DATA LOGGING AND TRANSMISSION

IoT

INTERNET OF THINGS (IOT)

- The **Internet of things** (**IoT**) is the network of physical devices, vehicles, home appliances and other items embedded with electronics software, sensors, actuators, and connectivity which enables these objects to connect and exchange data

MOTIVATION OF TOPIC

- The main reason for choosing this topic was our college PRAVEG team which participates in SUPRA SAE competition.
- Main problem faced was the assumption data for analysis, which was taken from books and research paper.
- As that data was not our actual data so we would end up with lots of errors and reduction in performance of the car.

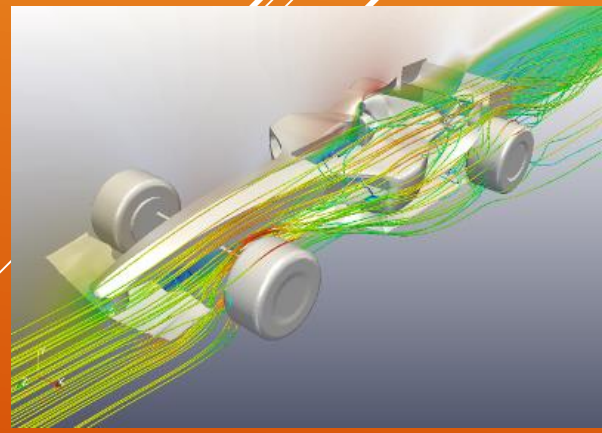
- The Internet of Things (IoT) is all about collecting, aggregating, and analyzing data from devices and sensors. And Formula 1 race cars are among the most interesting of those "things.“
- So as this racing car is prepared from scratch we provide a portable way for gaining the real time data for analysis.

IMPORTANCE OF DATA LOGGING & REAL TIME DATA TRAMSMISSION

- *1) To Analyze Vehicle Performance in real time*
- *2) To Analyze Driver Performance*
- *3) To Help with Vehicle Development*
- *4) To Monitor Reliability and Safety by checking problems at current time*
- *5) To Determine Vehicle Parameters*
- *6) To Keep Maintenance Logs – even if some thing happens to data on car due crash or other technical problems*

- Analytics is a key fundamental into understanding how a Formula 1 car behaves. An F1 car travelling at 200mph puts heavy pressure on the car, and not least, the driver, and knowledge of those characteristics can lead to the correct decisions being made in order to win.
- To understand that performance, analytics intuition is required so engineers and data analysts can make sense of the car's speed, stability, as well as aerodynamics and tyre degradation around a racetrack. More testing programs are also completed at the team's manufacturing base as well as their state-of-the-art wind tunnels.

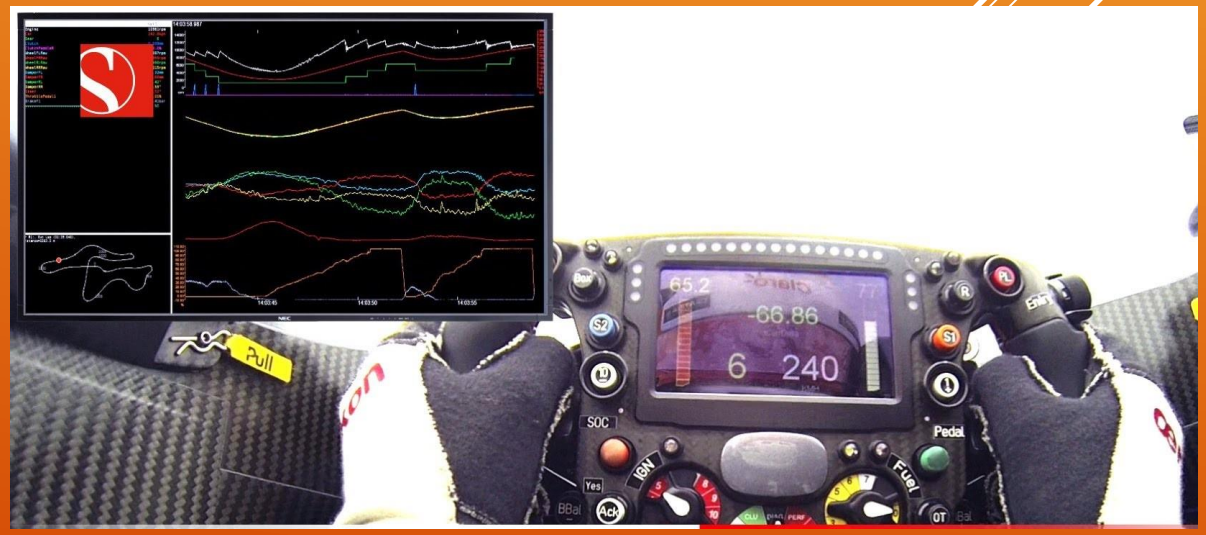
BENEFITS OF ANALYSIS IN REAL TIME



- And with this age of Formula 1 being surrounded by such advanced technology, it would be interesting to see how the sport can get audiences more integrated with real-time data.
- For instance, during race weekends television viewers are able to see heat maps that expose which parts of the cars are exposed to the highest temperatures, such as racing tyres and the car's engine. And fans can also listen into selective live radio feeds between the race engineer and the driver.
- Exposure to basic forms of live data gathered by teams via a mobile app may give viewers an indication of why teams make the strategic decisions that they do.
- Analytics has consumed the sport in ways like no other. With the ability to harness big data and actionable intelligence, teams can now pass on those trade secrets in industries such as pharmaceuticals and financial

WHICH DATA ?

- Particularly when looking to the formula 1 racing cars, when it comes to data logging There is a huge amount of parameters to looked at , and these parameters can be related to any part of the car.
- However, they are generally categorized in three types :-
  - powertrain and vital functions
  - driver
  - chassis



- 1) The main powertrain-related parameters to keep track are engine RPM (among engine parameters, this is the main one in terms of vehicle performance), oil pressure and temperature, water temperature, airbox pressure, inlet air temperature, fuel pressure, fuel mass flow, gearbox and differential temperature, turbocharger boost pressure, exhaust gas temperature, battery voltage, and so on.
- 2) Driver-related parameters are those from powertrain or chassis, which the driver has some control on. Examples include steering angle, throttle position, gear, brake position and brake line pressure.
- 3) Chassis-related parameters may be wheel speed (of one or the four wheels, we will get on that on later posts), lateral and longitudinal G-forces, steering angle, damper displacement, suspension loads, ride height, tyre pressures and temperatures, brake disc temperatures, and aerodynamics parameters like air speed and local pressures.

- So these 3 main categories of the parameters which can be used for the analysis.
- We have used some of the important parameters ,which are required while making of the car. These are the as follows:
  - Accelerometer data :- X axis , Y axis , Z axis.
  - Hall effect sensor data :- Speed , RPM , distance travelled.
  - Temperature sensor data :- Coolant temperature.

WHY THESE 7 PARAMETERS ?

- The most important data is the accelerometer XYZ axes data which gives us the G force acting on the major axes which are at the C.G of the vehicle which gives us the roll, pitch and yaw in the X, Y, Z axes respectively. So by that we can also calculate very precisely the forces acting on the parts to carry out a more accurate analysis.
- The second is the Speed which is also one of the most important parameter which helps in improving the chances of wining a race. So this parameter is required to check at particular instants where other things could have gone wrong.

- A RPM trace reveals plenty with just a quick glance :maximum rpm used on each straight, min rpm used in each corner and where the rider is upshifting or downshifting .This information can be used to make a gear change. So the improvements can be found by pointing out to the rider that rpm is low or high In certain corner and could be benefit by using a different gear.
- And also the distance traveled gives a idea of the run of the vehicle. Which can be used to check the fuel efficiency and lots of more things
- The coolant temperature tells when to turn on the radiator and if there is some effect of doing that at a particular temperature

RASPBERRY PI 3

- We have used a raspberry pi 3 which has the following specifications:-
- CPU: Quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz
- GPU: 400MHz Video Core IV multimedia
- Memory: 1GB LPDDR2-900 SDRAM (i.e. 900MHz)
- Network: 10/100Mbps Ethernet and 802.11n Wireless LAN
- Peripherals: 40 GPIO,
- Power source: 5 V via MicroUSB or GPIO header

HALL EFFECT SENSOR

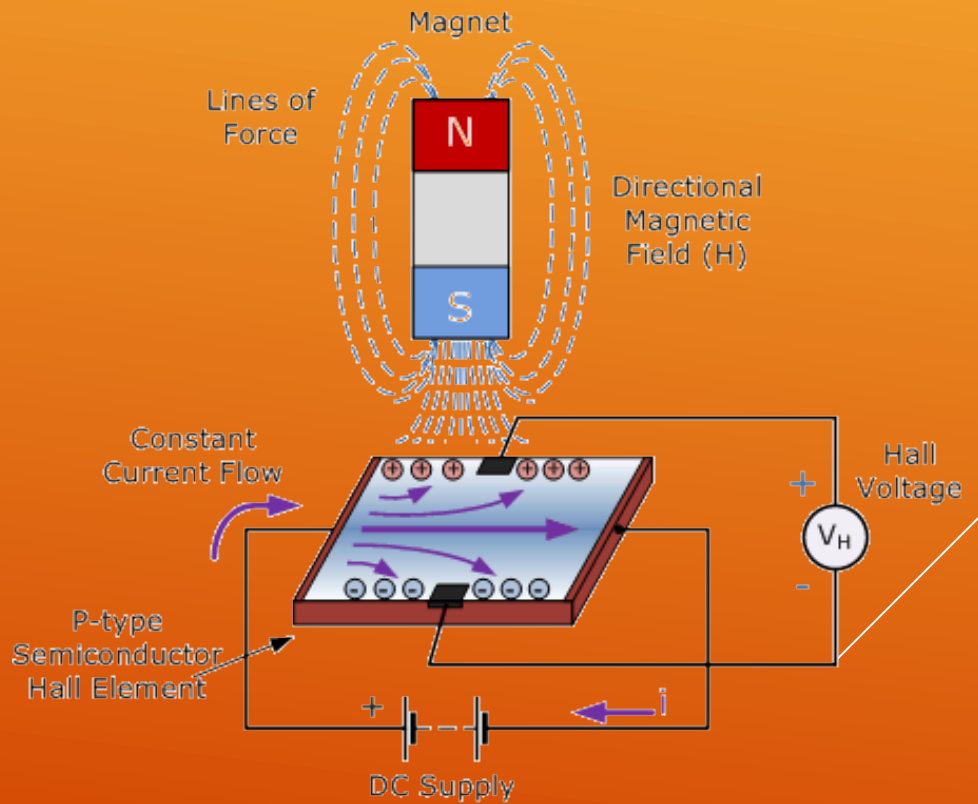
ADXL345

THERMOCOUPLE: MAX6675

SENSORS

- Hall effect sensor consist basically of a thin piece of rectangular p-type semiconductor. When the device is placed in magnetic field, the magnetic flux lines exert force on semi-conductor , which moves the charge carrier, electrons and holes in either direction. This sideward direction of electrons and holes creates potential difference and the current flows and gives an output one.

WORKING OF HALL EFFECT SENSOR




Magnet
Hall Effect Sensor

WORKING OF ADXL345 SENSOR

- The sensor consists of micro machined structure on silicon wafer. The structure is suspended by polysilicon springs which allow it to deflect smoothly in any direction when subjected to acceleration in X, Y and/or Z axis.
- Deflection causes a change in capacitance between fixed plates and plates attached to suspended structure . This change in capacitance on each axis is converted to an output voltage proportional to the acceleration on that axis

- The MAX6675 performs cold-junction compensation and digitizes the signal from a type-K thermocouple. The data is output in a 12-bit resolution, SPI™-compatible, read-only format.
- This converter resolves temperatures to 0.25°C, allows readings as high as +1024°C, and exhibits thermocouple accuracy of 8LSBs for temperatures ranging from 0°C to +700°C.

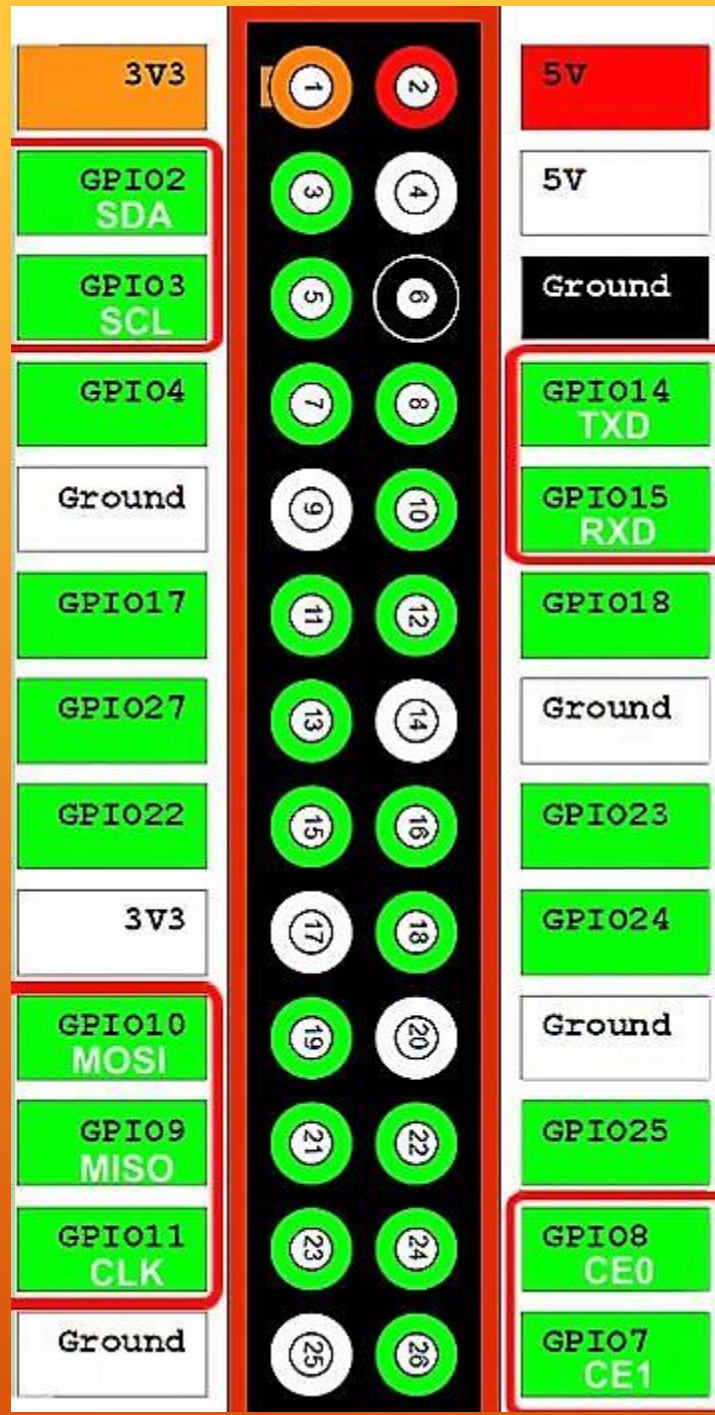
WORKING OF THERMOCOUPLE: MAX6675

PROGRAMMING PART

- We have used python 3 for our code. And for ADXL readings we used the code form one of the GITHUB repo. And for used a series of steps to calculate the RPM, speed and the distance travelled.
- We have used/imported following libraries
- # Thingspeak - import paho.mqtt.publish as publish , import psutil , import string ,import random
- # rpm and adxl connections - import RPi.GPIO as GPIO, import time , adxl code -import smbus , import time

CONNECTIONS

- The connections are as follows
- ADXL345 HALL
  - 6)GND – GND 25)g - ground
  - 1)3V - 3V3 2) + - VCC 5 volt
  - 3)SDA – SDA 8) DO - GPIO 14 TXDO
  - 5)SCL - SCL



SENDING DATA THINGSPEAK SERVER

- For sending the data to ThingSpeak we were having mainly 2 options i.e. by using 1)REST API 2)MQTT API
- Both were having their own advantages and disadvantages.
- All the details for the required libraries and the code syntax for sending the parameters is given in detail on ThingSpeak website
- For our need we selected the MQTT API for the following reasons :-
  - The speed of sending the data to ThingSpeak server by this method is faster than the REST API method
  - Also this MQTT connection was a secure connection.
  - Your device is power-constrained, and you want lower battery consumption to send data to ThingSpeak

MQTT API

- The ThingSpeak IoT platform enables clients to update and receive updates from channel feeds via the ThingSpeak MQTT broker. MQTT is a publish/subscribe communication protocol that uses TCP/IP sockets or WebSockets. MQTT over WebSockets can be secured with SSL. A client device connects to the MQTT broker and can publish to a channel or subscribe to updates from that channel.

Publish

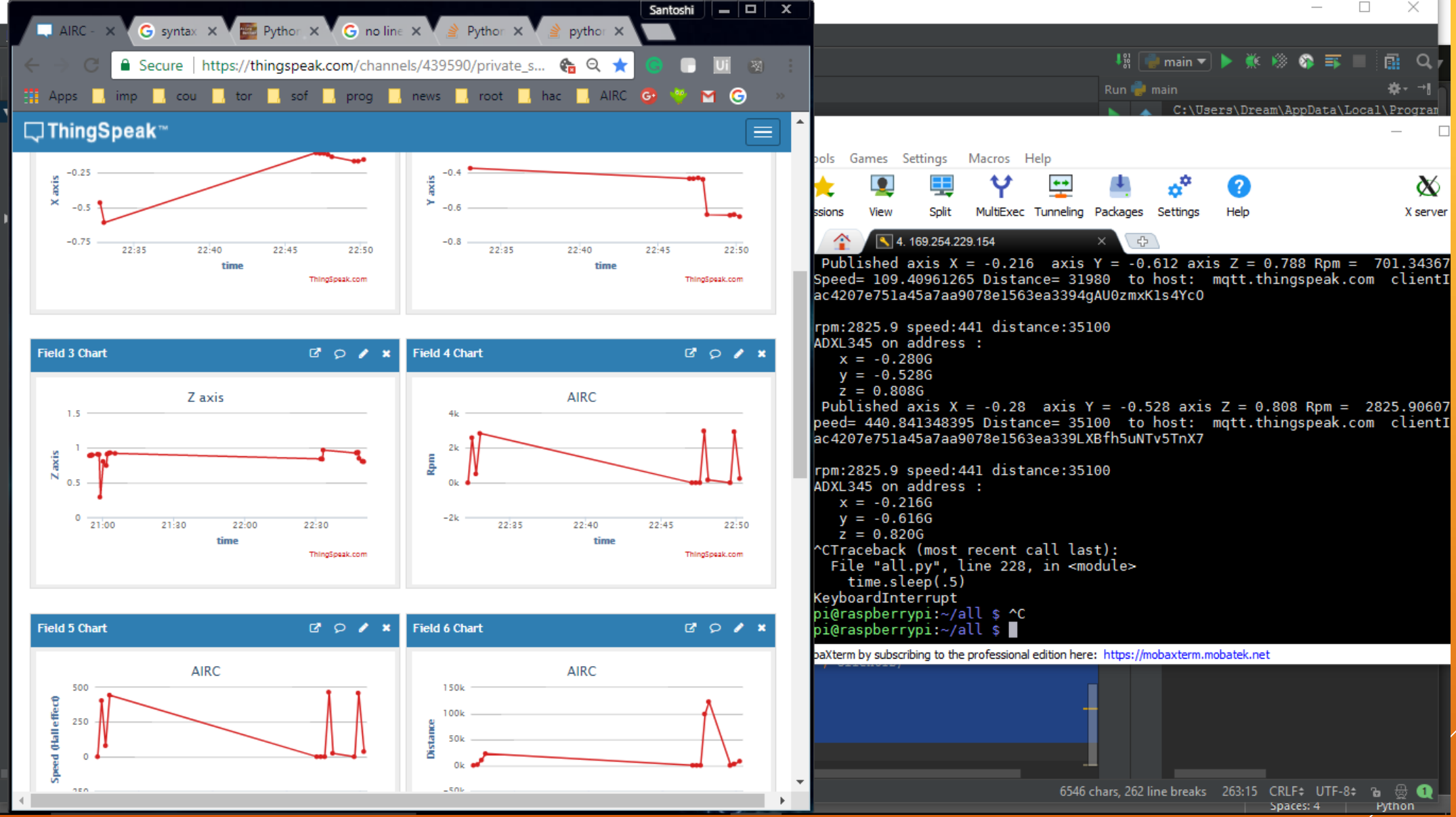
`Publish to a Channel Feed`	Publish message to update multiple channel fields simultaneously
`Publish to a Channel Field Feed`	Publish message to update single channel field

Subscribe

`Subscribe to a Channel Feed`	Subscribe to updates from a channel feed
`Subscribe to a Channel Field Feed`	Subscribe to channel updates from a particular field of a channel

OUTPUT AND READINGS FORMAT

- The output of our code will consists values as RPM, Speed , Distance travelled and the accelerometer data i.e. X,Y,Z axes and then it would try to connect to the ThingSpeak server and then on successful connection it will print the values which are published on the server if the connection is not successful (due to no internet or any other) error will be given and program will stop the execution after 3-5 non successful connections.



READING AND OUTPUT

LOGGING THE DATA IN CSV FORMAT

- After the data is transmitted to the thing speak server it is automatically saved and the data can be accessed in various formats i.e. not only in CSV but also in various other formats. There is DATA export option which has the following formats :-
  - JASON
  - XML
  - CSV
- Also we can get particular field wise data in the above mentioned formats.