Two wheeler Data logging and visualization

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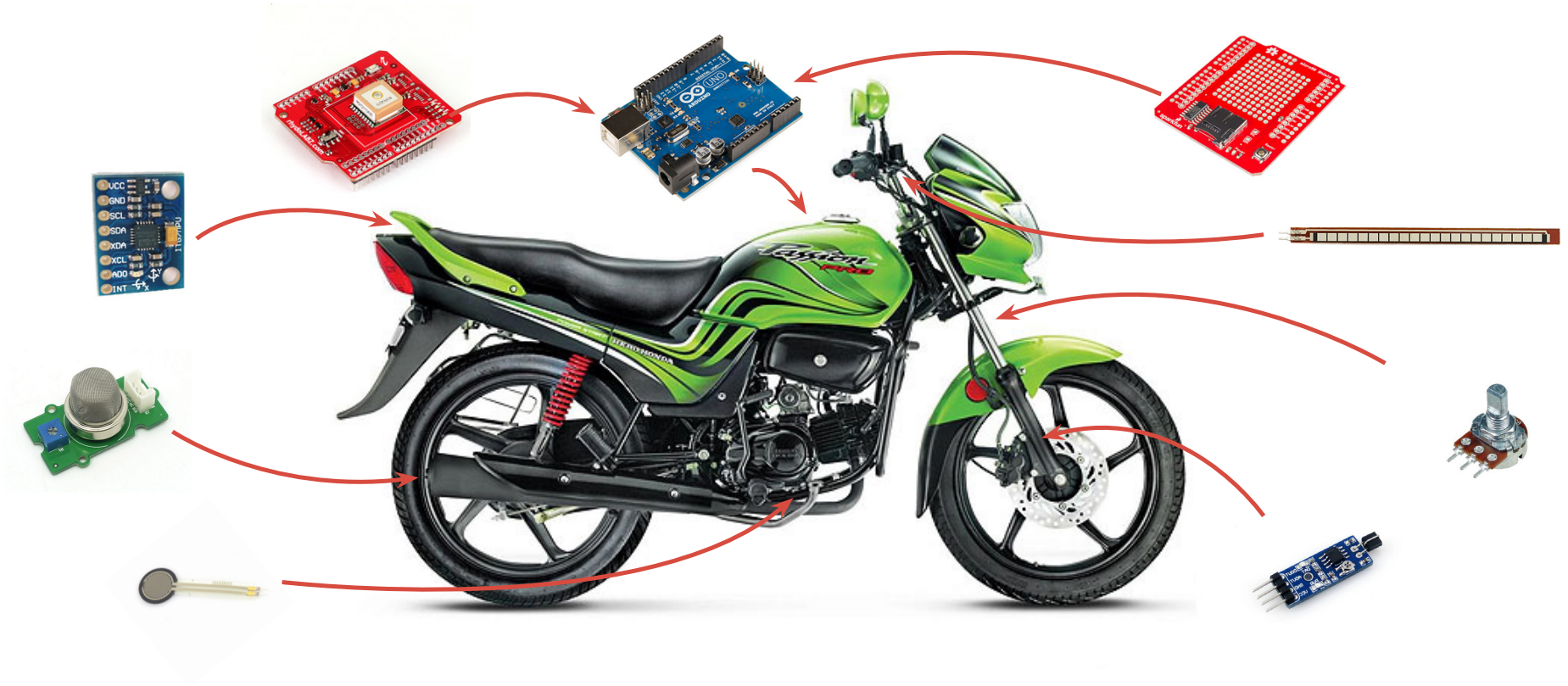

Declaration

The research work embodied in the written submission titled “Two wheeler Data logging and visualization” has been carried out by the undersigned as part of the post graduate program in the Industrial Design Center, IIT Bombay, India under the supervision of Prof. Girish Dalavi.The undersigned hereby declares this is his original work and has not plagiarized in part or full from any source. Furthermore, this work has not been submitted for any degree in this or any other University. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also provoke penal action if need arises.

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Approval Sheet

This design research entitled “Two-wheeler Data logging and visulization” by Prem Lokesh (136330006) and Piyush Churad (136330007) is approved in partial fulfillment of the requirements for Master of Design Degree in Interaction Design.

Project Guide: 

Date: 25 / 03 / 2015

Acknowledgement

We would like to thank our guide Prof. Girish Dalvi for guiding us throught the project. We would also like to thank Limaye family for lending their motorcycle to carry out our tests and Riken Patel for helping us out with programming of Arduino and processing. Also, to all our batchmates for bearing it with us.

Contents

Abstract

In India, two-wheeler is amongst the popular mode of transportation. In the past decade, we've seen growth in the sales of two-wheelers [1]. With the advancement in technology, the efficiency and the of two wheelers have improved. Data logging can further help in improvement by recording and analysing various parameters.

The aim of the project is to develop a tool for logging data using low-cost physical computing devices. Different parameters of two-wheeler were monitored to understand user's riding behavior. A variety of sensors were used for logging data. Arduino microprocessor was used for controlling and receiving data from sensor. Collected data is later visualized in Processing.

The tool monitors two-wheeler's speed, GPS location, angular displacement of handle, tilt angle of vehicle, clutch lever usage and rear brake usage. The generated data can be used to find statistical correlation between different parameters.

Introduction

This project was initiated by the thought of understanding the mechanism of self-cancelling indicator in two wheelers. The idea was to analyze the parameters which affect these self-cancelling devices. The other goal was to explore and learn low-cost physical computing devices for data logging and visualization.

To explore Arduino more parameters were included as a part of study. Finally, this project is about analyzing user's behavior while riding a two wheeler and presents it in a form that is easily understood.
At the beginning of the project, we analyzed mechanism of various self-cancelling indicators and later we looked for projects or research done on the same thought by different research labs, design schools etc. to understand their approach and techniques used for data logging.

Various parameters were finalized and accordingly sensors were installed in the motorcycle. Data from various sensors together can help to create a bigger picture of what is happening on the road for the driver and the vehicle.

The outcome of this project is a Working Prototype of a system which will record data of different parameters of a motor bike while on the road, which is then visualized.

Research

Data logging

Data logging is a process of measuring and recording physical or electrical parameters at set intervals over a period of time. The parameters can be anything to from current temperature to eye movement etc. The system that recors and measures these parameter is called as a Datalogger. A typical data logger essentially have three parts . i) Sensors for measuring the desired parameter ii) Processor to convert the data from sensors to understandable form and ii) Storage for recording all the measured data.

Working : a sensor converts the physical phenomena into an electrical signal (voltage or current). This signal is converted into binary data ehich is then processed to convert into understandable form. This information is recorded on a storing device which is further used for analysis.

Usage : Datalogger have a wide speturm of usage. Wherever data analysis could help in improving perfomances, preventing accidents etc. data loggers are used. For eg. Monitoring, temperature, pH, humidity while conducting a lab experiment; monitoring vehicle movement for traffic management ot monitoring volcano behavior to prevent casualties.

Figure 1. Hall effect sensor installation

Figure 2. Potentiometer installation

Furthur, we looked for projects related to data logging. Data logging finds its place in a veriety of domains so, we foucuse our search to two-wheelers. The projects were studied to undersatnd the technique and the technology used for measuring parameters. Following are a few projects:

Traction control system [2]

This project is about improving safety of two wheelers by creating a feedback system to prevent wheels of a vehicle from losing traction. Speed of front and rear wheel is monitored with hall effect sensors. Loss of traction or slippage is detected by change in speed of front and rear wheel speed. Change in angle of angle is detected using a potentiometer. The traction control system is built using Arduino based microprocessor to compare data from different sensors.

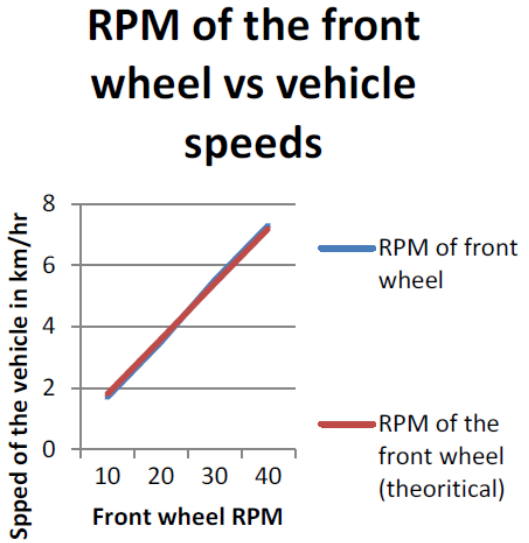


Figure 3. Results

Figure 4. Demo bike

Figure 5. Data logger

Saferider [3]

Saferider – SAFERIDER is a research project aimed at studying the potential of Advanced Riding Assistance System and On Bike Information System integration on motorcycle. The project proposes to create a intelligent system in motorcycle which uses various sensors to detect speed, acceleration, location of the motorcycle and information like traffic, weather and navigation to enhance riding experience, safety and comfort. Rider is provided real time analysed information from the different sensors which could help in decision making. Some of the functionalities of the riding assistance system developed in the project are as follows:

Speed alert – Alerting the rider when speed crosses legal limit. This is done by integrating static info (maps) with vehicle data (speed)

Front collision warning – This function aims at alerting the rider when an obstacle has been detected in the pathway.

Curve warning – This function warns the rider when speed is too high in relation to the approaching curve.

Haptic Glove – It is special glove equipped with electronics and vibration motors. Alerts and warnings are communicated to the rider through vibrotactile clues.

Scooterputer [4]

It is an experimental project by Kurt Sculz aiming at displaying all sorts of information related to driving on a display. The project was initiated with the thought of communicating current battery level of an electric scooter. Later, designer added other information like speed, time, date, latitude, longitude, tilt angle and temperature on the display. A variety of sensors was used to capture these parameters. Information by all the sensors is processed by Arduino processor.

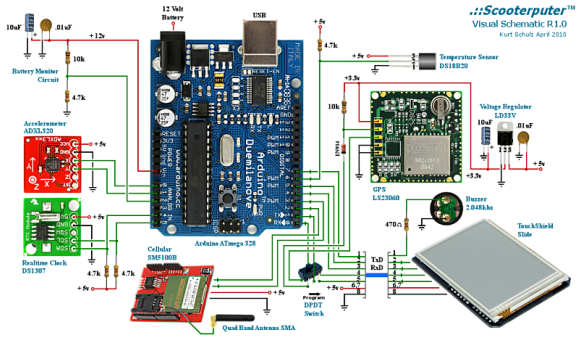


Figure 6. Circuit Diagram

Figure 7. Display

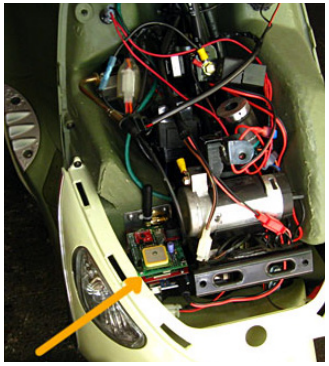


Figure 8. Microprocessor installation

Motodunio [5]

Motodunio is a project by Rene Sanchez in which he has built a small module to display bike's GPS coordinates and temperature. A GPS sheid is used to get the current location and a heat sensor is connected to Ardunio which processes the data and displays the information.

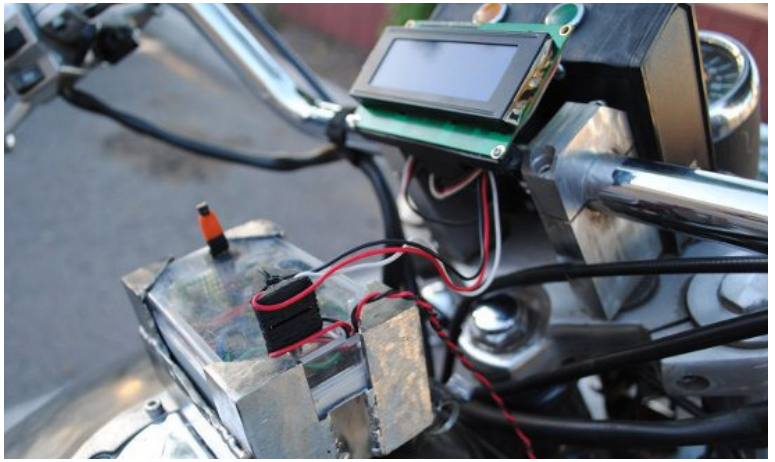
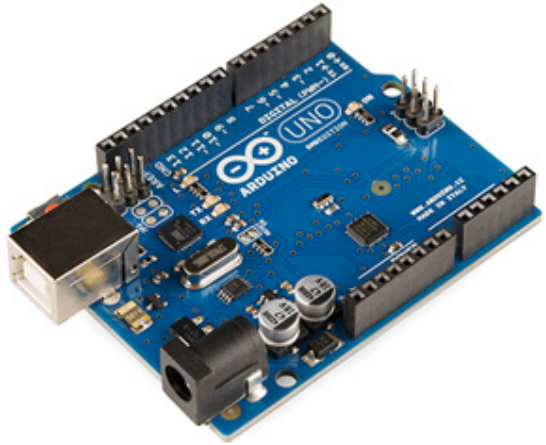


Figure 9. Microprocesssor and display

Most of the projects involves arduino and different sensors to capture data and focuses on communicating real time data to the driver. All the information can be captured and analysed to get a bigger picture which can help to improve driving experience.

In this project, we've tried to capture different parameters and display all the data such that it can be analyzed to draw some insight. The parameters we've monitored are angular displacement of handle, lean/tile angle of motorcycle, clutch usage, brake usage and the travelling path.

Prototyping



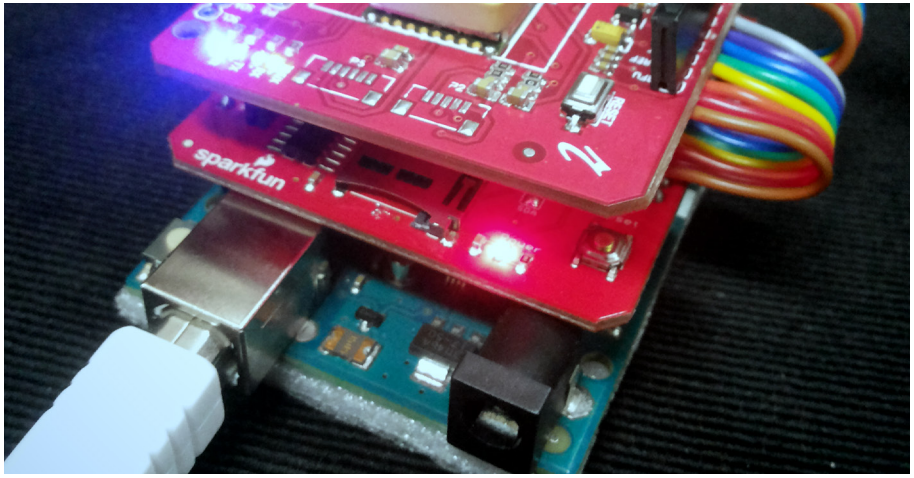


Figure 10. Arduino microprocessor (top) & installation on bike

Arduino Uno

Arduino is an open-source physical computing platform based on a simple microcontroller board. It is based on easy-to-use hardware as well as software. It's an easy tool for anyone who wants to make DIY interactive projects. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs.

In this project we are using Arduino Uno, as it is a basic version and best for newbies to start from scratch as well as easy to understand the hardware, Most of the sketches and examples are available on internet and write programs without making it difficult for the learner.

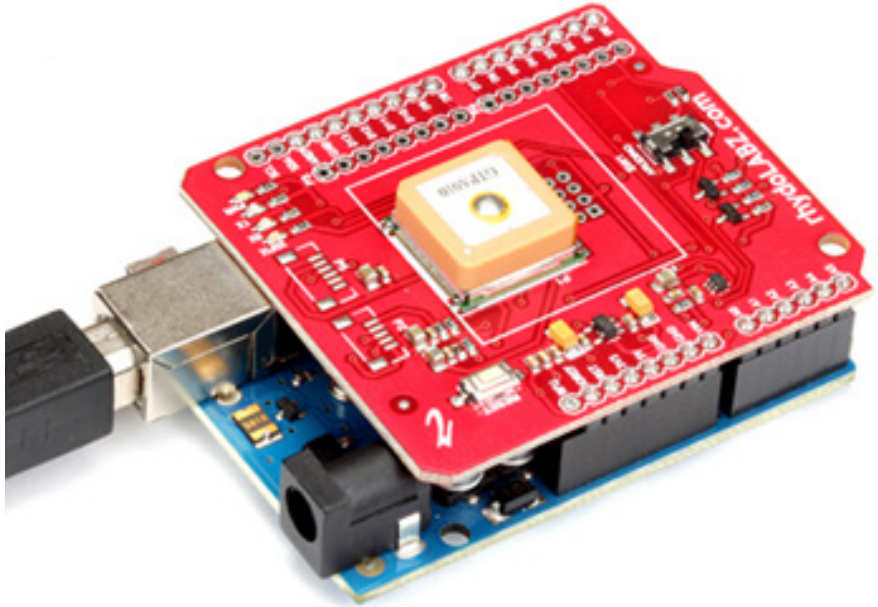


Figure 11. GPS sheid mounted on Arduino

Sensors

A sensor is a device that senses events or changes in quantities and triggers or provides a corresponding output, generally as an electrical or optical signal. Here in this project we are using following sensors:

GPS Shield

Arduino GPS shield is a GPS module breakout board for Arduino. It is used to track user's path during the ride, providing the longitude and latitude data. GPS module was used to get the path of the ride. It was place right at the top of fuel tank to have a clear vision of sky to have better signal strength.

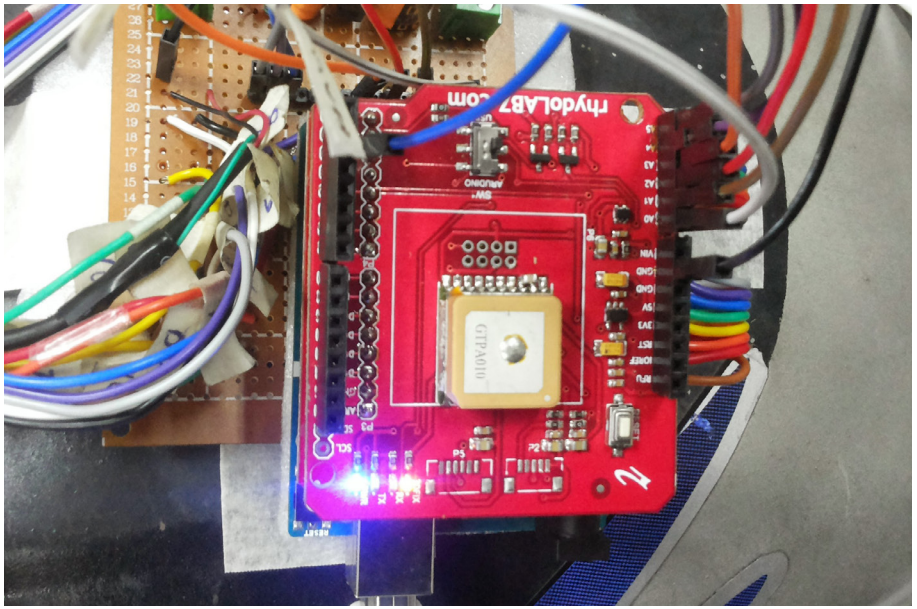


Figure 12. GPS sheid usage in the project

Gyro 6DOF Sensor

The InvenSense MPU-6050 sensor contains an accelerometer and a gyro sensor in a single chip. It captures the x, y, and z channel data at the same time. It provides a Digital-output X-, Y-, and Z-Axis angular rate sensors, which are gyroscopes, with a user-programmable fullscale range of ±250, ±500, ±1000, and ±2000°/sec.
Accelerometer was used to measure the tile lean angle of the motorcycle while driving. The sensor was placed such that one plane of the accelerometer is parallel to the ground and one axis parallel to the driving direction.

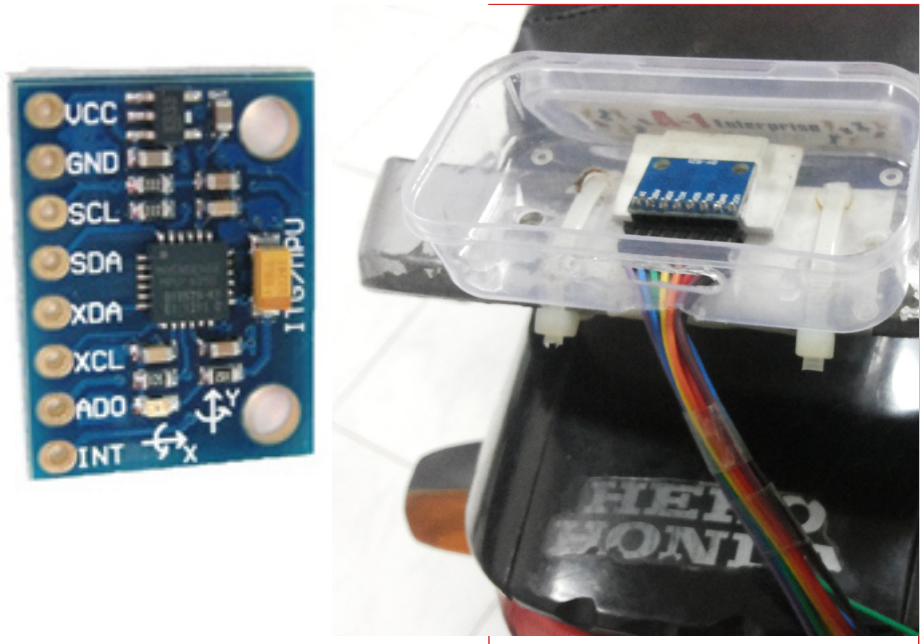


Figure 13. Gyro sensor (left) and installation on Bike

Flex Sensor

Flex sensors are passive resistive devices that can be used to detect bending or flexing. The flex sensor decreases its resistance in proportion to the amount it is bent in either direction. The sensor we are building is about 3/8" wide by 5" long. Flex sensors may be used in robotics to determine joint movement or placement.
This sensor was placed at the clutch lever to monitor clutch usage. It was placed in such a manner that there was enough bending of the sensor strip to get significant variation in the reading.

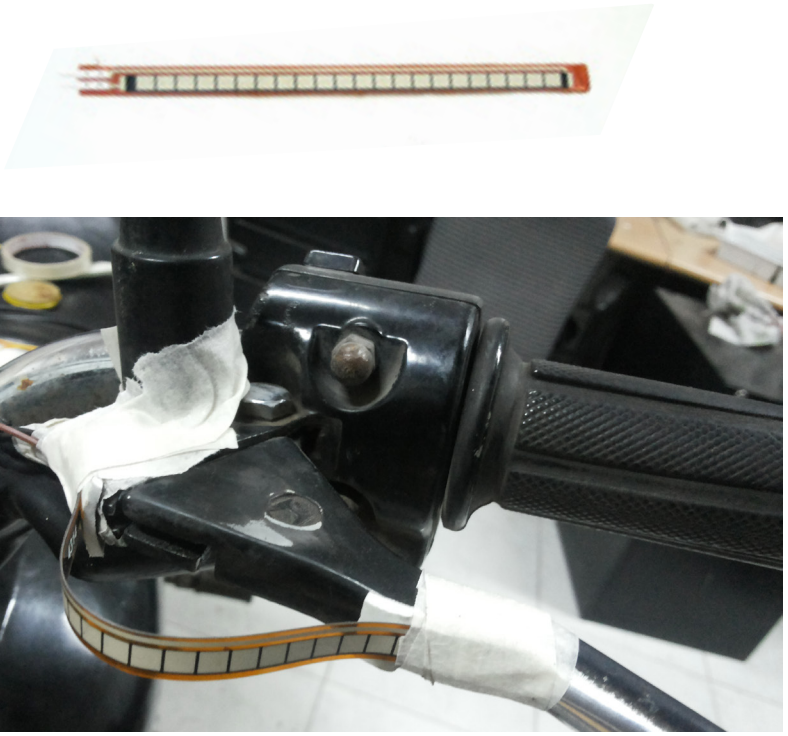


Figure 14. Flex sensor (top) and its installa

Force Sensor

A force sensor is a transducer that converts a mechanical force input into an electrical output signal. Most force sensors operate on the principle that the resistance of silicon embedded piezoresistors will increase when they flex under an applied force.
Force sensor was used to monitor the usage of rear brake. It was placed right at the top of the rear brake pedal. Whenever brakes were applied, sensor also gets pressed and resistance increases.

Figure 15. Pressure sensor and its installation on Bike

SD card Shield

The SD card shield adds storage to your Arduino project. It would have been very difficult to record the data of the rides on laptop. So SD car shield was used to record the data of the rides. ¬

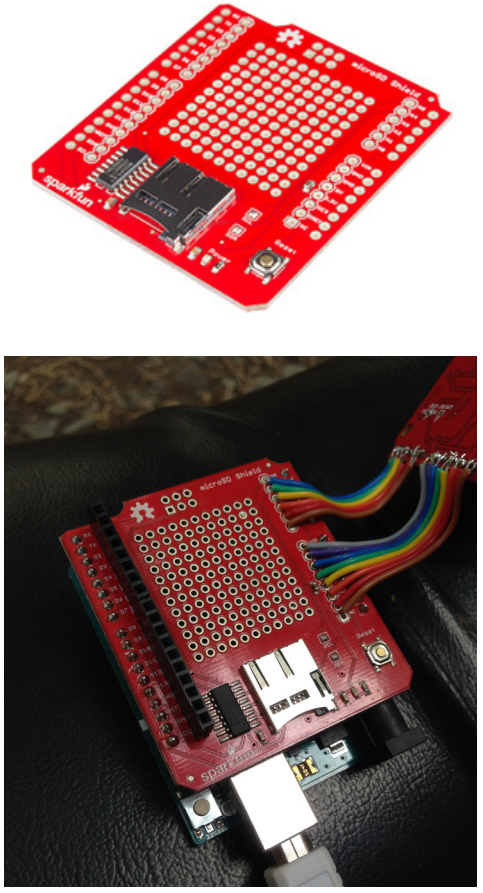


Figure 16. SD card Shield and its usage.

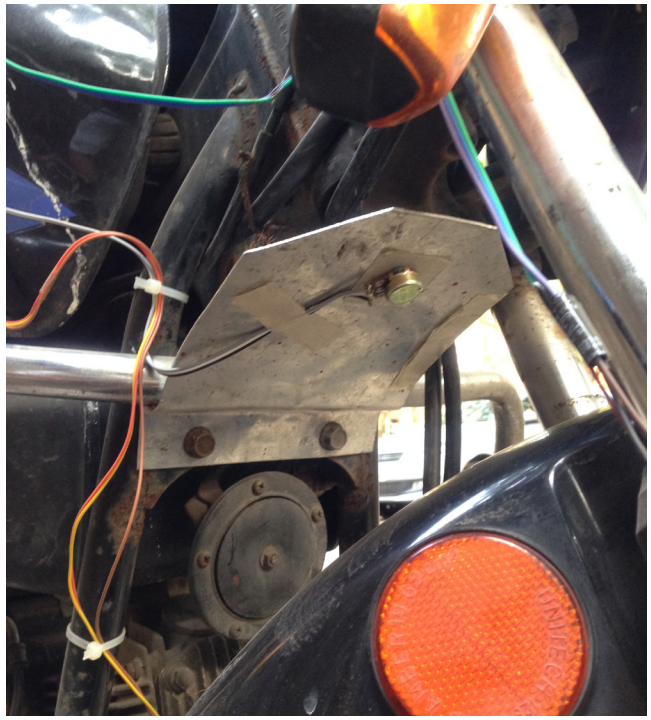


Figure 17. Potentiometer (top) and its installation in Bike

Potentiometer

A potentiometer is a resistive sensor used to measure linear displacements as well as rotary motion. In a potentiometer an electrically conductive wiper slides across a fixed resistive element. A voltage is applied across the resistive element. Thus a voltage divider circuit is formed. The output voltage (Volt) is measured as shown in the figure below. The output voltage is proportional to the distance travelled.
There are two types of potentiometer, linear and rotary potentiometer. The linear potentiometer has a slide or wiper. The rotary potentiometer can be a single turn or multi turn.

Potentiometer was used to detect the radial displacement in the handle while driving. Installing it was a bit tricky as the rotating knob of the sensor had to be calibrated to the exact center of motorcycle's handle and the remaining part should stay static so that only knob rotates with the handle.

Figure 18. Potentiometer installation detail.

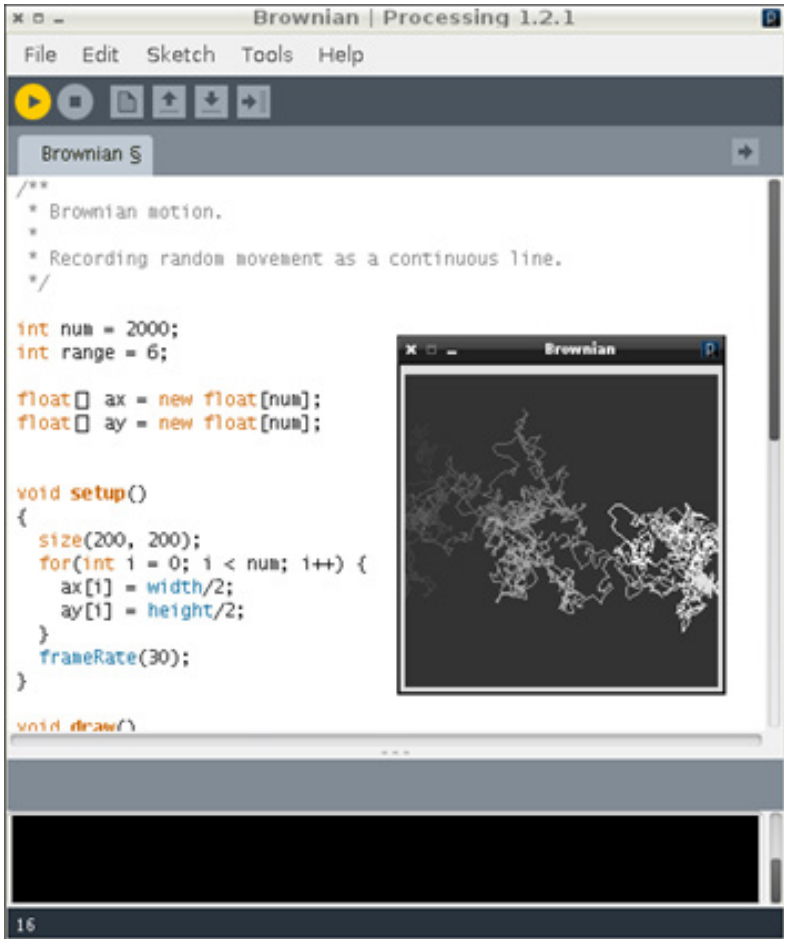


Figure 19. 'Processing' window

Processing

Processing is a programming language, development environment, and online community. Initially created to serve as a software sketchbook and to teach computer programming fundamentals within a visual context, Processing evolved into a development tool for professionals. Today, there are tens of thousands of students, artists, designers, researchers, and hobbyists who use Processing for learning, prototyping, and production.

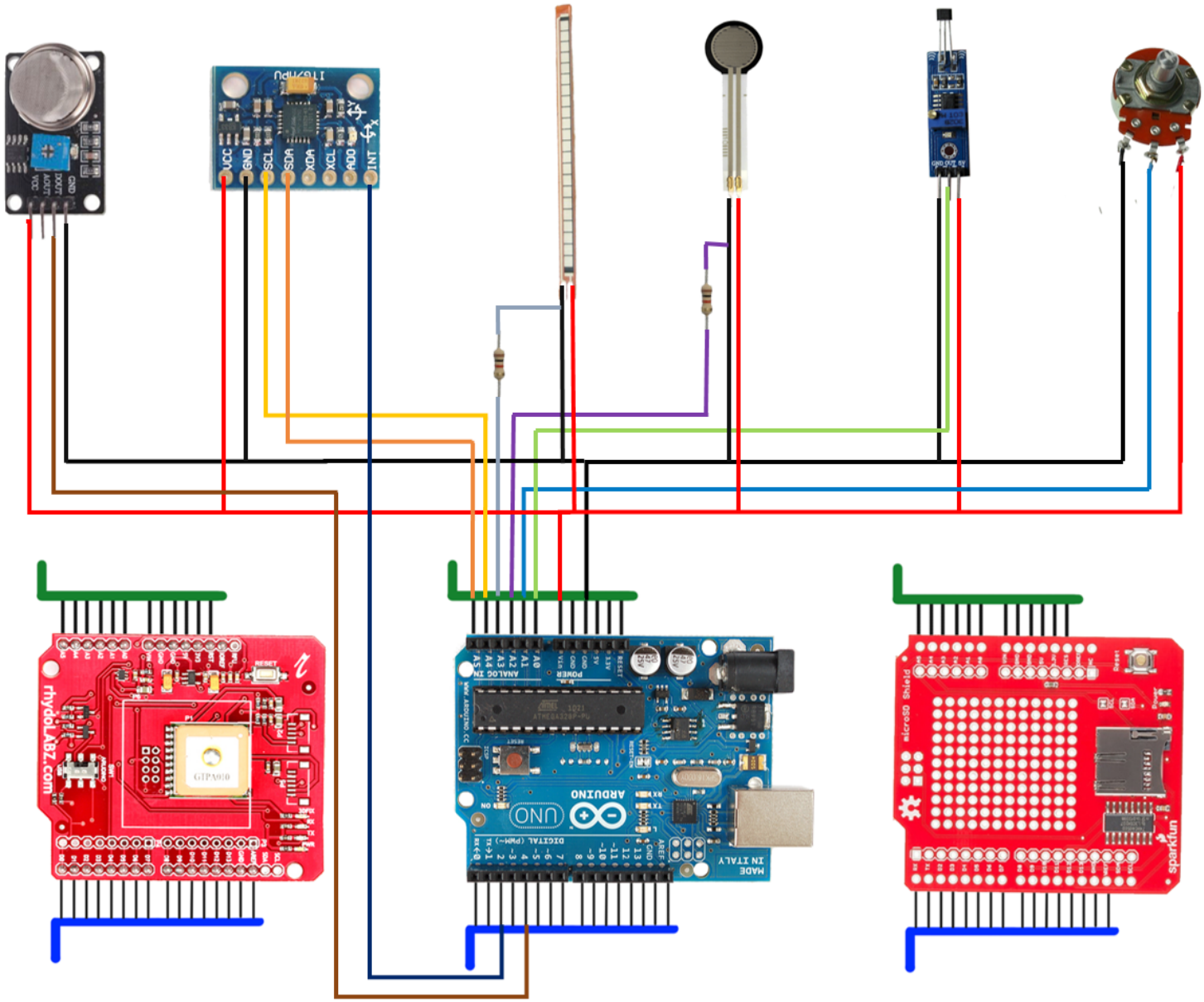


Figure 20. Circuit Diagram

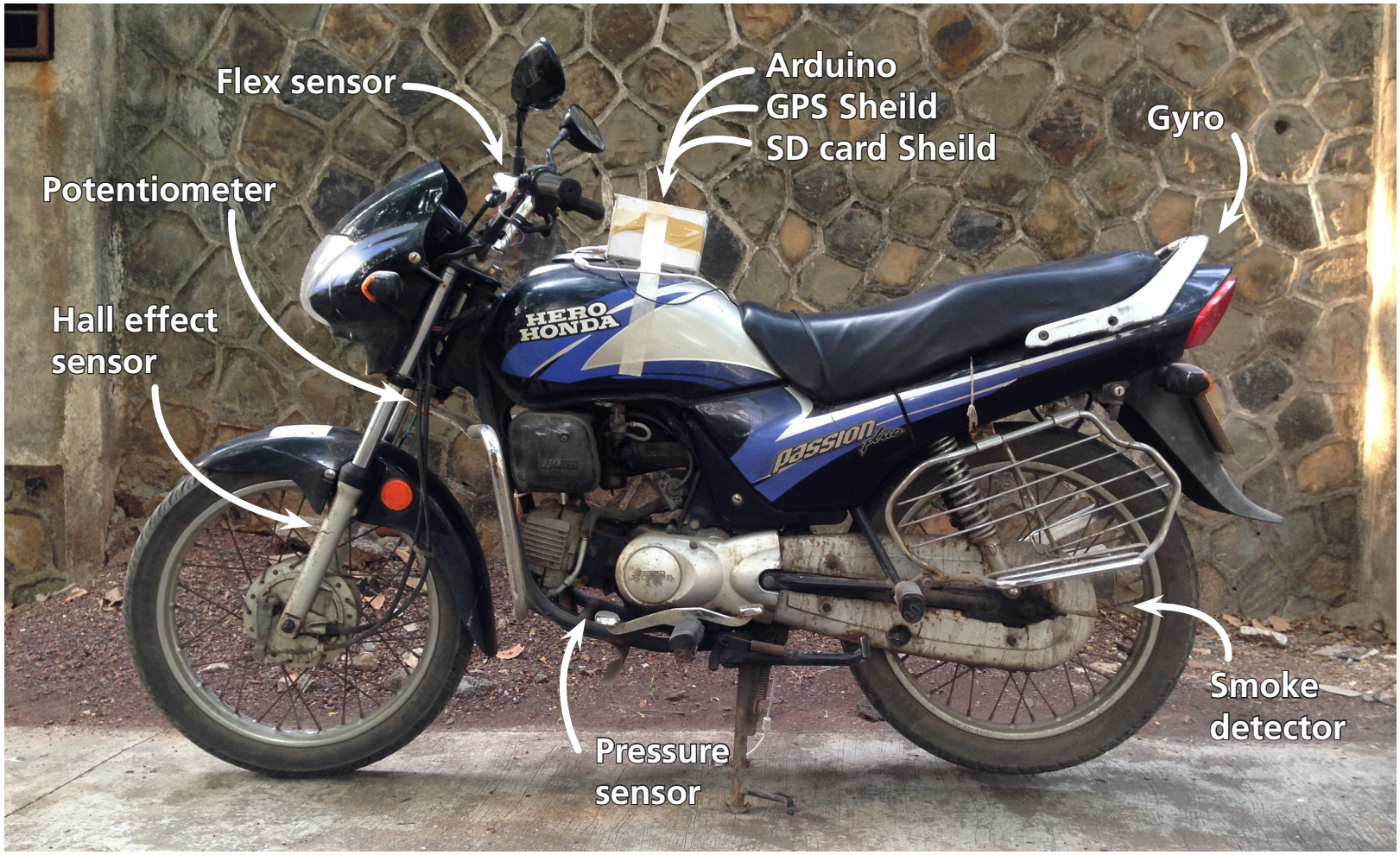


Figure 21. Sonsors and other components placement on Bike

Data collection

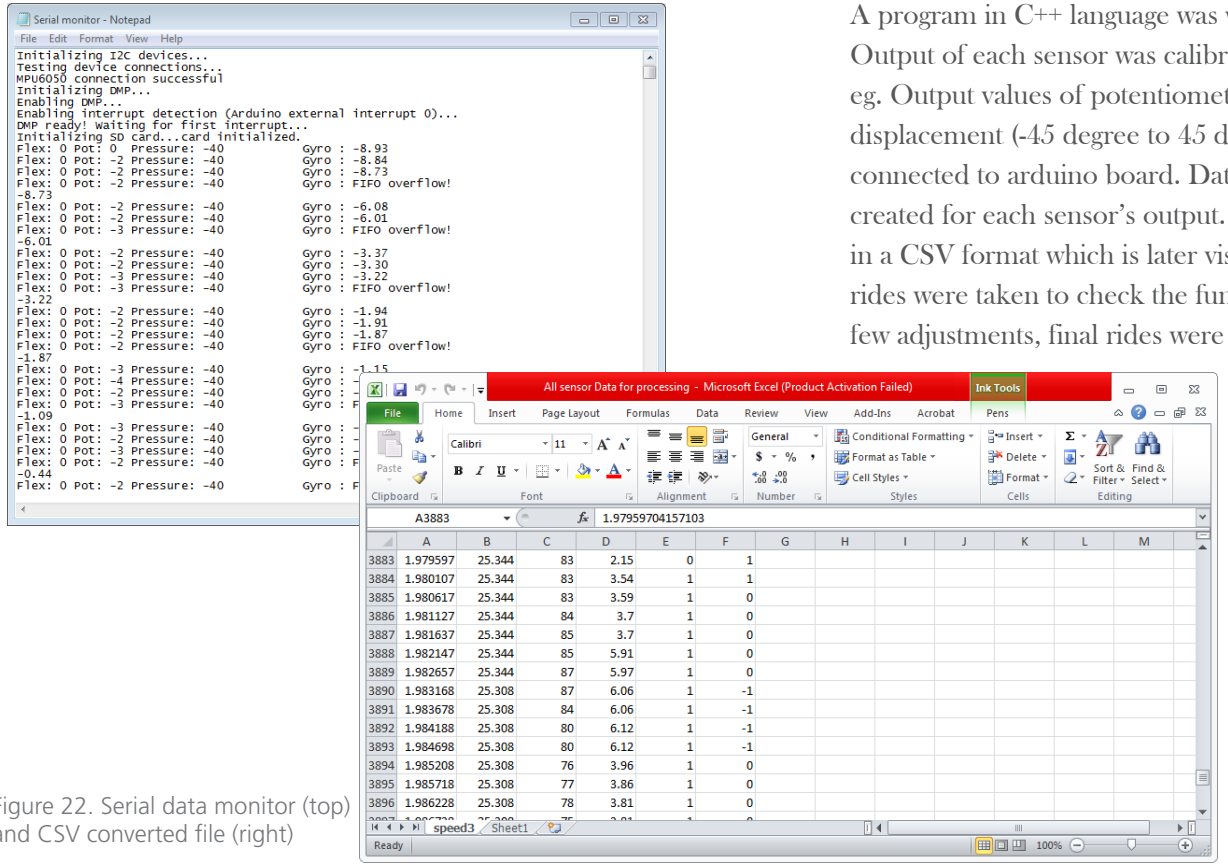


Figure 22. Serial data monitor (top) and CSV converted file (right)

A program in C++ language was written to log the data from various sensors. Output of each sensor was calibrated and mapped as per requirement. For eg. Output values of potentiometer was mapped according to the angular displacement (-45 degree to 45 degree). All the data was stored on a SD card connected to arduino board. Data was stored in text file and a separate file was created for each sensor's output. Later, all the text files were merged together in a CSV format which is later visualized in processing. Initially various short rides were taken to check the functioning of the sensors while driving. After a few adjustments, final rides were taken within IIT campus.

Data Visualization

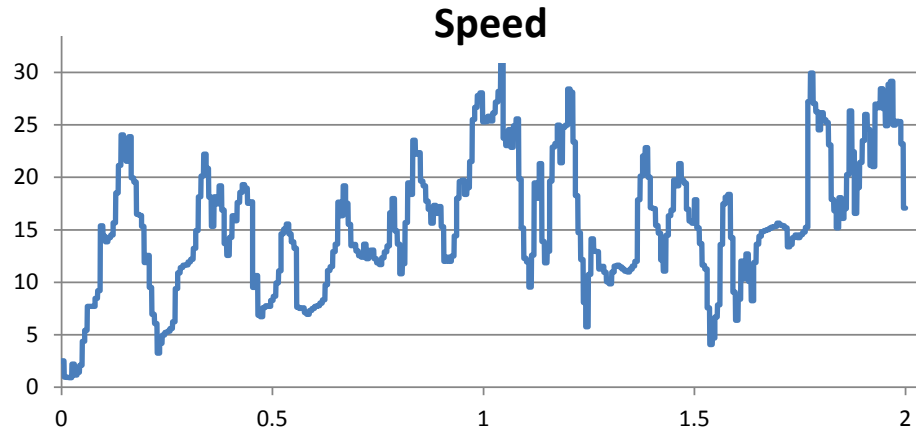


Figure 23. Speed (y axis) X Distance (x axis) chart

Initially the idea for representing the data was to develop various graphs but we felt that graphs were static and not communicating the information efficiently. Later the data was visualized by developing a interative tool using 'Processing'. The tool consists of a map on which ride path is shown, bike handle that depicts angular displacement of handle, clutch lever to show clutch state(pressed or open), bike's front view for showing tilt angle, a brake pedal to show rear brake status and a slider to navigate through the ride. User can use the slider to know bike's state at a particular point.

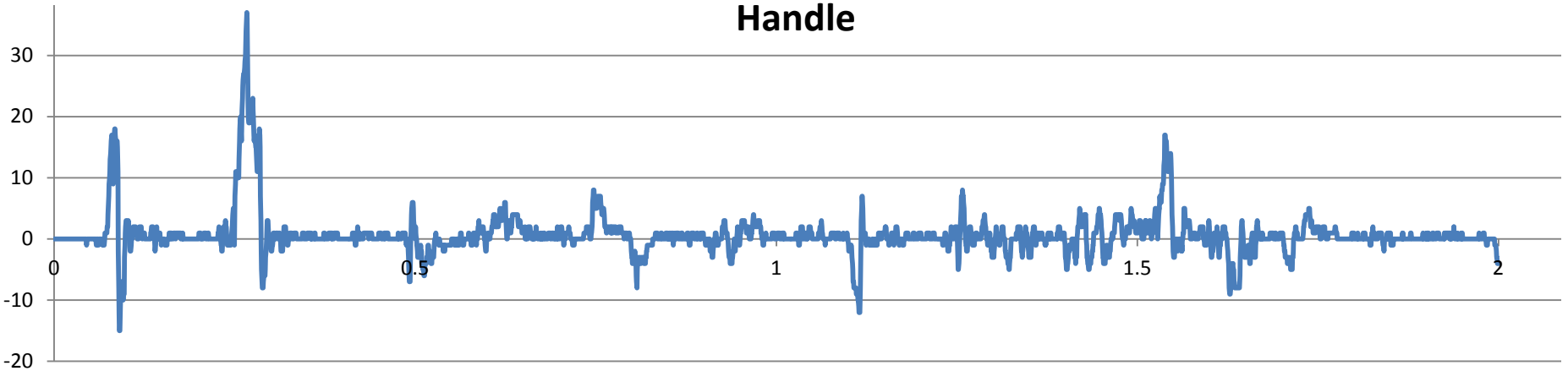


Figure 24. Angular displacement of handle (y axis) X Distance (x axis) chart

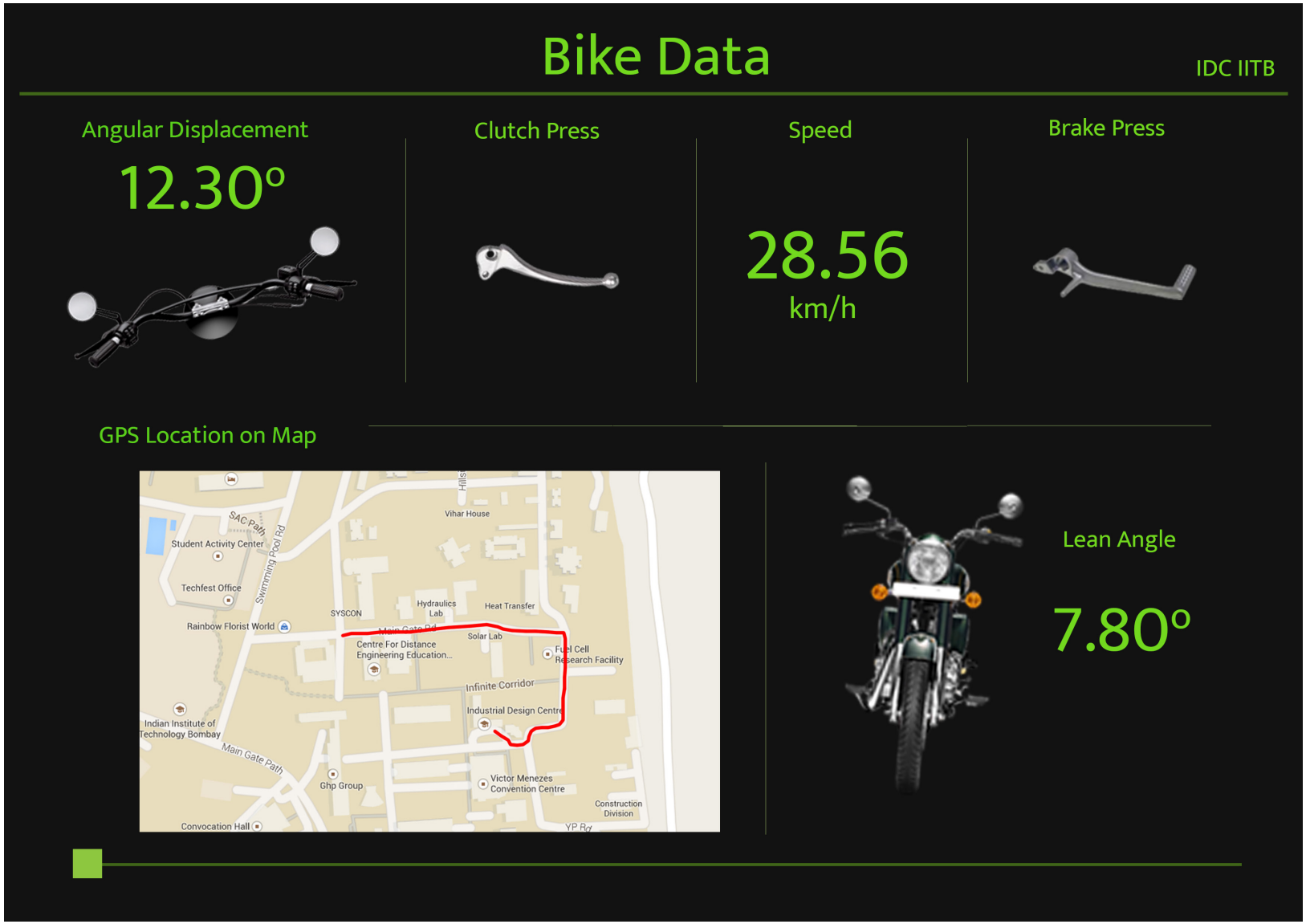


Figure 25. Interactive visulization tool

Conclusion

From all the readings and observations from the data collected following were concluded.

• Different hypothesis can be made and statistical correlations between different combinations of parameters can be found out.
Ex. The lean angle is less tahn 10 degrees when the radial displacement is less than 30 degrees while taking a turn.

•The Bike data tool can be used to analyze the data of the ride and find different patterns between the parameters

These findings need further validation with the help of more rigorous user testing.

References

[1] Two-wheeler sales in India from 2011/12 to 2013/14 (in units), accessed March 2015. http://www.statista.com/statistics/318023/two-wheeler-sales-in-india/

[2] Jagannath Korody et al, *Traction Control System – An Integrated Safety for Two Wheeler*, 3rd International Conference on Mechanical, Automotive and Materials Engineering (ICMAME'2013), Singapore, April 29-30, 2013.

[3] Roberto Montanari , Andrea Borin, Andrea Spadoni, *Saferider – Results From Yamaha Test Site On Advanced Rider Assistance System,* CHI, Italy, 2011.

[4] Kurt's Arduino projects, accessed December 2014. http://www.janspace.com/b2evolution/arduino.php/2010/06/26/scooterputer

[5] Arduino + Motorcycle = Motoduino, acessed December 2014. http://makezine.com/2010/09/17/arduino-motorcycle-motoduino/w