Securing your Future with your own Hands

NETTUR TECHNICAL TRAINING FOUNDATION

PROJECT REPORT

ON

NTTF CANSAT

DONE BY:

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Abstract:

This project is taken as an opportunity, rather a challenging mission to design and develop a real emulation CanSat a miniature satellite. It comprises of technology used for communicating from one device to other and is integrated in a small structure to do a real time mission of computing the data and having a probe carried with it. The challenge is achieved as per the standards required.

Introduction

A CanSat is an emulation of real satellite, integrated within the volume and shape of a soft drink can. The challenge here to fit all the major subsystems found in satellite, such as power system, sensor, and communication system into this minimal volume. The CanSat is then launched to an altitude of a few hundred meters by a rocket or dropped from a drone or captive balloon and its mission begins: to carry out a scientific experiment and achieve a safe landing.

Project objective

Our aim is to measure **AIR POLUTION** after release, during descent to transmit the data to the Ground Station once every 2 seconds. Post-flight result is analysed and represented on a graph. In the meantime, of the satellite descent, it can uplink the signal from ground station to the sat to perform secondary mission.

Desired characteristics

Structure must be capable of withstanding

Like regular satellites, the CanSat will house the basic subsystems.

1. ESP32_LORA – Microcontroller & communication.
2. MQ135 Gas sensor – Air pollution
3. SG90 Servo motor – Deployment
4. Buzzer- Retrieval system
5. Li-ion battery – Power supply

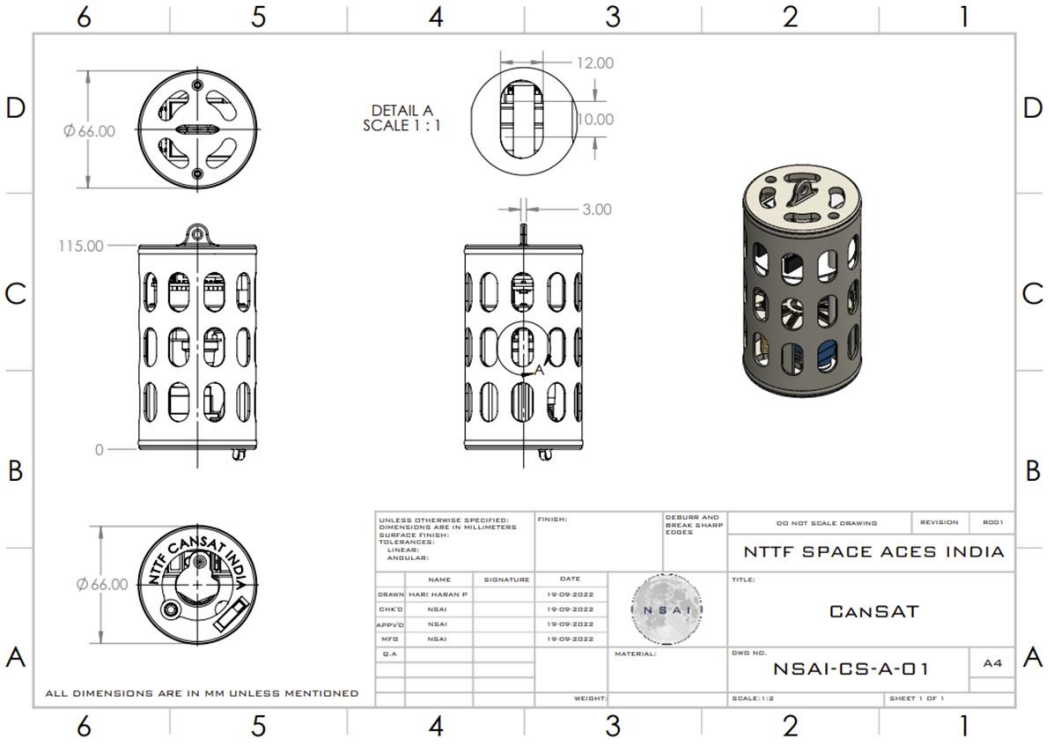
Design prosses overview

STRUCTURE
CANSAT STRUCTURE

For CanSAT Structure has been printed with ULTEM 9085 Resin Material from Stratasys

About Material :
https://library.stratasys.com/directdownload.php?ti=117272918&tok=e2rBBua77WQ8aTldxY1a7gRR

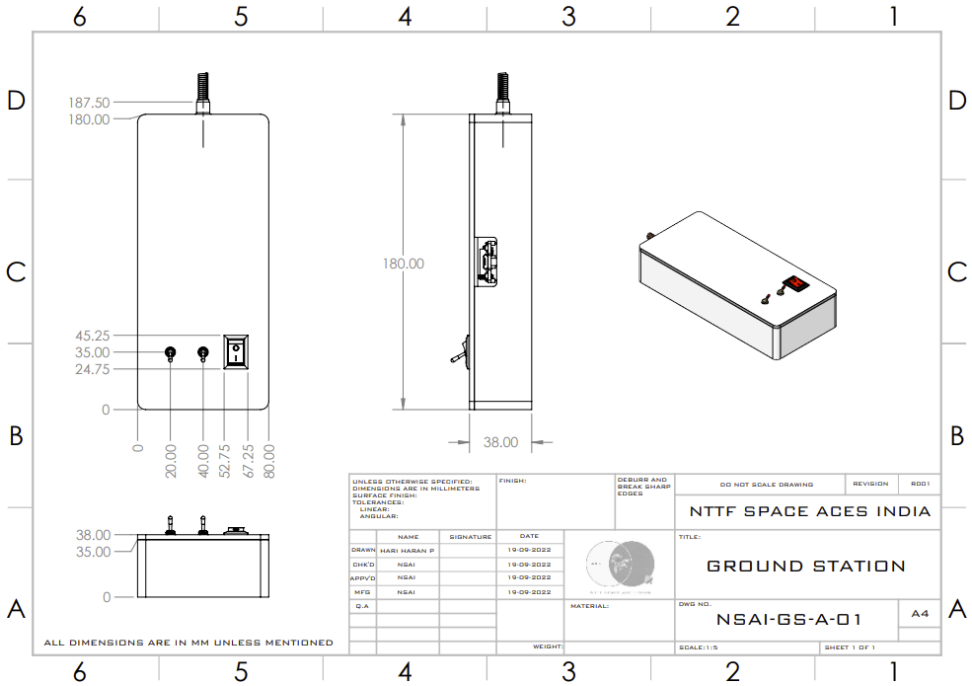
DRAFTING



GROUND STATION STRUCTURE

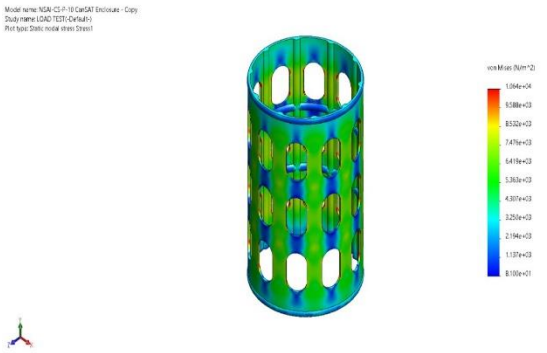
For GROUND STATION casing we have designed and printed in VERO material from Stratasys

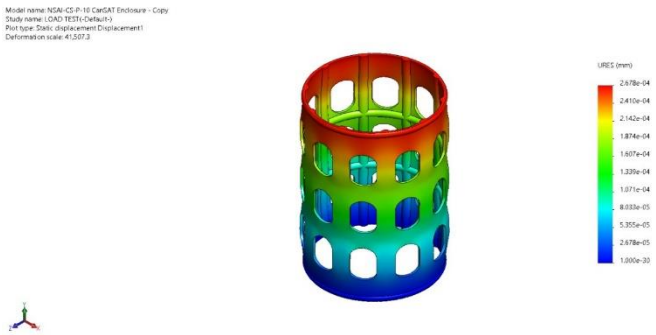
About Material : https://www.stratasys.com/siteassets/materials/materials-catalog/polyjet-materials/verovivid/mds_pj_vero_for_j55_0320a.pdf



TENSILE LOAD

STRESS

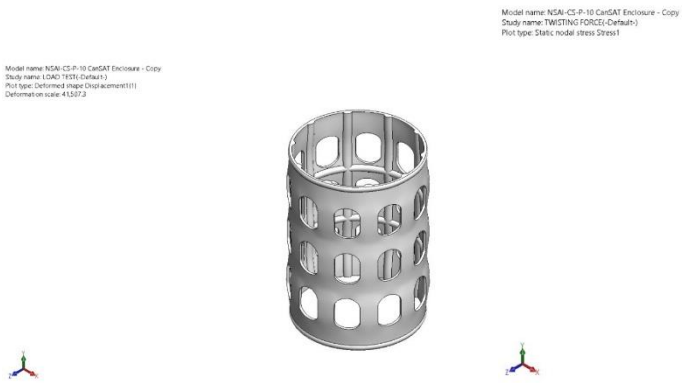


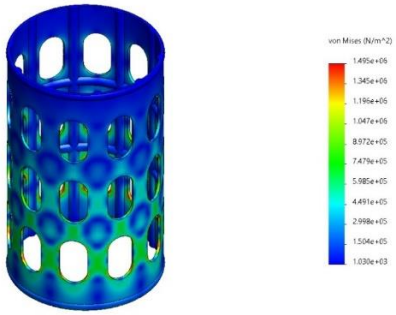


Name	Type	Min	Max
Stress1	VON: von Mises Stress	8.100e+01N/m^2 Node: 114	1.064e+04 N/m^2 Node: 35941

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	2.60E-08 Element: 8865	3.54E-06 Element: 31316

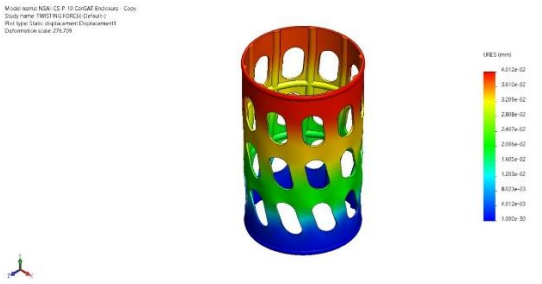
DISPLACEMENT



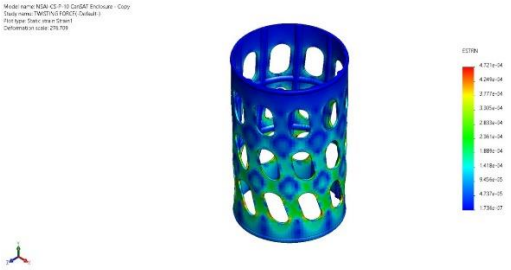


Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.000e+00 mm Node: 742	2.678e-04mm Node: 24394

Name	Type	Min	Max
Stress	VON: von Mises Stress	1.030e+03N/m^2 Node: 20046	1.495e+06 N/m^2 Node: 37439



Name	Type	Min	Max
Displacement	URES: Resultant Displacement	0.000e+00 mm Node: 742	4.012e-02mm Node: 1064



Name	Type	Min	Max
Strain	ESTRN: Equivalent Strain	1.74E-07 Element: 26475	4.72E-04 Element: 33333

MICROCONTROLLER & COMMUNICATION

In our CANSAT we used Heltec ESP32_Lora board for microcontroller. It is capable of two-way communicating system normally know as duplex system. it's a highly integrated product based on ESP32 + SX127x, it has Wi-Fi, BLE, LoRa functions, also Li-Po battery management system, as additional feature 0.96″ OLED are also included.

Microprocessor ESP32 (dual-core 32-bit MCU + ULP core), with LoRa node chip SX1276/SX1278. Wi-fi band is 802.11 b/g/n (802.11n up to 150Mbps). Bluetooth

Specification V4.2 BR/EDR and Bluetooth LE. Lora we are using of Node-to-node communication or Lora WAN. Maximum output power of LoRa is 19dB. Flash memory is 8MB (64M-bits) SPI FLASH.

It is having 520KB internal SRAM. It interfaces Micro USB; LoRa Antenna & 18 x 2.54pins (2 sets).

It includes CP2102 USB to Serial Chip. It has two external Device power control pins.

Its max low power state is 800uA. It consists of 0.96-inch OLED display on top of it.

Its working temperature is from -40^{0}C to 80^{0}C.

If we are powering up the module with USB, then its current rating should be (>_500mA) and voltage can be min 4.7V and max 6V. and if we are powering up with Lithium battery, then its current rating should be (>_250mA) and voltage can be min 3.3V and max 4.2V. If it is powered by 3.3V pin, then current rating should be (>_150mA) and voltage can be min 2.7V and max 3.5V. If it is powered with 5V pin, then its current rating should be (>_500mA) and voltage can be min4.7V and 6V max.

It provides 500mA output from the 3.3V pin and from 5V pin USB powered it will give the output equal to the input current. 350mA we'll get output for external device power control.

MQ135 Gas sensor – Air pollution

As mentioned in the Mission overview we must measure the AIR POLLUTION after descent the CanSat. So, we have used "MQ135 Gas sensor" to measure the air pollution.

The **MQ-135 Gas sensor** can detect gases like Ammonia (NH3), sulphur (S), Benzene (C6H6), CO2, and other harmful gases and smoke. Like other MQ series gas sensor, this sensor also has a digital and analog output pin. When the level of these gases goes beyond a threshold limit in the air the digital pin goes high. This threshold value can be set by using the on-board potentiometer. The analog output pin, outputs an analog voltage which can be used to approximate the level of these gases in the atmosphere.

We can operate this sensor with min 2.5V and max 5V and with a current rating of 150mA.It is able to produce 0V to 5V as digital output by using TTL logic. In analog it can produce 0-5V.

We can detect many harmful gases by using digital pin. We can control the sensitivity of digital pin by 10K potentiometer, which is already interfaced in the sensor. Whenever it detects a harmful gas the D0 LED will glow, and the digital pin go from logic high to Logic Low. The LM393 Op-Amp Comparator IC is used to compare the actual gas value with the value set using the potentiometer. If the actual gas value increases than the set value, then the digital output pin gets low. This digital pin can directly be used to drive a buzzer or LED with the help of simple transistors.

The Analog output pin of the sensor can be used to measure the PPM value of the required gas. To do this we need to use an external microcontroller like Arduino. The microcontroller will measure the value of analog voltage and perform some calculations to find the value of Rs/Ro where Rs is the sensor resistance when gas is present, and Ro is sensor resistance at clean air. Once we find this ratio of Rs/Ro we can use it to calculate the PPM value of required gas using the graph below which is taken from the datasheet of MQ135 Sensor.

BUZZER- Retrieval System

For retrieval system they given options like GPS, Buzzer, radio beacon, etc. So, we choose buzzer as option. A buzzer is like an audio signalling device. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage. The **pin configuration of the buzzer**, two pins namely positive and negative.

The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the '- 'symbol or short terminal and it is connected to the GND terminal. Its operating voltage is min 3V and max 24V.and its temperature resistance is -20^{0}C to +60^{0}C. The sound pressure level is 85dBA or 10cm. The supply current is 15mA.

There are two kinds of buzzers commonly available like simple and readymade. Once a simple type is power-driven then it will generate a beep sound continuously. A readymade type looks heavier & generates a Beep. Beep. Beep. This sound is because of the internal oscillating circuit within it.

Li-on BATTERY- POWER SUPPLY

A lithium-ion battery or Li-ion battery is a type of rechargeable battery composed of cells in which lithium ion move from the negative electrode through an electrolyte to the positive electrode during discharge and back when charging. The reactants in the electrochemical reactions in a lithium-ion cell are materials of anode and cathode, both of which are compounds containing lithium atoms.

During discharge, an oxidation half-reaction at the anode produces positively charged lithium ions and negatively charged electrons. The oxidation half-reaction may also produce uncharged material that remains at the anode.

For powering the whole CanSat we are using Lithium-ion battery. We are using a rechargeable type battery with specifications of 3.7V & 630mAh.

Power management

COMPONENT	CURRENT SPECIFICATION
MQ135	150mA
SG90	220mA
Wi-Fi	115mA
LoRa	50mA
Buzzer	30mA

SG90 Servo motor – Deployment

To achieve our secondary mission, we are using SG90 Servo motor for deploying small balls. The basic function of a servo motor is to take a feedback signal from the output and provides the required angle to deploy the balls from the satellite. The operating voltage is +5V typically. It has a torque of 2.5kg/cm

WIRE COLOUR	FUNCTION
BROWN	GROUND
RED	+5V VCC
ORANGE	PWM SIGNAL

Cost Estimation

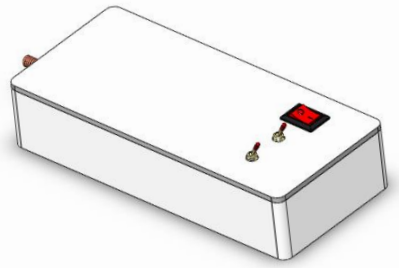
Structural Cost

STRUCTURE COSTING				
Sl.No	DESPCRIPTION	QTY	MATERIAL	PRICE
1	Main Structure	1	UTLEM	₹ 18,000.00
2	Top Plate	1	ULTEM	₹ 6,000.00
3	Bottom Plate	1	ULTEM	₹ 9,500.00
4	Spacers	8	VERO	₹ 4,000.00
5	Deployer Plate	1	VERO	₹ 1,000.00
6	Ground Station Top Plate	1	VERO	₹ 2,800.00
7	Ground Station Bottom Plate	1	VERO	₹ 8,800.00
			TOTAL	₹ 50,100.00

Electronics cost

ELECTRONIC COMPONENTS COSTING				
Sl.No	DESPCRIPTION	QTY	MATERIAL	PRICE
1	ESP32 LORA	2	STD	₹ 4,800.00
2	MQ135	1	STD	₹ 120.00
3	3.7V Battery	1	STD	₹ 450.00
4	SG 90 Servo	1	STD	₹ 190.00
5	Limit Switch	1	STD	₹ 50.00
6	Rocker Switch	1	STD	₹ 50.00
7	Sliding Switch	1	STD	₹ 50.00
8	Buzzer	1	STD	₹ 40.00
9	LED	1	STD	₹ 5.00
10	2 Pin Connectors	3	STD	₹ 60.00
11	Toggle Switch	2	STD	₹ 80.00
			TOTAL	₹ 5,895.00

Ground control system

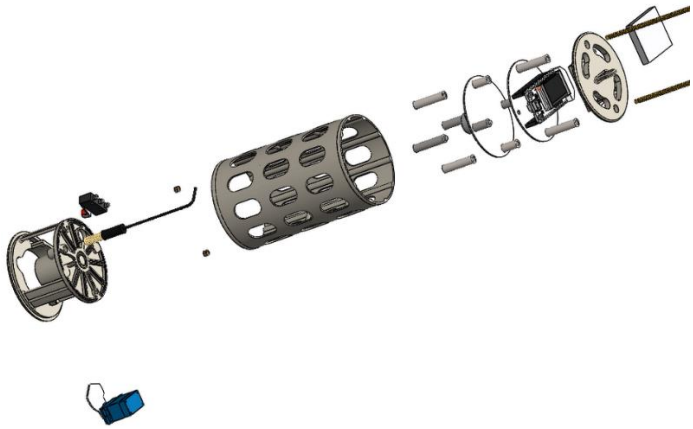


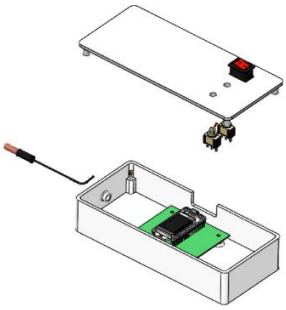
Ground control system is used to duplex the data to CanSat and collects the data from the CanSat.

GS > ELEMENTS LIST

1. ESP32 LORA x 1 NO.s
2. TOGGLE SWITCH x 2 NO.s
3. ROCKER SWITCH x 1 NO.s
4. HELIX ANTENNA (433MHz) x 1 NO.s
5. 3.7V 630 mAh Li-on BATTERY x 1 NO.s

Structure and stacking





Flight Decelerator

Flight Decelerator:

The parachute is aerodynamic

system belonging to the class of aerodynamic

Decelerators.

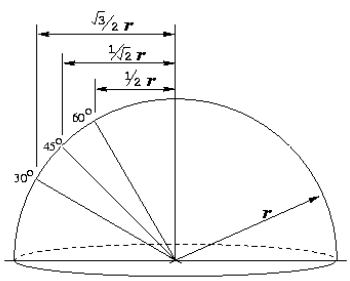
Hemispherical Parachute type

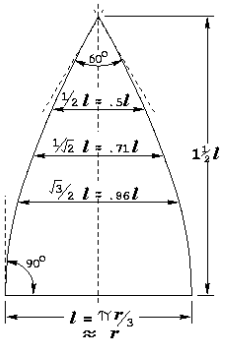
Gores 6

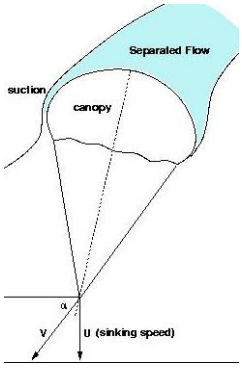
Decent rate 8.5m/sec

Diameter of parachute 25cm

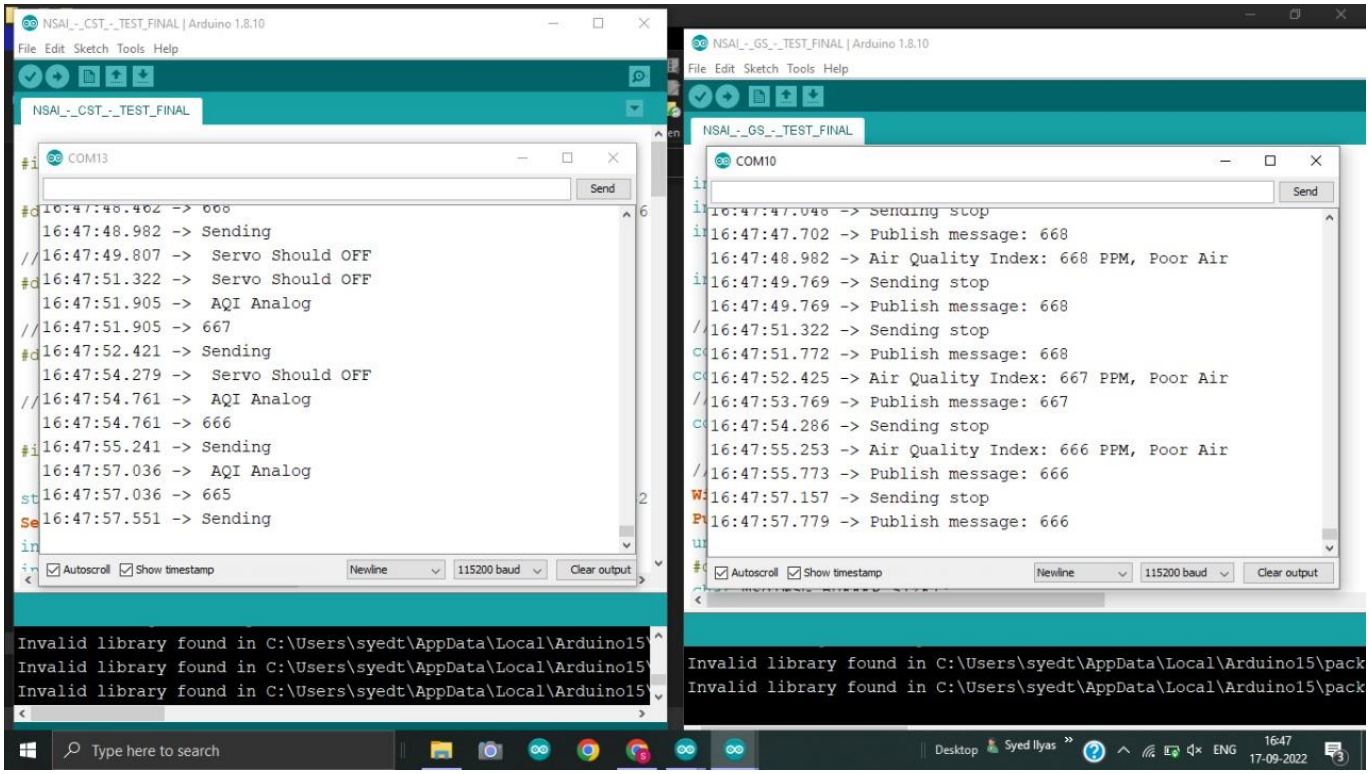
Spill hole dia 4.5cm

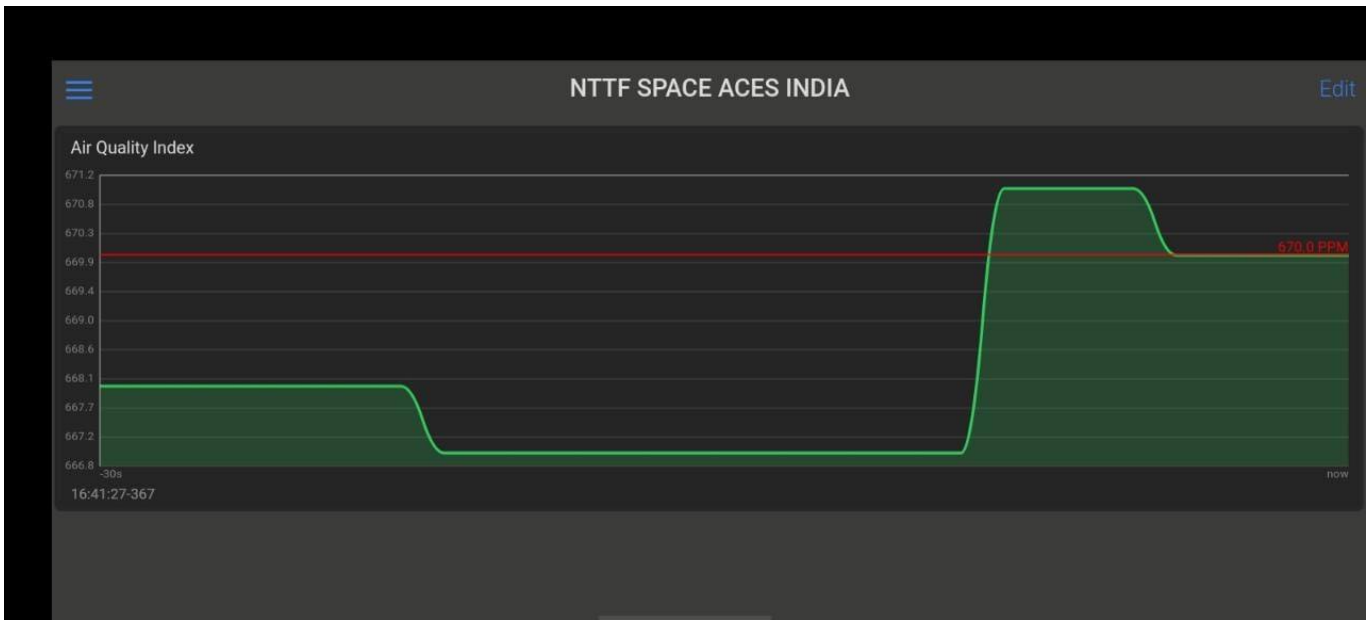






Field test & Evaluation





Conclusion

According to the requirements we achieved the mission.