SOMAIYA VIDYAVIHAR UNIVERSITY
K J Somaiya College of Engineering

Somaiya TRUST

Undergraduate – Last Year Project
Project Ref no.: 09
Semester 8 Final Evaluation

Crowd sensing Road Surface Data with Geo-spatial Visualization for Augmenting Navigation of Ground Vehicles

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Problem Definition

- Create a system that measures and analyzes information about the condition of the road surface to assist vehicles in navigation.

Objectives

- Creation of a sensor-based data acquisition system for road surface quality.
- Building a database of information about road quality.
- Deriving conclusions from acquired data to assist in navigation of vehicles.

How our System can be useful ?

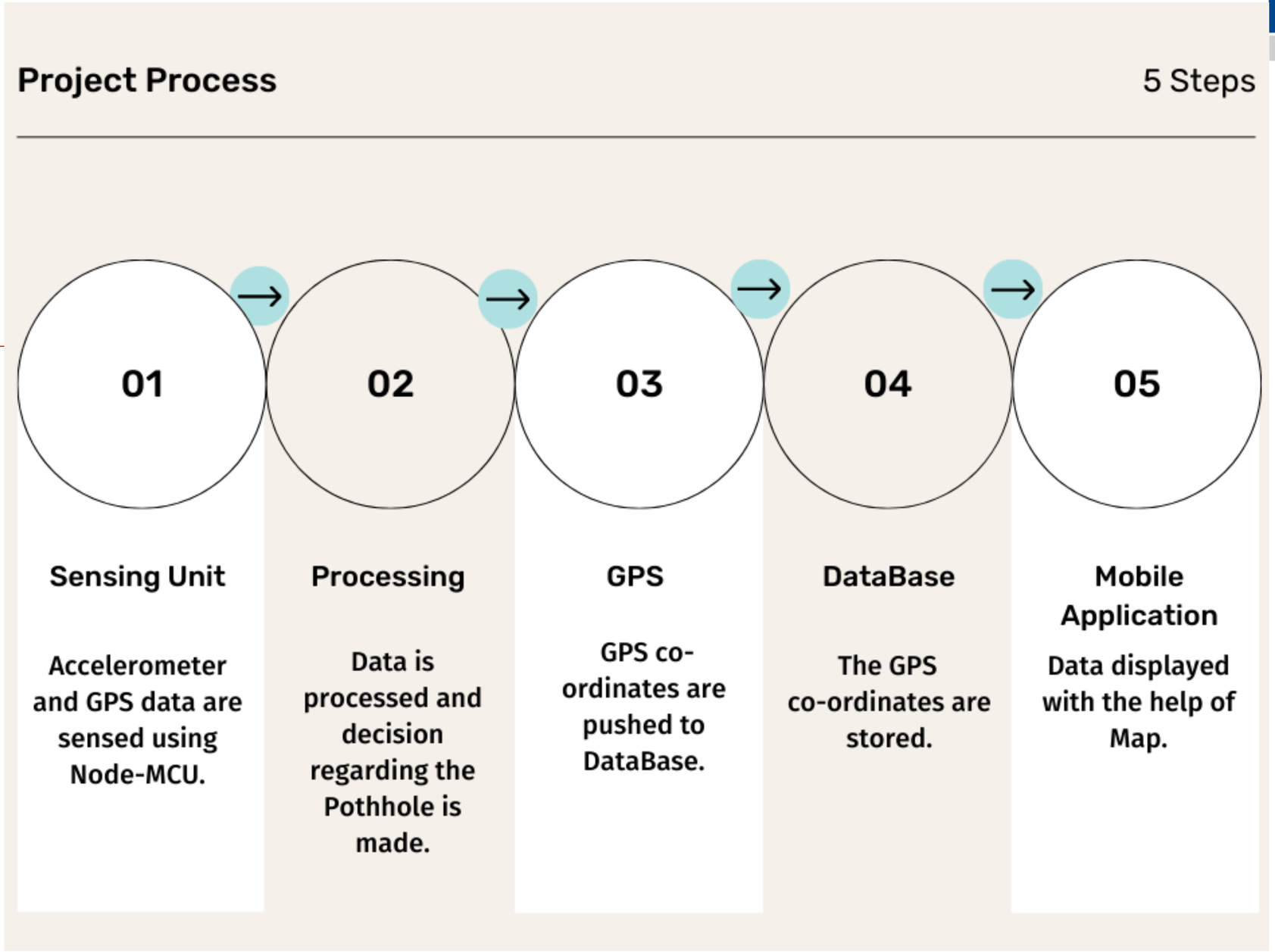
- The Government Authorities.
- The Logistics businesses.
- Common People.

Literature Survey

Sr. No.	TITLE	Publication Details	Remarks
1	The Pothole Patrol: Using a Mobile Sensor Network for Road Surface Monitoring	Presented in Mobisys '08, June 17-20	• Importance of mobility in spatiotemporal coverage of Road Surface. • Implementation of delay-tolerant, reliable transmission scheme. • Analysis of possible positions for accelerometer placement. • Considering/Recognizing road features that represent the actual road anomalies • Filtering acceleration data to remove false positives. • ML model, that recognizes acceleration profiles, classifies events in near real-time.
2	Wireless Sensor Networks Composed of Standard Microcomputers and Smartphones for Applications in Structural Health Monitoring	Sensors (MDPI Journal), 2019	• Wireless sensor networks have attracted great attention for applications in structural health monitoring • A prototypical implementation demonstrates the feasibility of integrating smartphones as data acquisition nodes into the network, utilizing their internal sensors. • The results confirm the high performance of the measurement system in terms of stable sampling at high sampling rates up to 1 kHz. • Limitations seen in the results provided are mostly due to the use of very cheap MEMS-based sensors, where the costs of a single node are below 50 e, not accounting for power supply and enclosure.

Sr. No.	TITLE	Publication Details	Remarks
3	The Car as an Ambient sensing Platform	Proceedings of the IEEE, Vol. 105, No. 01, January 2017	• The car as an urban sensing platform. • Exploration of an immense CAN sensory data set. • Focus our attention on specific examples dealing with: weather and environmental sensing, road safety, driver behaviour analysis.
4	Crowdsensing Framework for Monitoring Bridge Vibrations using Moving Smartphones	Proceedings of the IEEE, Vol. 106, No. 4, April 2018	• Condition Monitoring and Evaluation of Civil Structures. • Mobile Sensor Networks as a Scalable Monitoring Solution • Civic Data Collection through Human Mobility. • Measuring Vibrations in Civil Engineering using Smartphones • Data collection for SHM has relied on fixed sensor networks, which must be designed, installed, and maintained by experienced personnel.

Functional Flowchart



Hardware

Accelerometer Working

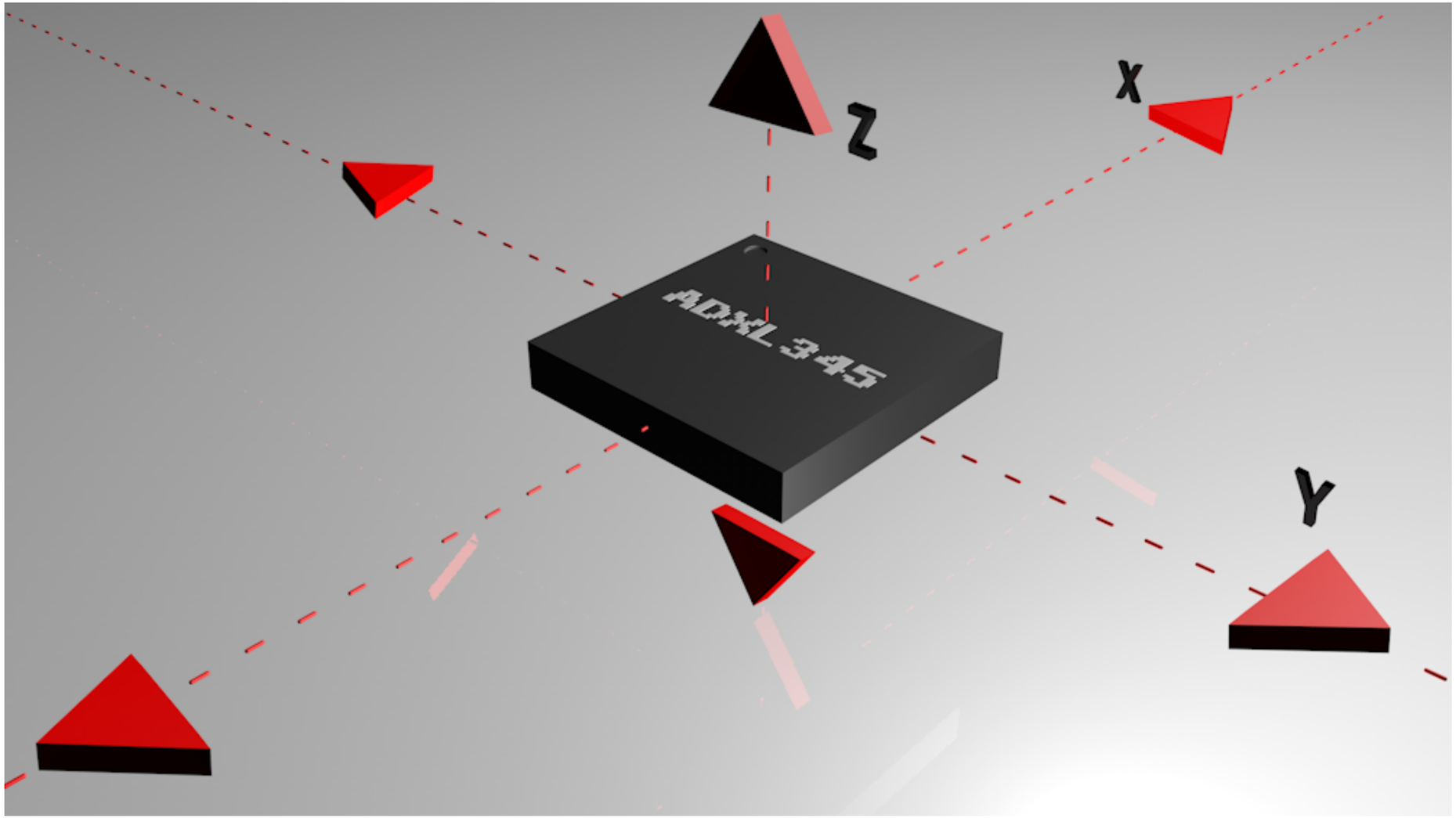
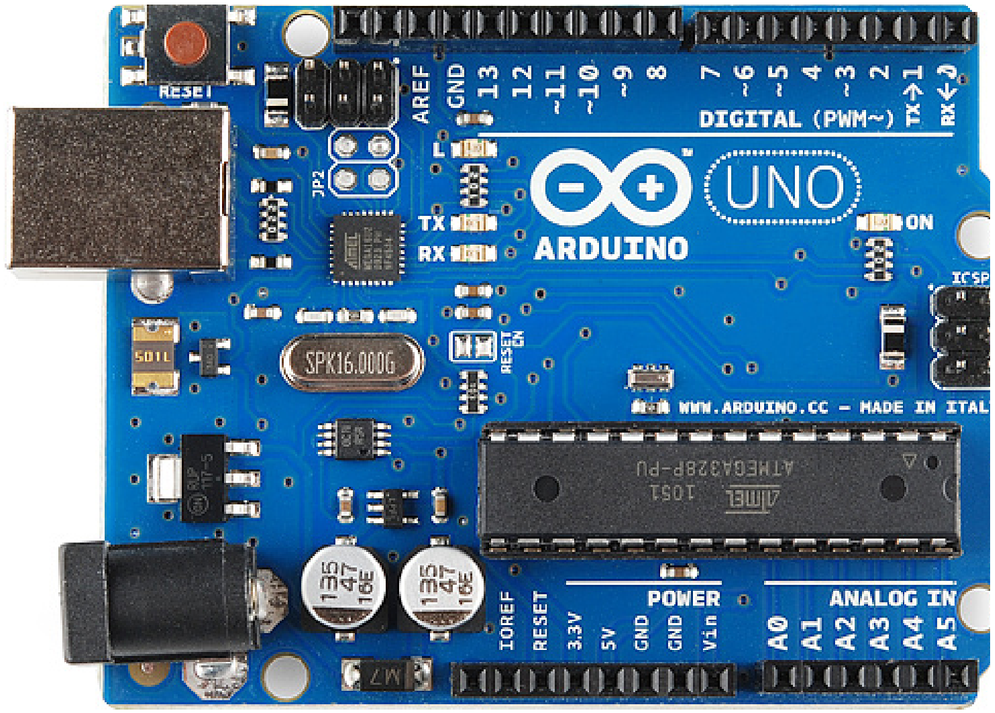


Image Source : sparksfun

Micro-Controllers



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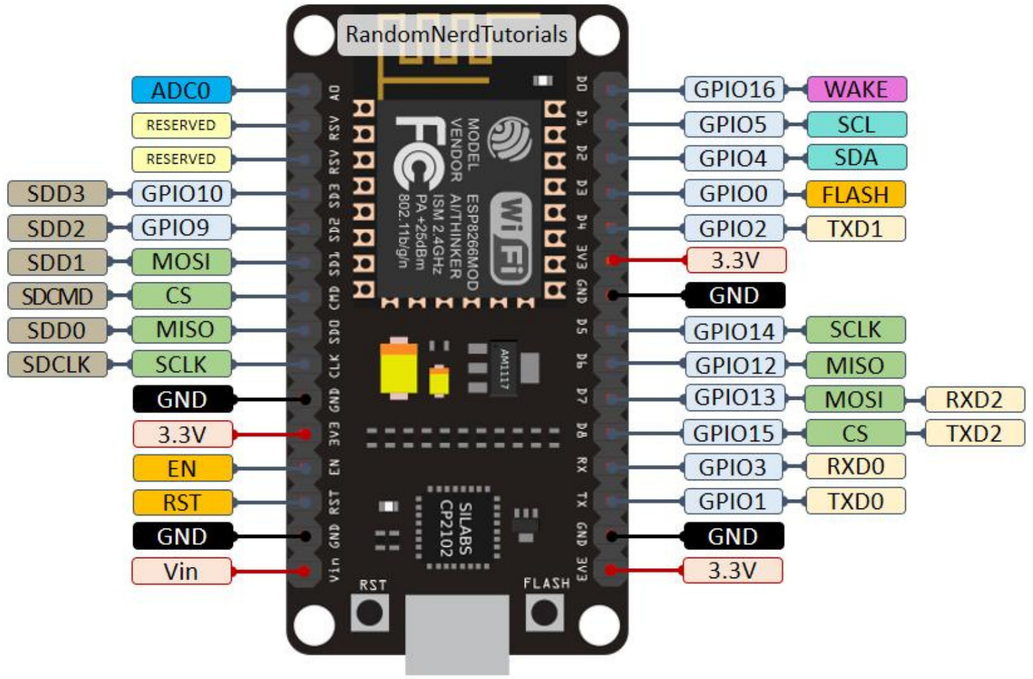
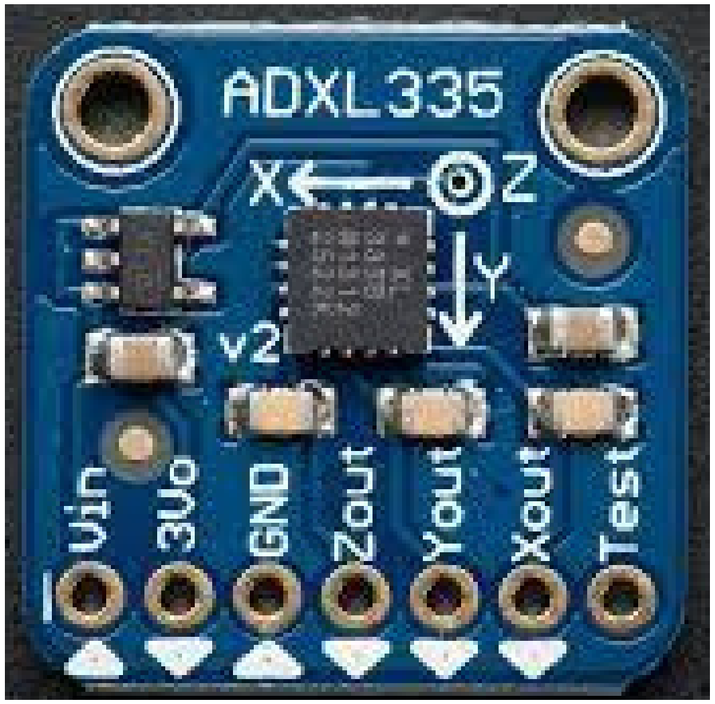


Image Source : RandomNerdTutorials

Accelerometers



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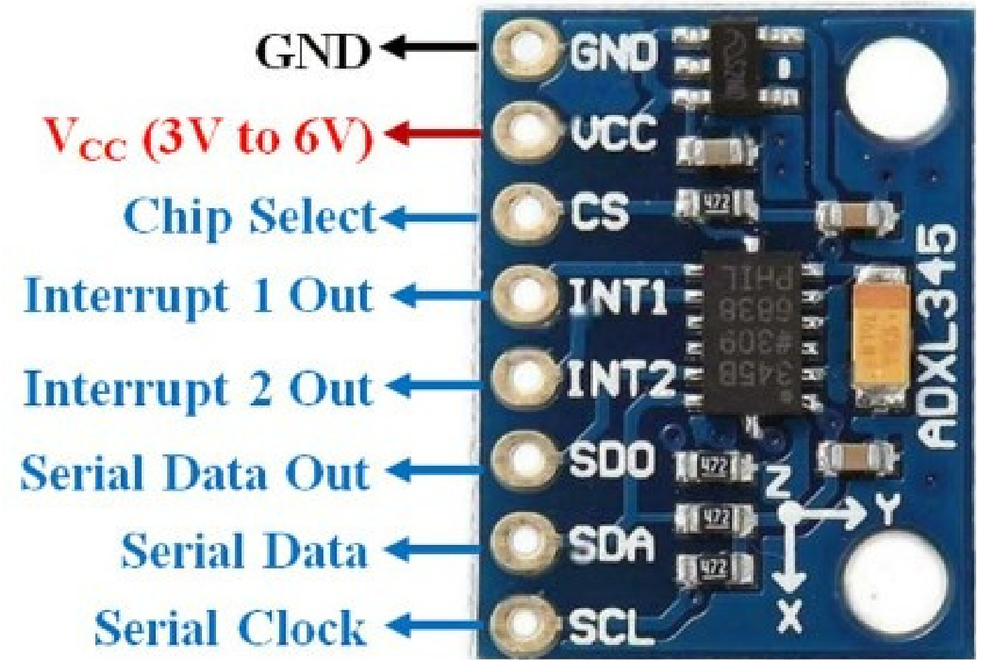


Image Source : components101

Deployment Setup

Detection Algorithm

Pothole Detection Algorithm

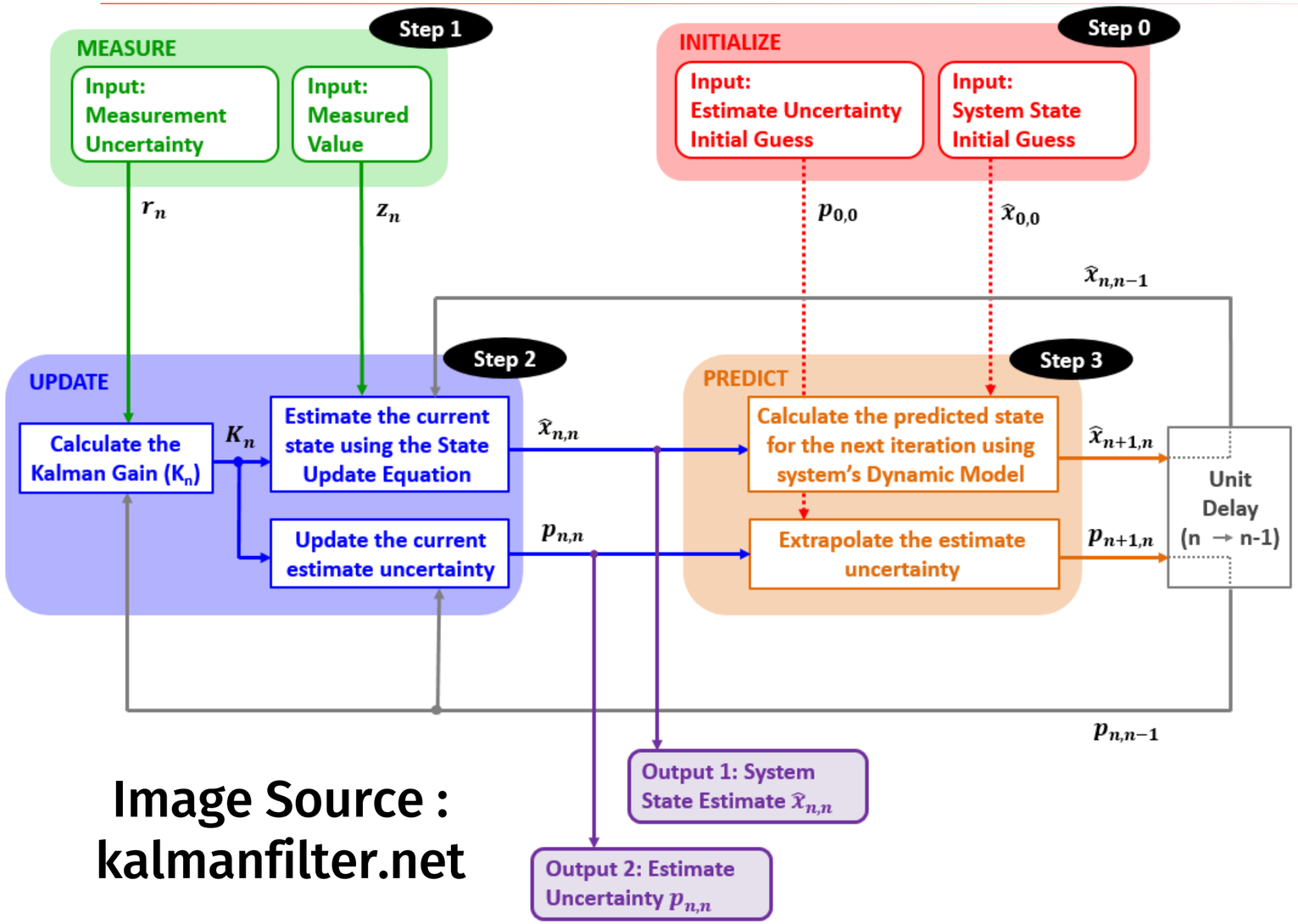


Image Source : kalmanfilter.net

Kalman Estimation Algorithm

Equations for Kalman Estimation Algorithm

The equations of Kalman prediction algorithm at n^{th} iteration are as follows,

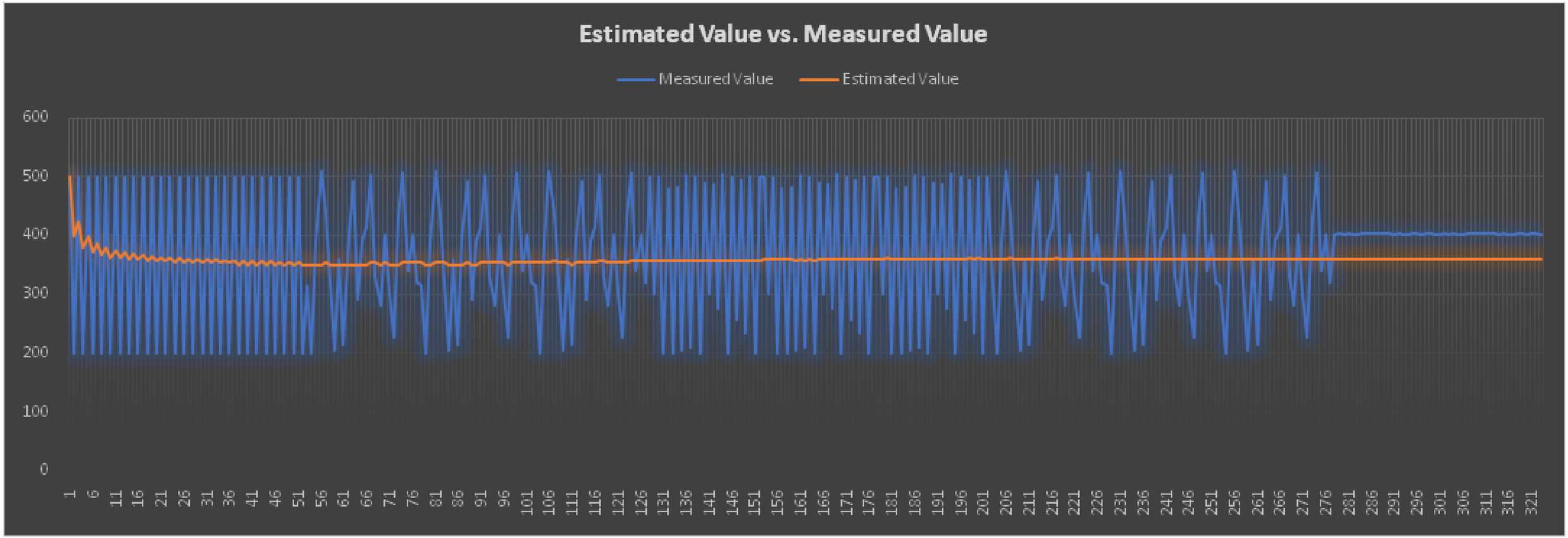
Step 1 > $$(Kalman\ Gain)_n = \frac{[(Error\ in\ Estimated\ Value)_{n-1}]}{[(Error\ in\ Estimated\ Value)_{n-1}] + [(Error\ in\ Measured\ Value)_{n-1}]}$$

Step 2 > $$(Estimated\ Value)_n = (Estimated\ Value)_{n-1} + [(Kalman\ Gain)_n] * [(Measured\ Value)_n - (Estimated\ Value)_{n-1}]$$

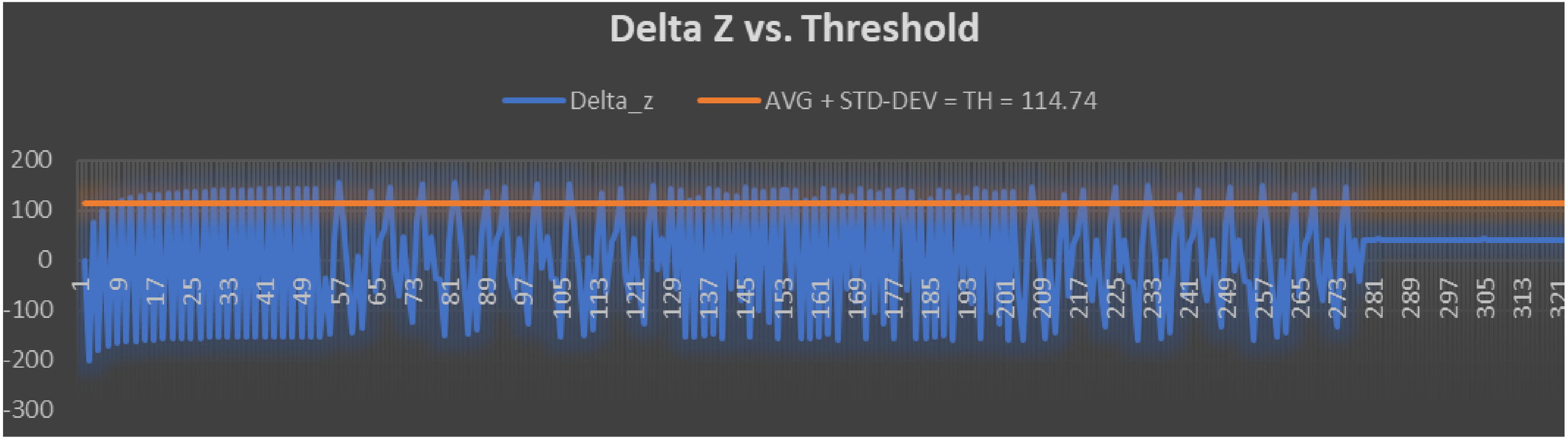
Step 3 > $$(Error\ in\ Estimated\ Value)_n = [1 - (Kalman\ Gain)_n] * (Error\ in\ Estimated\ Value)_{n-1}$$

Step 4 > $$(DELTA)_n = (Measured\ Value)_n - (Estimated\ Value)_n$$

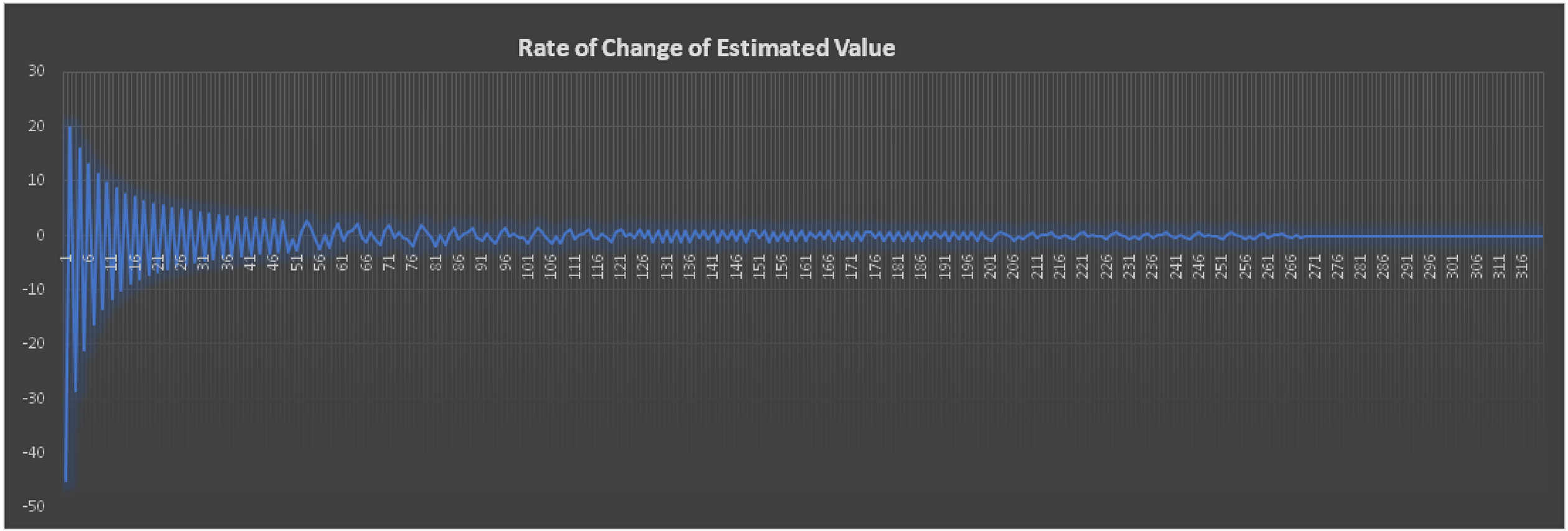
Estimated and Measured Values vs. Time



Variation of Delta Z w.r.t. Threshold vs. Time



Limitations of Kalman



Software

Retrieval of GPS Co-ordinates

NEO-6M GPS Module

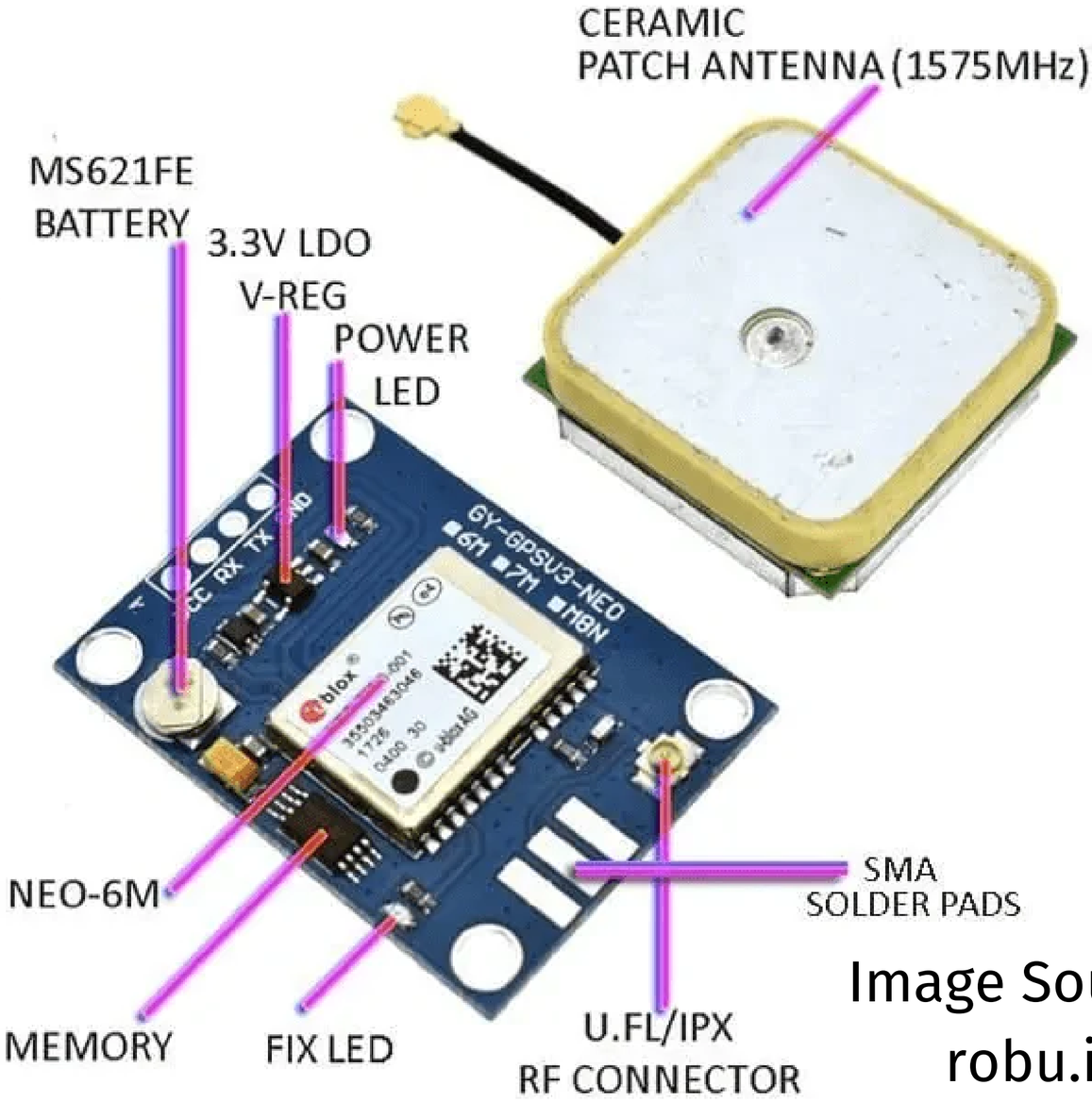
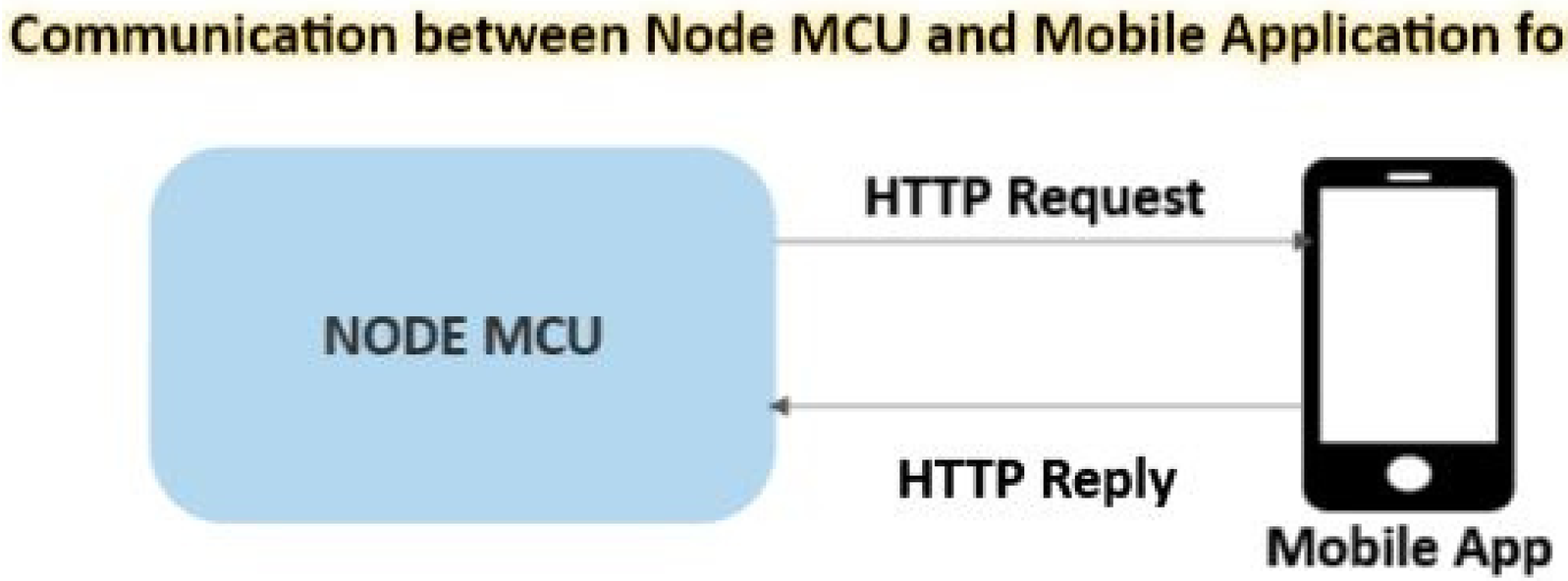
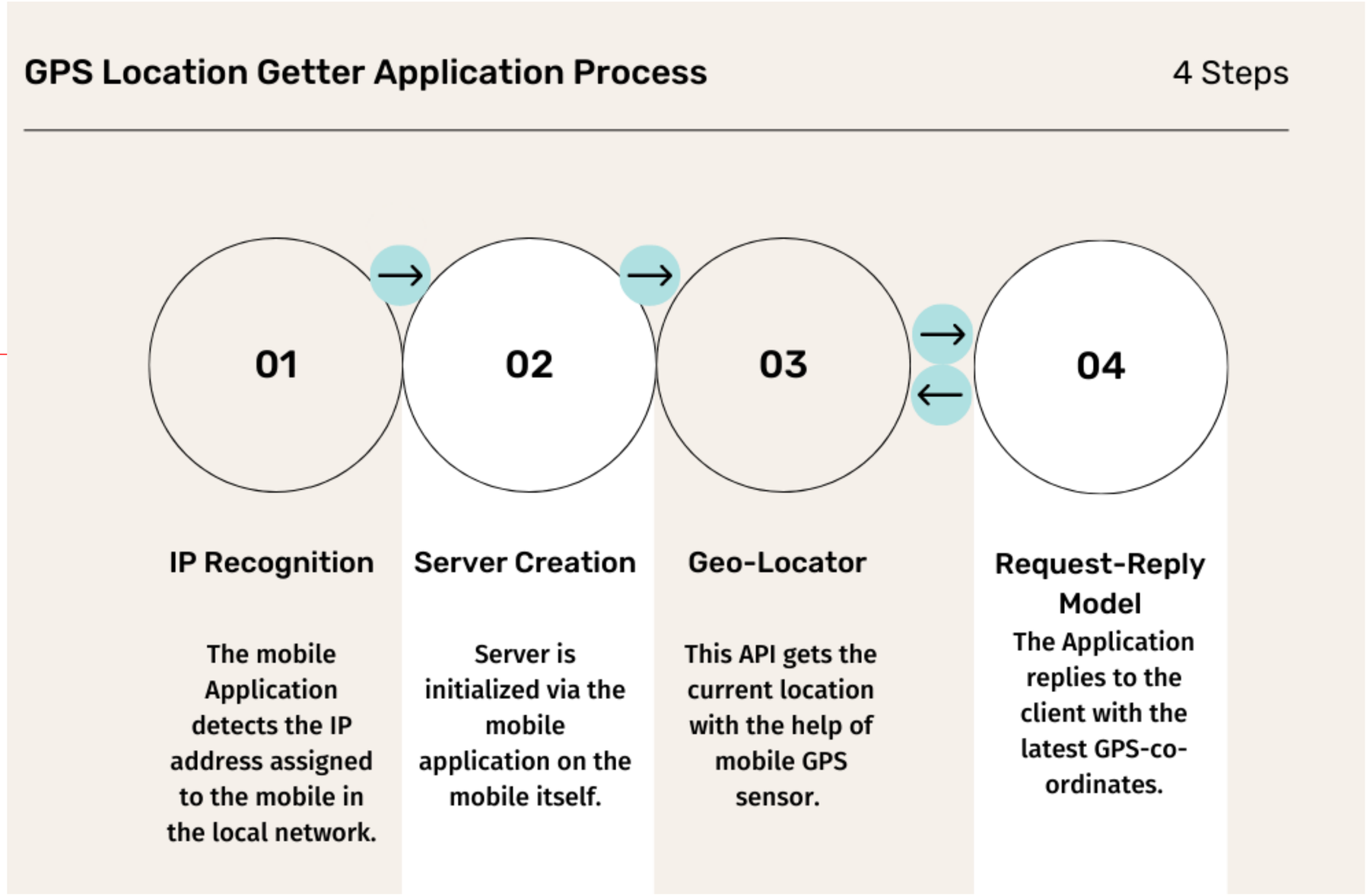


Image Source : robu.in

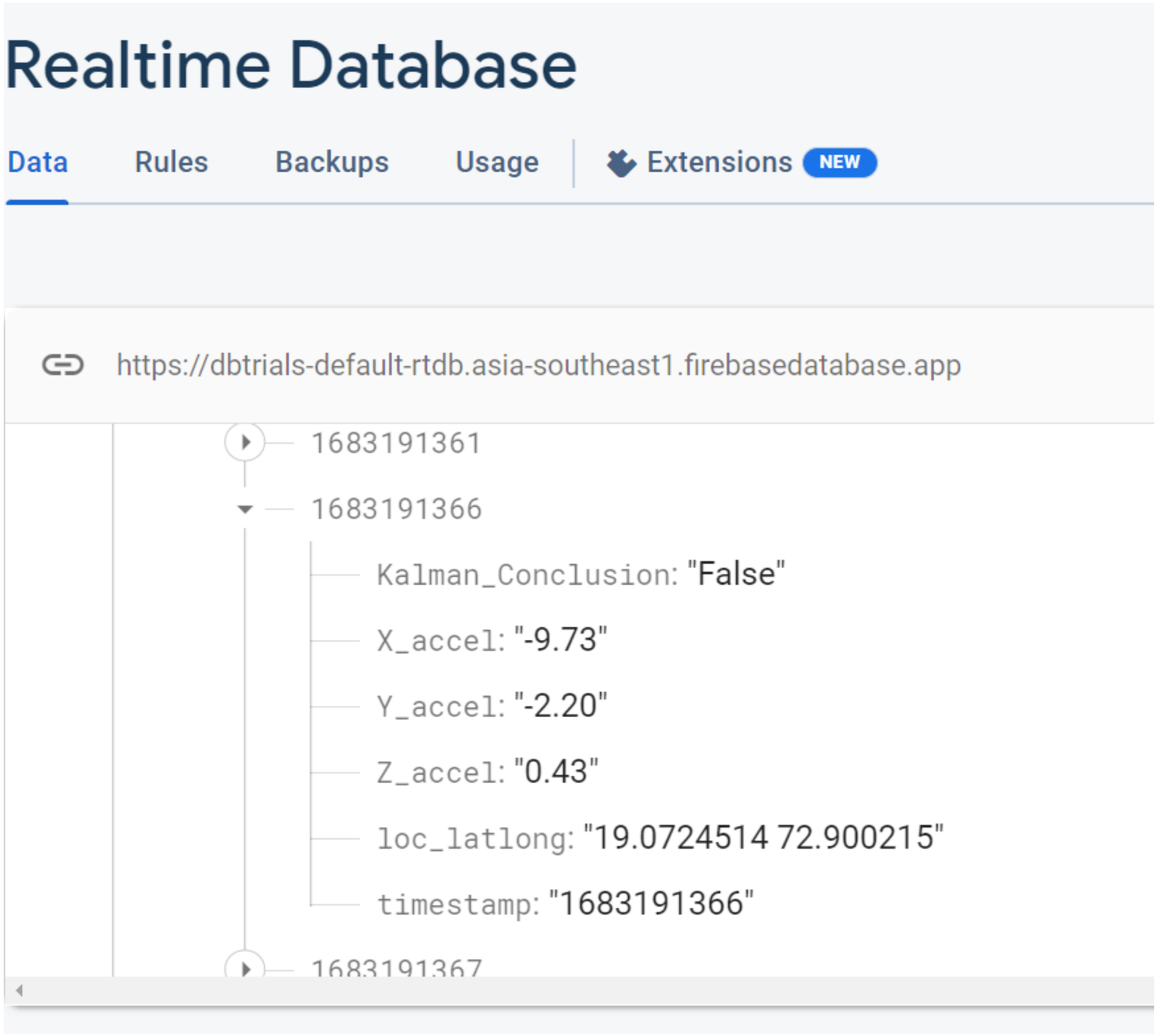
GPS Location Application Working



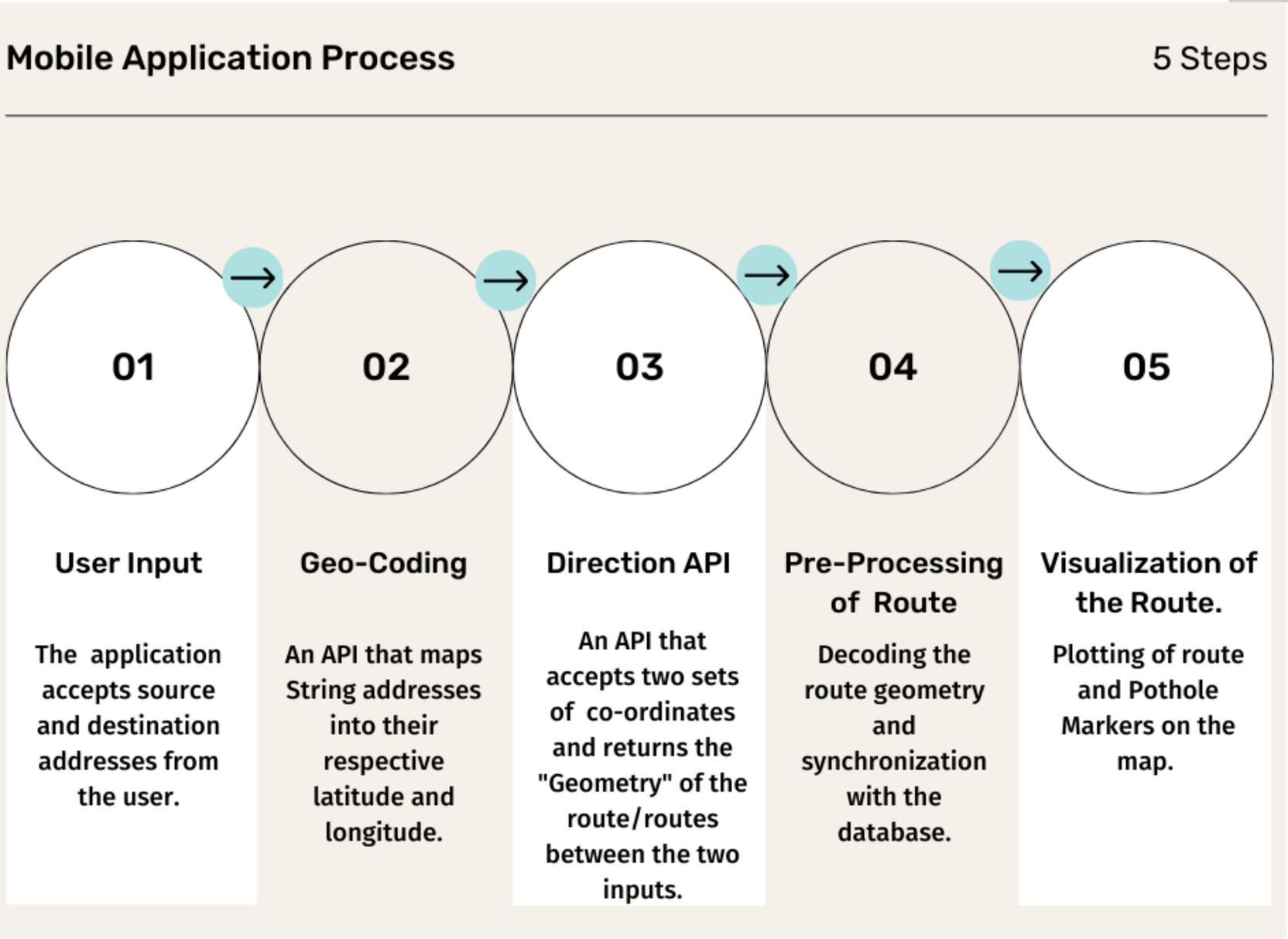
GPS Locator Application Flowchart



FirebaseRealtime Database



Main Application Flowchart



Possible Improvements

- Designing of PCB for robustness and compactness.
- FFT algorithm to evaluate the frequency of change of acceleration values.
- Deployment on 2-4-wheeler vehicles in large numbers for aggregating data.
- Evaluating multiple routes, between source and destination based on road surface quality.

References

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THANK YOU

QUESTIONS ?
COMMENTS ?
SUGGESTIONS ?