presented in September 2003 at an educative conference, and the first Argentine CanSat was launched in November 2004, prepared by students of Colegio San Felipe Neri.

## 2.7. ZACan-1

ZACan-1 is the first South African Pico Sat, and was carried to height of 1650m, as payload aboard a High-Power Rocket, on 6 November 1999. ZACan-1, the Satellite was designed and built by Stéfan Stoltz and launched in the Roodewal FAR76 airspace (Limpopo Province) as part of a Technology Exhibition by the University of the North (now the University of Limpopo). In 2011/12, the University of Cape Town (UCT)  launched its first CanSat competition in association with the South African Astronomical Observatory. South African universities have started evaluating and integrating CanSat projects into their curricula. Starting with ZACan-1, South African National Space Agency will play a leading role in the future promotion of CanSat competitions within South Africa.

# Chapter 3: Design and Implementation

## 3.1. System Requirement Specification

Pico Sat is a simulation of a satellite for lower level atmosphere. We have used different hardware and software in order to build this system.

### 3.1.1. Software Specification

### 3.1.1.1. Front End Tools

**a. Microsoft Visual Studio:** Microsoft Visual Studio is an integrated development environment from Microsoft. It is used to develop computer programs, as well as websites, web apps, web services and mobile apps. We used Microsoft Visual Studio to create the desktop GUI for our project.

**b. HTML:** HTML stands for Hyper Text Markup Language. HTML describes the structure of Web pages using markup. HTML is the building blocks of web pages. We used HTML to create the basic page setup for web application of our project.

**c. CSS:** Cascading Style Sheets (CSS) is astylesheet language used to describe the presentation of a document written in HTML. CSS describes how elements should be rendered on screen or on other media. CSS was used for layout and adding beauty to our project.

**d. JavaScript:** JavaScript is a lightweight, interpreted programming language. It is one of the core technologies of WWW. It enables interactive web pages and is an essential part of web applications. All major web browsers have a dedicated JavaScript engine to execute it.

**e. React:** React is a JavaScript library for building user interfaces. It is maintained by Facebook and a community of individual developers and companies. React can be used as a base in the development of single-page or mobile applications.

**f. Ant Design:** Ant Design is an enterprise-class UI design language and React UI library with a set of high-quality React components. We have used Ant Design for creating several React components for our web application.

**g. Chart.js: C**hart.js is an open source JavaScript library supporting different chart types. It is a small JS library at just 60kb. It uses canvas element for rendering and is responsive on window resize to maintain scale granularity. We have used chart.js for graphical representation of our data.

**h**. **JSX:** JSX is a form of markup used in React. It looks very similar to HTML but is converted to JavaScript behind the scenes. Since writing JSX requires less code than JavaScript this will allow for a faster and more optimal performance.

### 3.1.1.2. Back End Tools

**a. NodeJS:** Node.js is a very powerful JavaScript-based framework/platform built on Google Chrome's JavaScript V8 Engine. It is used to develop I/O intensive web applications like video streaming sites, single-page applications, and other web applications. We have used Node.js to create API for our project.

**b. MongoDB:** MongoDB is a cross-platform document-oriented database program. Classified as a NoSQL database program, MongoDB uses JSON-like documents with schema. MongoDB is developed by MongoDB Inc. We have used MongoDB for our database in this project.

**c. Robo 3T: Robo 3T is a free and lightweight GUI for MongoDB.** It is a MongoDB management tool which has a shell-centric cross-platform and is supported by JSON. With the help of this mongo shell, a user could view, edit and delete mongo documents. We used Robo 3T for better data visualization during the API creation for our project.

### 3.1.1.3. Hardware Programming

**a. Arduino Software:** The Arduino Software (IDE) allows us to write programs and upload them to our board. The environment is written in Java and based on Processing and other open-source software*.* We have used Arduino IDE to program our Arduino boards.

**b. C:** C is a general-purpose, procedural computer programming language supporting structured programming, lexical variable scope, and recursion, while a static type system prevents unintended operations. We have used C programming language for programming our Arduino boards.

## 3.1.2. Hardware Specification

The hardware specification for our project are:

**3.1.2.1. Arduino Uno:** The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits.

**3.1.2.2. Arduino Nano:** The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P. It has more or less the same functionality of the Arduino Uno. It lacks only a DC power jack and works with a Mini-B USB cable instead of a standard one.

**3.1.2.3. MQ- 135:** The MQ- 135 Gas sensor is mostly used for detecting   NH3, NOx, alcohol, Benzene, smoke and other harmful gas in environment. It can be used in home, industries as domestic gas leakage detector, portable gas detector and many more.

**3.1.2.4. DHT11:**  DHT11 module is digital humidity and temperature sensor mostly used for detecting humidity and temperature of surrounding environment and outputs a digital signal on the data pin. It is durable and has anti-interference ability.

**3.1.2.5. BMP180 Pressure Sensor:**  It measures the atmospheric pressure. It helps to measure environment temperature and pressure and barometric pressure.by which we can calculate altitude which can be used in various application like weather monitoring, navigation with I2C interface.

**3.1.2.6. Dust Sensor:** Dust Sensor Sharp’s GP2Y1010AU0F is designed to sense fine dust particles.  It allows to detect the reflected light of dust in air.

**3.1.2.7. Motion Sensor:** The Intenseness MPU-6050 sensor contains a MEMS accelerometer and a MEMS gyro in a single chip. It is very accurate, as it contains 16-bits analog to digital conversion hardware for each channel.

## 3.2. System Design

### 3.2.1 Procedure

### STEP 1: Mechanical design and construction

* Testing of sensors.
* Assembling PCB with all the sensors.
* Continuity Testing.

### STEP 2: Data communication

* Simplex mode of data communication.

### STEP 3: User Interface

* Design the UI.
* Develop the GUI using Visual studio for desktop application and React for web application.

### STEP 4: Data handling and analysis

* Create a schema for storing data efficiently.
* Bind the API with front end.
* Data analysis and comparing with other data sources.

### 3.2.2. System Architecture

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Figure 4 System Architecture

### 3.2.2. ER Diagram

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Figure 5 ER Diagram

### 3.2.3. Data Flow



Figure 6 Data Flow Diagram

# Chapter 4: Challenges and Achievements

## 4.1. Challenges Faced

Since this kind of project is relatively new in our country , developing this project proved to be a rather challenging task. There were things which we had to figure out on our own after making several mistakes. But this project was not only a challenge but a great opportunity for us to learn. The challenges faced by us can be categorized as:

### 4.1.1. Non-Technical Challenges:

* The project needed a lot of time for researching and figuring out things. Juggling between classes, assignments and labs it was a huge challenge for us to make time for completing this project in limited amount of time.
* There was no dedicated lab or workspace for hardware works for this project. We are thankful to Kathmandu University Robotics Club for providing us the workspace and tools required for this project.
* Although most of the equipment were provided by the department on time, a few of them were not. As we were short on time, we had to manage the equipment by ourselves.

### 4.1.2. Technical Challenges:

* There were some hardware failures. The microcontroller was re-programmed large number of times, and there was wear and tear on its ports.
* Different sensors required power on their own. So, power management for every sensor was a huge challenge for us.
* Since we did our project on Matrix board with hand wiring, the soldered connections were not that robust and dealing with connectivity issues was challenging.
* There was not much support on the internet for serialport library which we used for reading our data from ground station.

## 4.2. Significant Features

### 4.2.1. Portability

Here is the specification of our product:

* Weight: 100 grams
* Diameter: 8 cm
* Height: 10 cm

The device is portable, can be installed anywhere easily, be it any terrain or a house room.

### 4.2.2. Wireless Transmission

The Pico Sat transmits the data wirelessly to the ground station through radio frequency using ISM band 2.4 Ghz. The transmission range is around 1100 meters.

### 4.2.3. Economical

The cost to build this project is approximately Rs. 4000 for the hardware and Rs. 1000 for the software. The device is economical that most of the people living throughout the country can easily afford it.

### 4.2.4. Self-Sustainable

Pico Sat come with a solar panel making it self-sustainable. So, this can be used in remote areas or difficult terrain where supply of electricity would be a challenge.

### 4.2.5. Graphical Representation

The environmental data collected is represented graphically in real time as well as graphs are available for history data.

### 4.2.6. API

The API used in system, if hosted somewhere on the internet can be used by developers for developing their own products. It promotes the use of locally generated data.

# Chapter 5: Conclusion and Recommendation

Pico Sat is an environmental monitoring system consisting of hardware equipments, web application and desktop application focused on the Sustainable Development Goals number 3 (Good Health and Well Being), 11 (Sustainable Cities and Communities), 13 (Climate Action) and 15 (Life on Land) [12]. This project can provide the environmental parameter data of a specific location which would help to monitor, alert and make policies regarding the environmental aspects.

While we worked really hard to create this project in the time span of three months, due to time constraints there are certain limitations in the system, and we expect to make some future enhancements in the coming days.

## 5.1. Limitations

Although we have tried our best to create a robust and perfect system, due to the time constraint of the project, there are still a few gaping inconsistencies in it.

* The connections made by hand soldering are not as robust as we desired.
* The system is not waterproof, so might be a problem after system installation.
* As double-sided printed PCB was not available in Nepal, we had to use matrix board which makes our system a bit weaker.
* Due to lack of sufficient data, data analysis could not be that effective and our system cannot be used for prediction system.

## 5.2. Future Enhancements

Based on the limitations of the project, we intend to make some enhancements to the project to make it more deployable in the market.

* Use of double-sided printed PCB instead of matrix board to make our system robust and much durable.
* Use of outer covering to make the system waterproof.
* Use of data logger in the Pico Sat itself to save the data in satellite itself in case of any data transfer failure.
* Development of weather prediction system using ML.

References

1. *About Aavishkar 2019*. (2019). Retrieved from Aavishkar 19: http://kurc.ku.edu.np/aavishkar/

*2. About DARPA*. (2019). Retrieved from DARPA: https://www.darpa.mil/about-us/about-darpa

*3. About ESA*. (2018). Retrieved from ESA: http://www.esa.int/Education/CanSat/What\_is\_a\_CanSat

*4. Air Quality Monitoring*. (2020, March). Retrieved from Pollution: http://pollution.gov.np

5. Argentina, A. (n.d.). *ACEMA*. Retrieved from ACEMA website: http://www.acema.com.ar/

6. Colin, A. (2015). *The cansat technology for climate monitoring in small regions at altitudes below 1km*. Retrieved from ResearchGate: https://www.researchgate.net/publication/317840722\_The\_cansat\_technology\_for\_climate\_monitoring\_in\_small\_regions\_at\_altitudes\_below\_1km

*7. Dyacon- Our History*. (2019). Retrieved from Dyacon: https://dyacon.com/about-us/

*8. KAIST*. (n.d.). Retrieved from kaist cansat: http://cansat.kaist.ac.kr/

*9. Nepal launches its first satellite NepaliSat-1 from US*. (2019, April 18). Retrieved from Business Today: https://www.businesstoday.in/current/world/nepal-launches-its-first-satellite-nepalisat-1-from-us/story/338295.html

10. Oberst, G. (2012, October 01). *Nano- and Pico-Satellites*. Retrieved from Via Satellite: https://www.satellitetoday.com/telecom/2012/10/01/nano-and-pico-satellites/

11. Paudel, G. (2018). *The Threat of Ambient Air Pollution in Kathmandu, Nepal*. Retrieved from Hindawi: https://www.hindawi.com/journals/jeph/2018/1504591/

*12. United Nations Sustainable Development Goals*. (2020). Retrieved from Sustainable Development: https://sustainabledevelopment.un.org/?menu=1300

13. Wikipedia. (2019, April). *NepaliSat-1*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/NepaliSat-1

# Appendix

# A1. Time Allocation for the project

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Week** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** |
| Planning |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Study and Research |  |  |  |  |  |  |  |  |  |  |  |  |  |
| System Design |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Hardware Development |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Software Development |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Testing |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Data Analysis |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Documentation |  |  |  |  |  |  |  |  |  |  |  |  |  |

*Time Allocation*

# A2. Photos

![A picture containing object, light, wall, indoor

Description automatically generated]()

Figure 7 Ground Station

A picture containing table, indoor, sitting

Description automatically generated

Figure 8 Pico Sat

# A3. Screenshots

![A close up of a map

Description automatically generated]()

Figure 9 Desktop Application

A screenshot of a computer

Description automatically generated

Figure 10 Main Page

A screenshot of a computer

Description automatically generated

Figure 11 Data Page

A screenshot of a cell phone

Description automatically generated

Figure 12 Live Readings

A close up of a device

Description automatically generated

Figure 13 History Data Graph

A screenshot of a cell phone

Description automatically generated

Figure 14 About Us Page

A screenshot of a cell phone

Description automatically generated

Figure 15 Settings Page