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University of Puerto Rico
Mayagüez Campus
Mayagüez, Puerto Rico

Department of Electrical and Computer Engineering

WindTel

WindTel: An Automated Wind Tunnel ~~Redesign~~ Report #2

by

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Course: ICOM-4217, Section 080
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Visto

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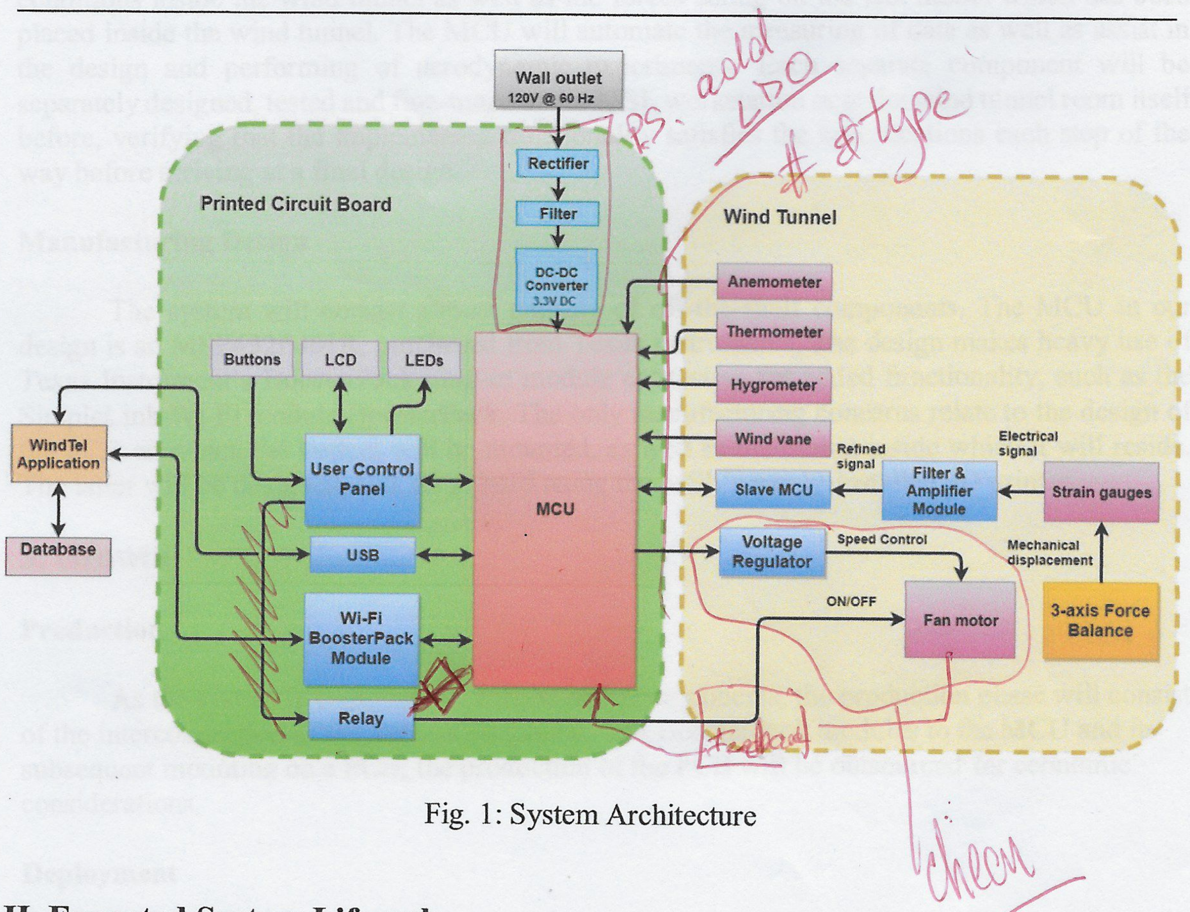

Fig. 1: System Architecture

II. Expected System Lifecycle

1. Birth

Need & Opportunity

This project arose out of the needs of the Department of Civil Engineering's wind tunnel. Its administrator, Dr. Raúl Zapata, requires a system that will automate the measuring of aerodynamic parameters inside the wind tunnel. A past attempt at a solution to this need was a project known as *Aerobal*, headed by students of this same course in 2013. This present project represents the retirement and replacement of that past system.

2. Design

Functional Concept

Our system consists of a microcontroller and various peripherals which will measure the conditions inside the wind tunnel as well as the forces acting on the test model which has been placed inside the wind tunnel. The MCU will automate the measuring of data as well as assist in the design and performing of aerodynamic experiments. Each separate component will be separately designed, tested and fine-tuned at our MSL workstation or at the wind tunnel room itself before, verifying that the implemented functionality satisfies the specifications each step of the way before arriving at a final design.

Manufacturing Design

The system will consist almost entirely of off-the-shelf components. The MCU in our design is an MSP432P401R, purchased from Texas Instruments. The design makes heavy use of Texas Instrument's BoosterPack plug-in module ecosystem for added functionality, such as the SimpleLink Wi-Fi module BoosterPack. The only manufacturing concerns relate to the design of the PCB on which the system will be mounted, as well as the casing inside which it will reside. The latter will be designed, and 3D printed using the MSL's newly-installed 3D printer.

3. Growth

Production

As the system is composed of off-the-shelf components, the production phase will consist of the interconnection of the various peripherals and BoosterPack modules to the MCU and its subsequent mounting on a PCB; the production of the PCB will be outsourced for economic considerations.

Deployment

After a final design has been reached and produced, the finished WindTel system will be installed at Dr. Zapata's wind tunnel in the Department of Civil Engineering.

4. Maturity

Maintenance

WindTel has been designed in such a way that it will be easy to detect the faults it may have in the future. In the case of hardware, the cables will be labeled and distinguishable in such a way that it will be easy to fix or replace if necessary. In the case of software, it will be easy to maintain through the internet by fixing, improving, adding and/or removing features as necessary.

How?
SW and HW maintenance

Upgrades

It is possible to add more features either hardware or software, by adding booster packs to our MCU and implementing new features on the source code. There are a vast variety of booster packs for different purposes such as for displaying of graphs, tables, among others, as well as new ideas for other measurements or features that may occur afterwards, that may be implemented and included on the source code.

5. Decline

Retirement & Disposal

There may come a time where our system becomes useless either because it's old and it's cheaper to create a new one, there are new requirements that are not possible to satisfy with the current system, among others, and it will be necessary to replace with a new one. In this case, the system may be disposed as appropriate and a design for a new system will be necessary.

III. System Operating Flowchart

The system operating flowchart shows the sequence of steps to accomplish the WindTel project functionalities. It is divided in a subset of flowcharts. Each of these represent a subroutine in the system that performs a specific task. Fig. 2 represent an overview of the system initialization where the execute option subroutine step represent any subroutine explicitly shown from Fig. 3 to Fig. 10. The subroutines in the system are the following: start wind tunnel, reset, calibration, shutdown, acquire data, data visualization, logs and diagnostics.

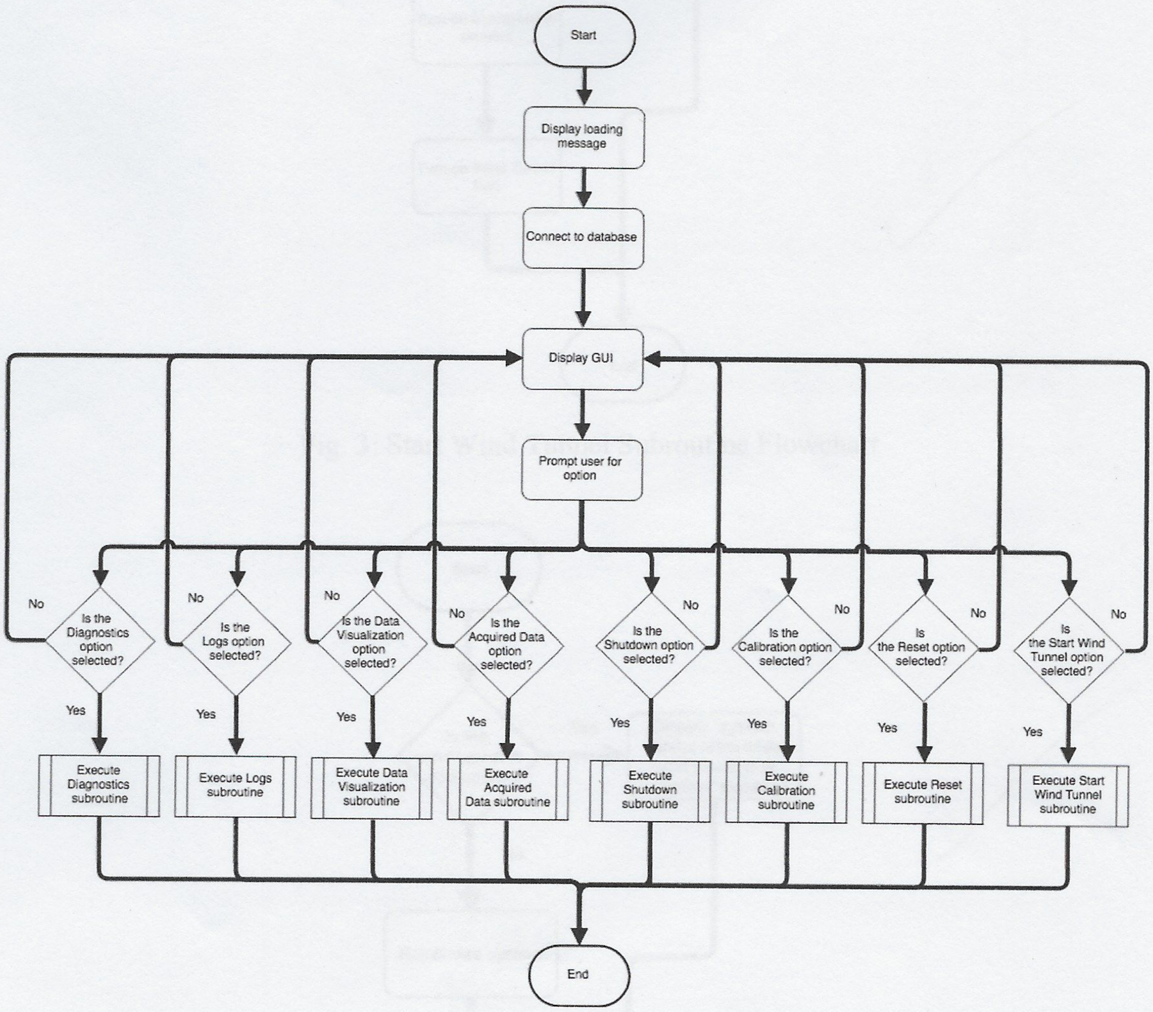

Fig. 2: WindTel Global View Flowchart

Make STD for System

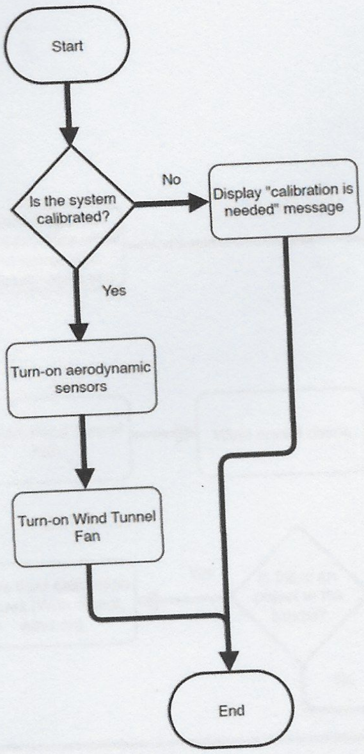

Fig. 3: Start Wind Tunnel Subroutine Flowchart

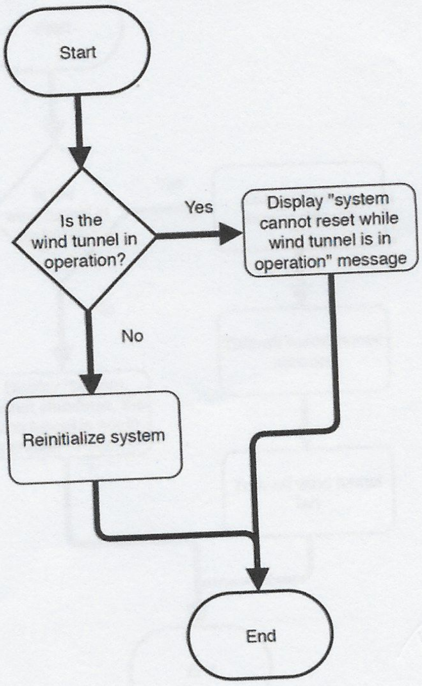

Fig. 4: Reset Subroutine Flowchart

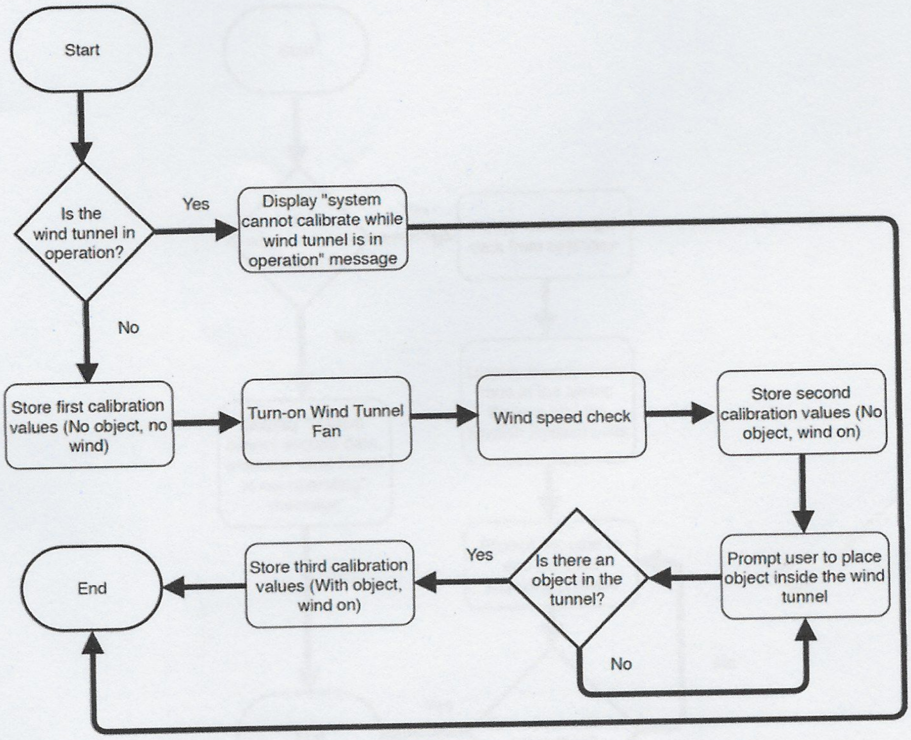

Fig. 5: Calibration Subroutine Flowchart

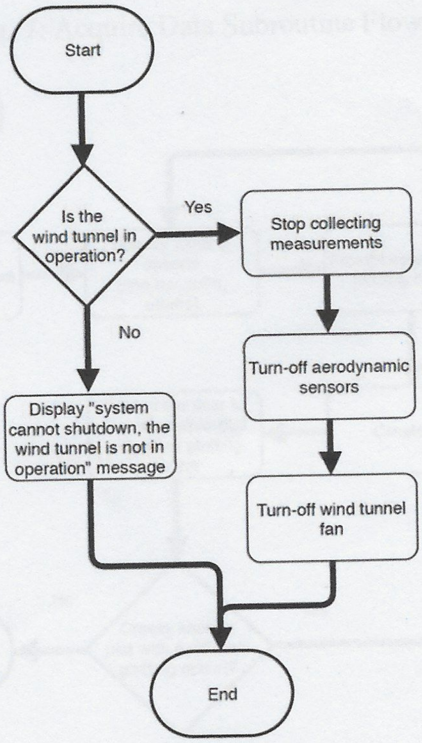

Fig. 6: Shutdown Subroutine Flowchart

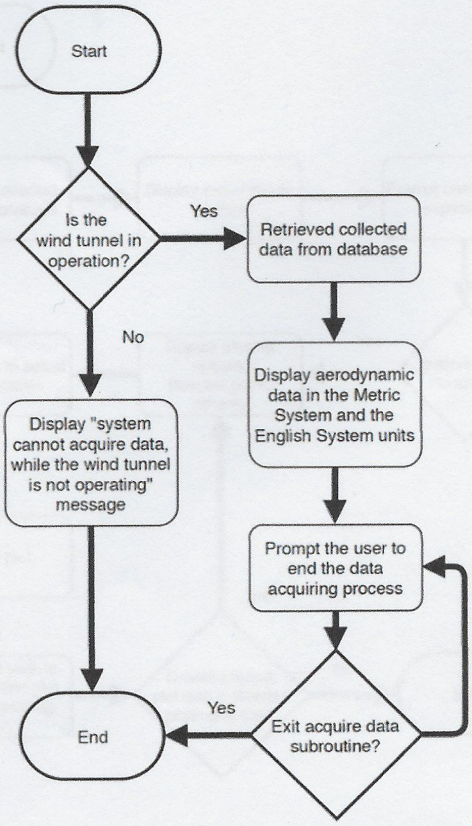

Fig. 7: Acquire Data Subroutine Flowchart

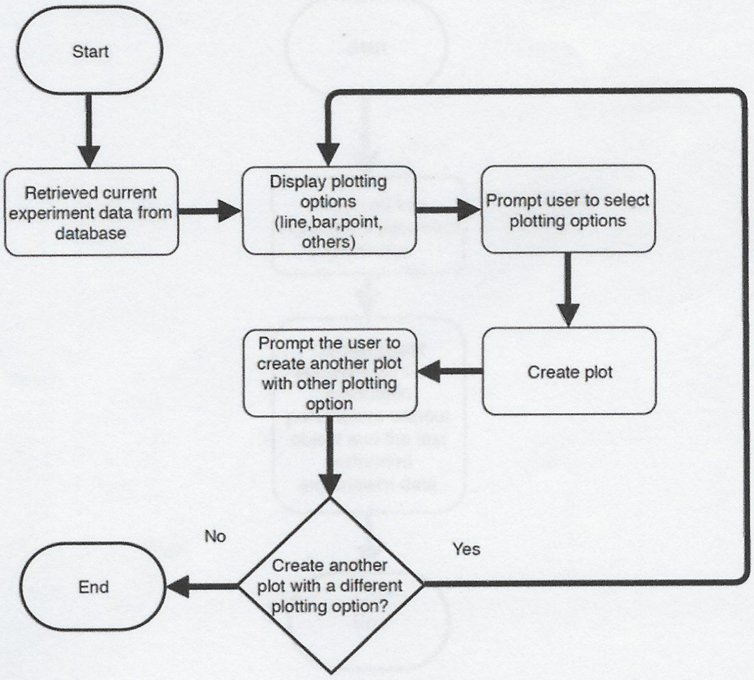

Fig. 8: Data Visualization Subroutine Flowchart

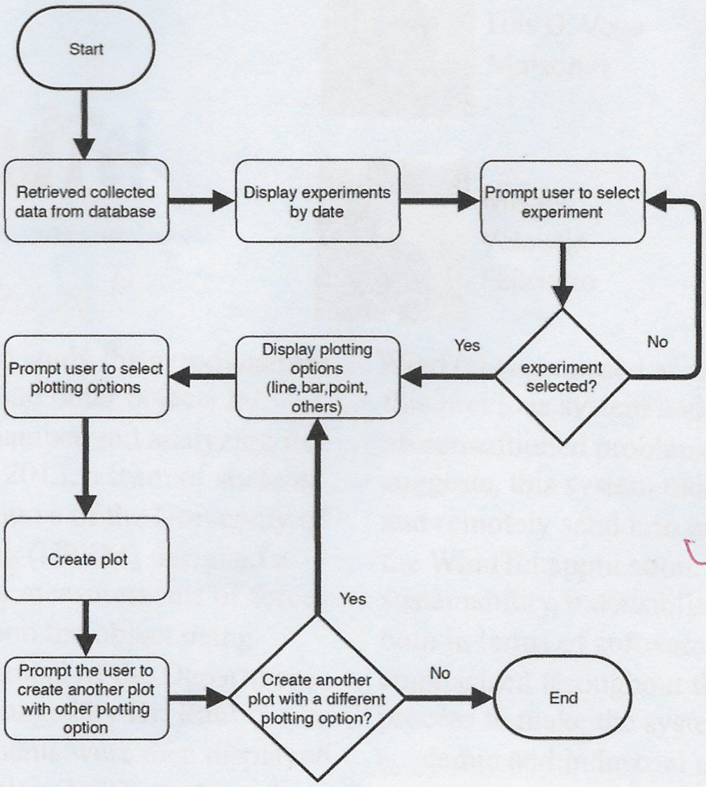

Fig. 9: Logs Subroutine Flowchart

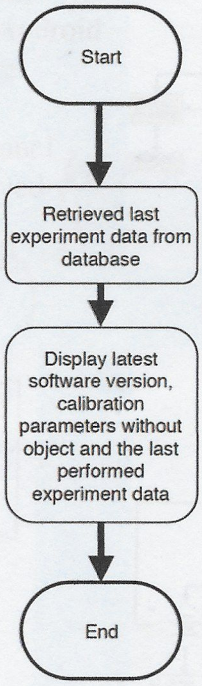

Fig. 10: Diagnostics Subroutine Flowchart

WindTel

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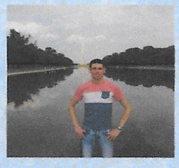
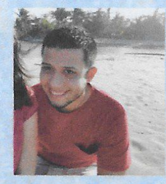
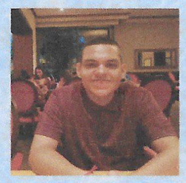


Nelson G. Rodriguez Ortiz



Misael Valentin Feliciano



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Title of Project

Wind tunnels are used to study the aerodynamics of cars, boats, aircrafts and other objects by moving air through a chamber and analyzing its effects on the object. In 2013, a team of students from the ICOM-5217 course of the University of Puerto Rico at Mayagüez (UPRM) designed a system capable of taking measurements of force, pressure and velocity upon the object being studied using the wind tunnel of the Department of Civil Engineering managed by Dr. Raúl Zapata. These measurements were then displayed on a Liquid Crystal Display (LCD), making these data visible for the users of the system. There was one limitation with their implementation: the software could only be accessed using an Android tablet. After a few years, the tablet software became obsolete and various hardware components were damaged, making the tunnel useless. Moreover, the hardware setup proved inadequate for proper maintenance or sustainability.

Too long

WindTel is proposed as an improvement upon this previous system and as a solution to the aforementioned problems. As its name suggests, this system measures telemetry data and remotely send it to any device that contains the WindTel application. In addition, sustainability, extensibility, and modularity—both in terms of software and hardware--is emphasized throughout the entire design process to make the system fruitful for academic and industrial use in the future.

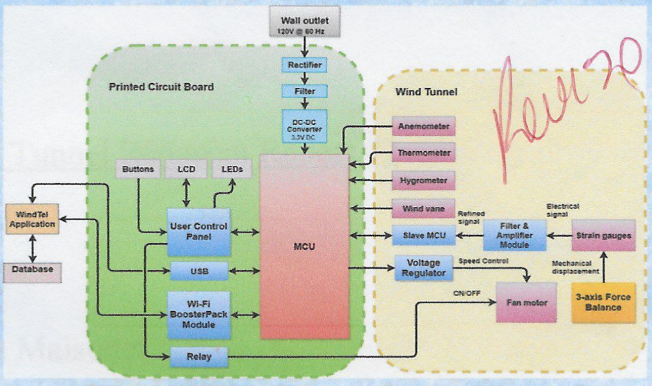

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Figure 2: WindTel System Diagram

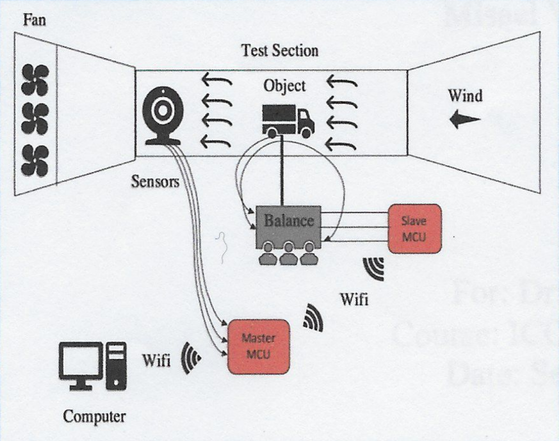

Figure 1: WindTel Global View

Use State Diagram

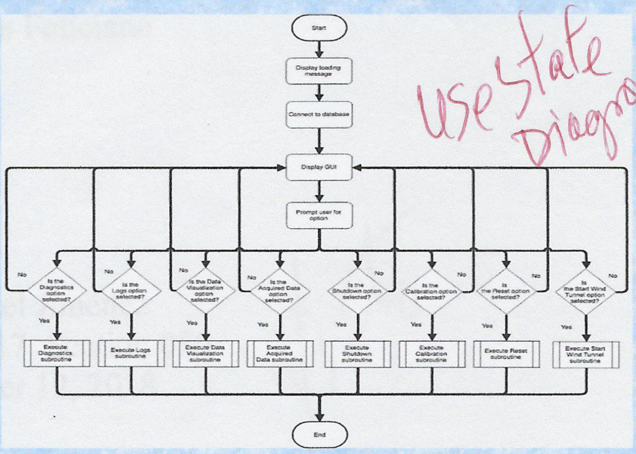

Figure 3: WindTel Global View Flowchart