Sensor Data Acquisition and Analysis

Conceptualization of Internet of Things

Data Analysis and Computational Methods with MATLAB(LOTI.05.019)
Master's of Science: Robotics and Space Technology
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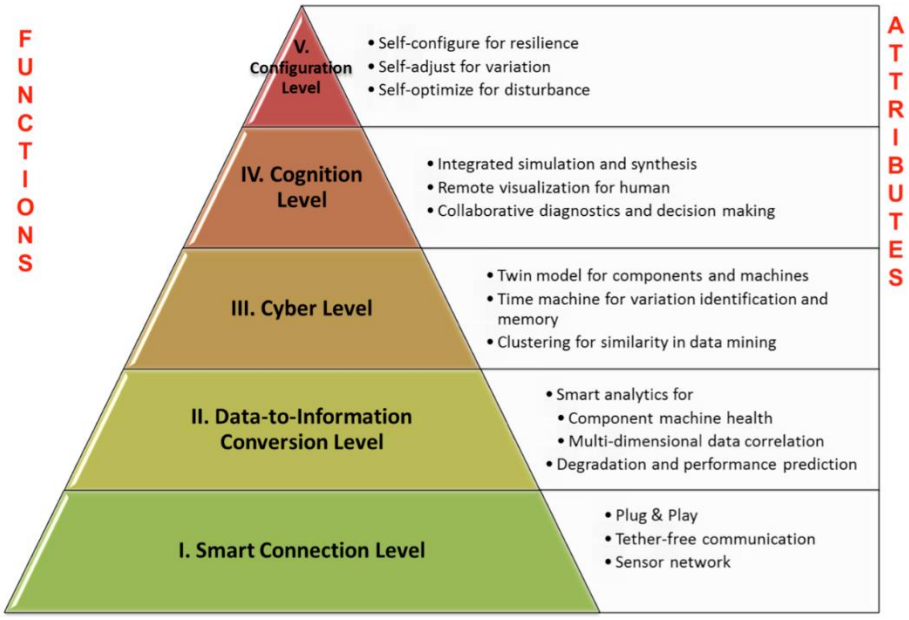
01. Introduction

As the world moves towards intelligent devices and directed communication between humans and devices, it is important to lay foundations and protocols that govern the interaction between the two entities.
This gives rise to the need of the hour to equip all devices with modules that connect them to a single network or a unit network relay with different quantizers and modems that could enable communication not only between same devices, but also devices that have different foot prints based on their manufacturers and protocols.

The same can be said for the networking that is established using protocols that can be efficient, ensuring no or minimum data loss, while communication so that the relayed functions and data from the transmission end is received substantially at the receiving end.

Conceptualizing the same, this project report, lays foundations to the idea of Internet of Things, by relaying information sent by a sensor subsystem to a cloud server. The scope of the project exists in the domain of quantitative data rendering of the This data once stored on the cloud, can be buffered or acquired real time, via suitable software and well defined algorithms that can efficiently handle, parse and display data for further analysis or even relaying to other nodes and modules for further applicative approaches.



http://imscenter.net/cyber-physical-platform

02. AIM

The project aims to conceptualize Internet of Things by sending data from a remote sensor system arrangement (cellular phone) to a cloud server and in turn retrieving the data from the cloud and displaying it via MATLAB.

03. Objectives

The following objective(s) have been sighted towards the project :

- Creating a Cloud Server for Data Storage
- Designing an android application for up-linking data to the cloud
- Writing a code for downlinking the data to MATLAB
- Generating a MATLAB GUI to display the values with interactive rendering

04. Resources

S. No.	Resource(s)	Rationale
1	Thingspeak Cloud Server	Setting up a Cloud Server for Data Storage
2	Android OS (7.0)	Environment to Run the application
4	MIT App Inventor 2.0	Android Application Repository and Development
3	Cellular Phone (Android based)	Device for Android Application
4	MATLAB 2017b	Code Structure and GUI Development

05. Procedure

The road map of the project was planned in a manner that every aspect of the project worked in harmony and simultaneously. Since it involved 3 different platforms to be worked upon, it was necessary for the sub modules to be worked on in parallel, to show effectiveness during runtime.

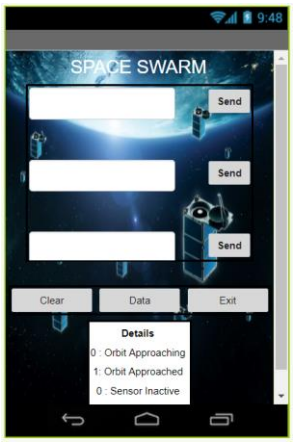
a. Creating Cloud Server

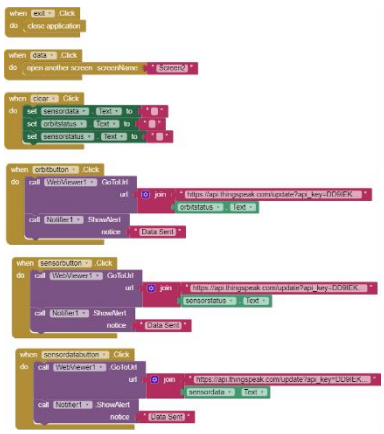
MathWorks Thingspeak was used as an open source platform to create a single channels that stored data values in different fields. These field were made accessible in the public domain and can be relayed into through an Application Index Key (API Key).
All data is Uplinked and Downlinked via the Hyper Text Transfer Protocol(HTTP) using the default ISP and 8080 Gateway. The fields are identified by unique tag names that are utilized during the MATLAB program

https://thingspeak.com/

b. Android Application

MIT App Inventor 2.0 was used to sight the development of the android application that served as the sensor system to uplink data to the cloud. A user interactive GUI was designed and built to be able to send to the cloud as desired.





c. MATLAB GUI

The Graphical User Interface Development Environment (GUIDE) was used to build the interactive GUI on MATLAB. The GUI extracts and parses data from the cloud using the ThingspeakRead function to display the results and plot them as well. Sensor data from the cloud, is also displayed on the GUI and since it is a sensor system, the option of setting a threshold is available on user definition.

The GUI renders the 'varargin' function that takes up the input parameters within the GUI using that 'handles' object case as instances. The varargin function bears the initialization structures for the GUI providing a development environment while talking to OpenGL that enables attributes and function calling within MATLAB. The parameters passed among the functions are as follows :

hobject : handles the figure of the GUI during development by sending current status.

Eventdata : The EventData class is the base class for all data objects passed to users of the GUI. When an event is triggered, the event method, assigns values to the properties of an event and parses data to a callback function.

Varargin : It is the command line interfacing all methods to the call back function.

Thingspeak Function :

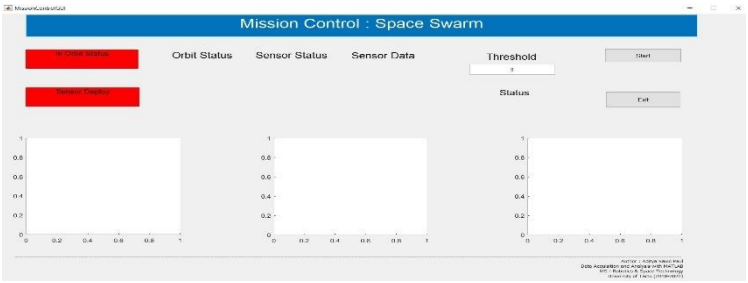
This is a predefined function that collaborates within the MathWorks workspace and conjuncts MATLAB and Thingspeak Cloud Server.

Syntax :

[data, time] = thingSpeakRead(readChannelID, 'Field', fieldID1, 'NumPoints', 30, 'ReadKey', readAPIKey);

Data and time are variables to store the Sensor Data and the Time at which it was sent.
readChannelID : It is the public / private channel ID to access the fields of the Server
Field : Defines the scope of the Data being pushed into the cloud
NumPoints : Total Number of Data points that are called from the Server. (here : 30)
ReadyKey : Public Access Application Index Key to access the data in the Field
readAPIKey : variable to store the Public Key.

A threshold analysis of the sensors value is user defined to check for thresholding of the Sensor data.The Call back Functions send control to the method calling for 'varargin' to handle All clusters and commands that have been sent by the user, at the backend.
Data is plotted by using stem, scatter and plot functions to graphically represent data.
Exit button is executed by the 'close' command that kills the GUI.



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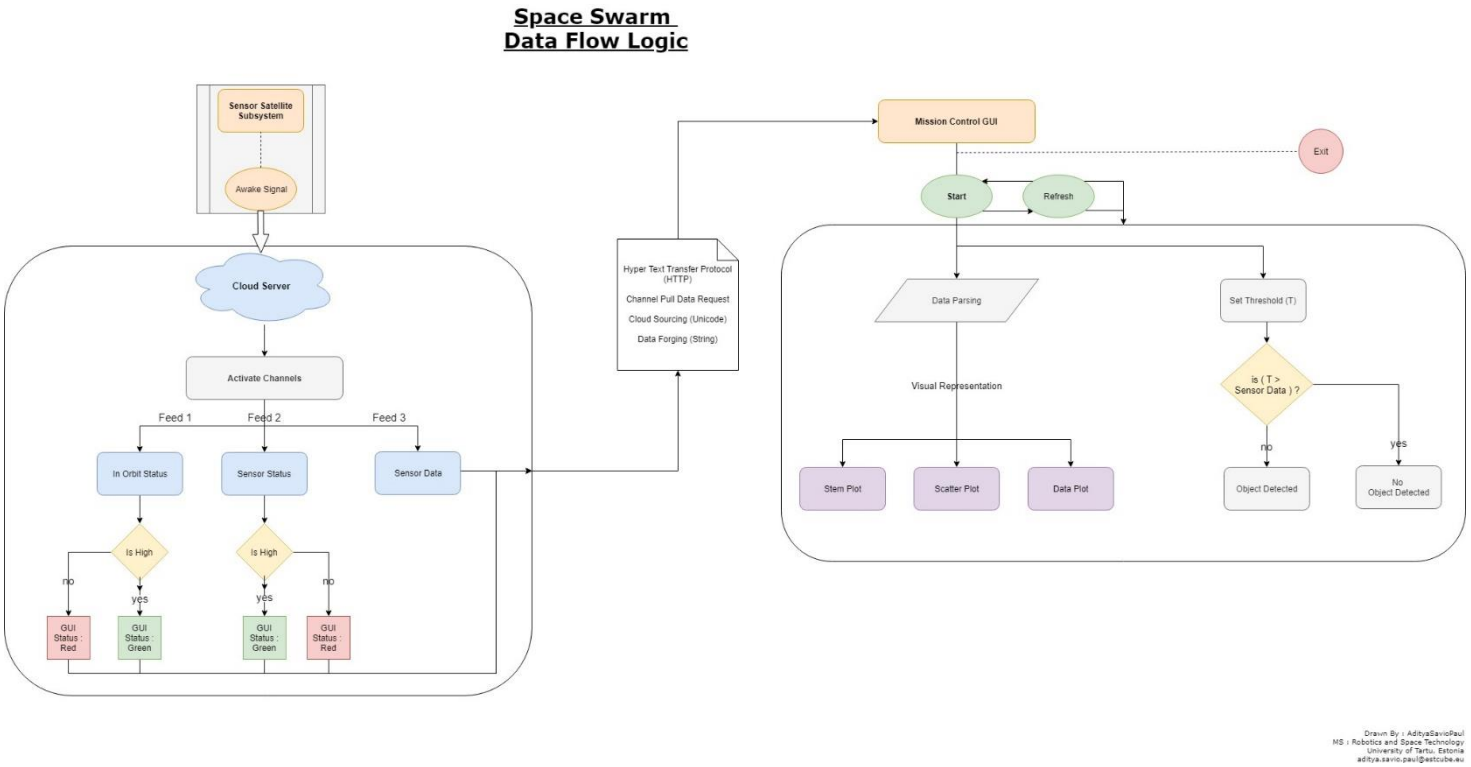

e. TimeLine

PROJECT TIMLINE

W / M	Oct-18	Nov-18	Dec-18
Week 1	Project Declaration	Research	Code Testing
Week 2		MATLAB Code and Server Configuration	Project Presentation
Week 3			
Week 4		App Development and Code Testing	

06. Applications

1. Internet of Things finds heavy application in home automation where intelligent devices can be connected with each other via the internet and decisive information can be relayed through a certain set of requests and pulls to execute a particular task.

> Example : The thermostat can be automated to receive the ambient temperature from a remote channel that stored current temperature. A series of electromechanical arrangement can then maintain suitable temperature within the house at the comfort of the residents.

2. The Concept of connected vehicles and infrastructure would be the most benefitted from the application of Internet of Things.

> Example : Multiple cars on the road could be communicating with each other and also the traffic lights. This would provide the driver with suitable routes to take via his google maps to navigate and reach his destination on time.

3. Space Technology : The application of internet of things in space technology shall ensure reliable communication between the satellite system and the ground station.

> Example : A Swarm of satellites in space that are interlinked via high speed UHF connection can be a network of subsystems having their own sensors on-board. This sensor value can be relayed back t the ground station via laser communication. Since all data is being buffered, lesser CRC would be needed hence delivering almost complete data sets from the satellites.

07. References

- http://dataottam.com/2016/07/09/the-pyramid-of-internet-of-things-iot/
- https://www.researchgate.net/publication/320936270_Big_Data_the_Internet_of_Things_and_the_Revised_Knowledge_Pyramid
- https://en.wikipedia.org/wiki/Internet_of_things
- https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT
- https://in.mathworks.com/products/thingspeak.html
- https://in.mathworks.com/help/matlab/creating_guis/about-the-simple-guide-gui-example.html
- https://www.mathworks.com/videos/creating-a-gui-with-guide-68979.html
- MATLAB GUI : https://www.youtube.com/watch?v=OyUYqgch-xk
- App Inventor 2 : https://www.youtube.com/watch?v=6hAAznJqPLk
- App Inventor 2 : https://www.youtube.com/watch?v=7dzGn6jFFgY

08. Appendix

The following project was an attempt to conceptualize the prodigy of Internet of Things and to establish an applicative approach towards space swarm int space technology

The concept of fast data transfer and via reliable communication medium is the need of the hour and internet of things is a prime approach in achieving it.

Internet of thing extending to Internet of Everything, bridges the gap between man and machine providing the relaxation of getting things done with a single point of decision. This combined with added efforts of different fields of engineering is making humongous tasks possible.

Smart cities, smart home controls and automated industries with power effective techniques are on the rise and internet of things is the way to achieve the desired components of communication within the particular ecosystems of devices and humans.

This is where advanced technology comes into play and giants like Samsung, siemens, and Philips etc. invest hug amounts to develop and research on the same.

The need of the hour is met by the revolutionizing of our surrounding with connected devices and that extends not only to our ecosystem but also further and beyond.

09. Note of Appreciation

I would like to extend my gratitude towards Mr. Eglis Avots for his lectures and guidance in laying the foundations of MATLAB during the curriculum and providing insights and critical comments that could make the project a success.

I also express my appreciation towards Mr. Gholamreza Anbarjafari, for his supervisory vision over the course content to enable us in better understanding the concepts and grasping the basis of MATLAB.