LoRa Based RTK Implementation in Autonomous Vehicle

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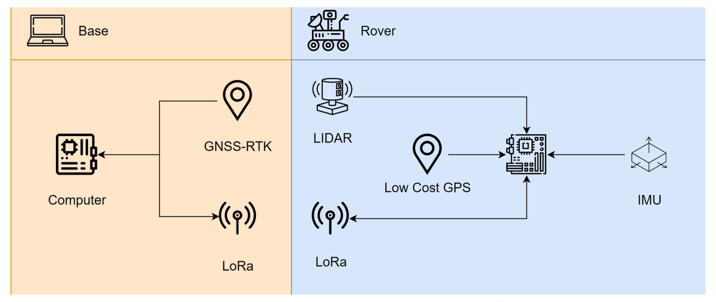
PROJECT DESCRIPTION



The main objective of the project is to design an autonomous rover system using LoRa-based RTK technology to solve the localization problem in closed environments such as factories where GPS signals are insufficient.

This system combines LoRa communication, RTK-GPS, LIDAR and IMU sensors to provide precise positioning and autonomous movement in closed areas.

MOTIVATION

In autonomous delivery processes, vehicles often face challenges with indoor localization accuracy.

PURPOSE

Low-cost, high-precision navigation with an integrated autonomous delivery robot.

SCOPE

Industry 4.0 IoT & Connectivity Indoor Localization Autonomous Systems

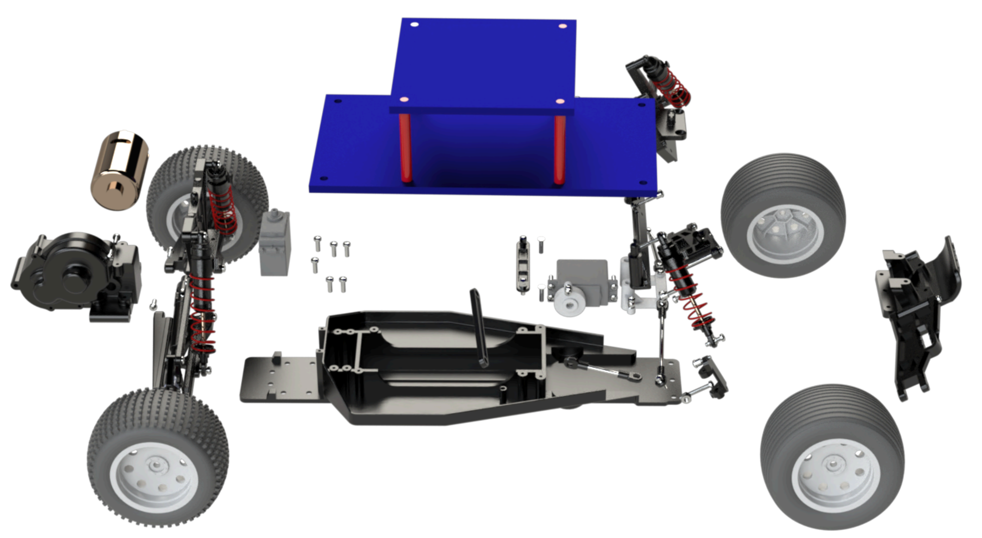
TECHNICAL REQUIREMENTS

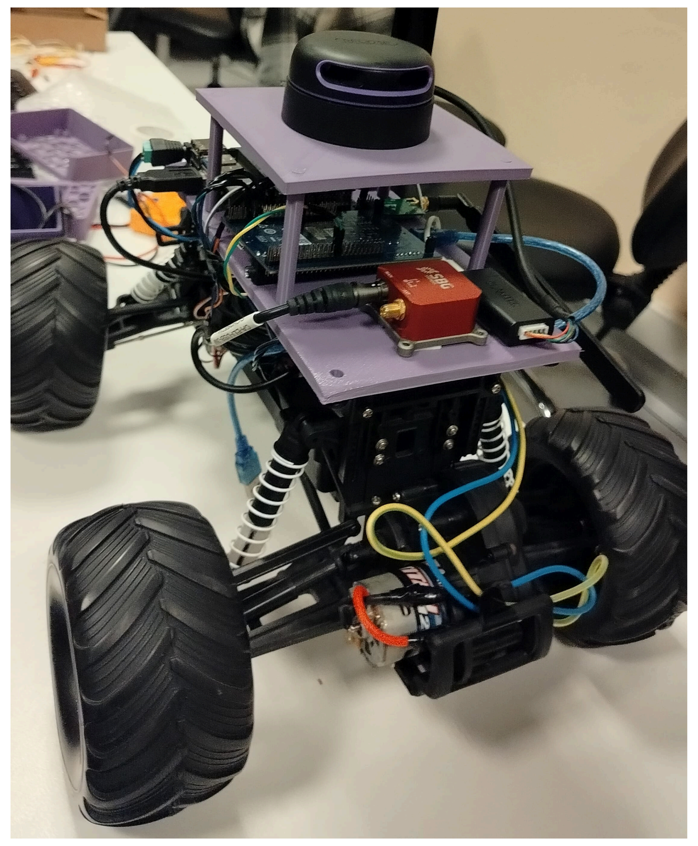
- Max 50 milisecond communication latency
- Max 8 km/h car speed
- Detect obstacles in the environment
- Dimensions: 200 - 300 mm width / 350-500 mm length / 300 - 400 mm height
- 30 minute operating time
- Location error 30 cm
- At least 500 meter range
- Max %1 trajectory following error

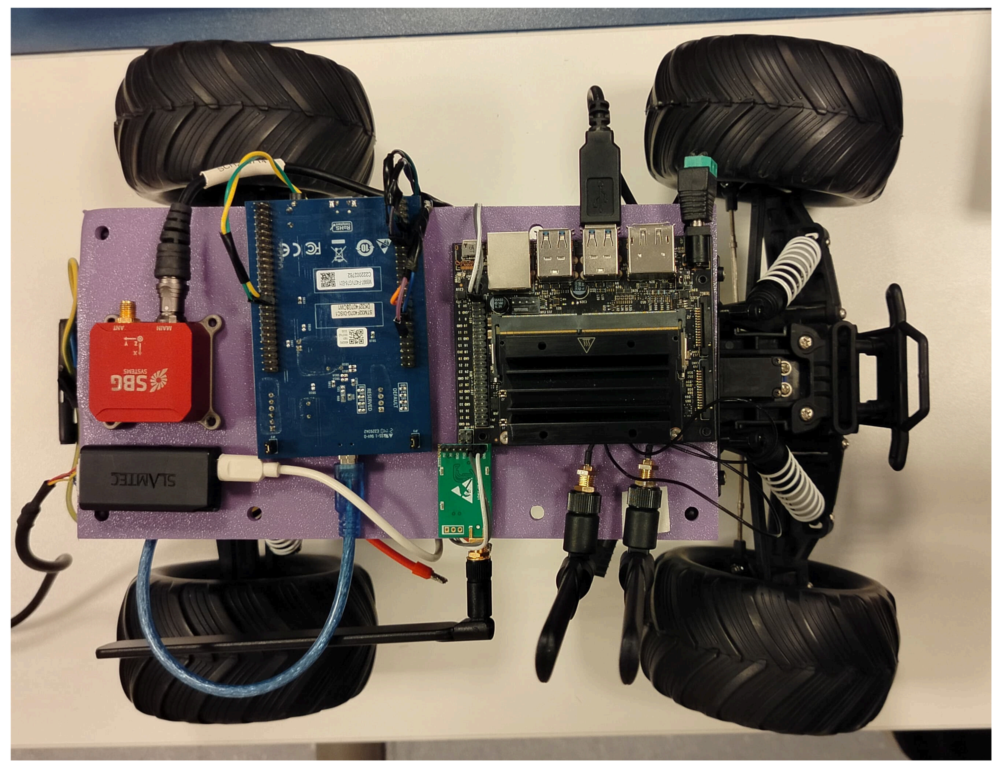
MECHANICAL SYSTEM

The designed platform by printing it with a 3D printer was placed on the prepared system. This method will also be applied for other parts that will be required.

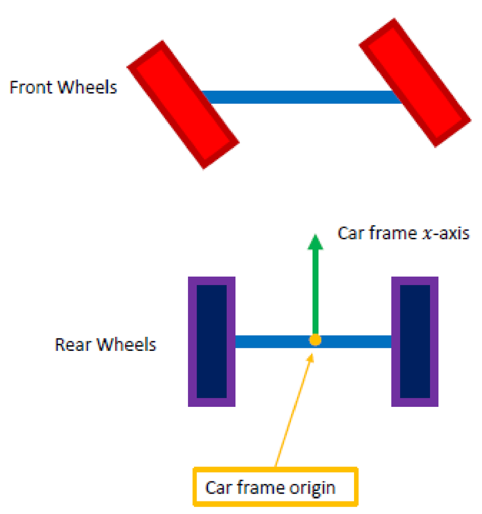
Dimensions:
- 250 mm width
- 450 mm length
- 300 mm height







KINEMATIC EQUATION



$$\dot{x} = v_{car}\cos\theta = u_1\cos\theta$$
$$\dot{y} = v_{car}\sin\theta = u_1\sin\theta$$

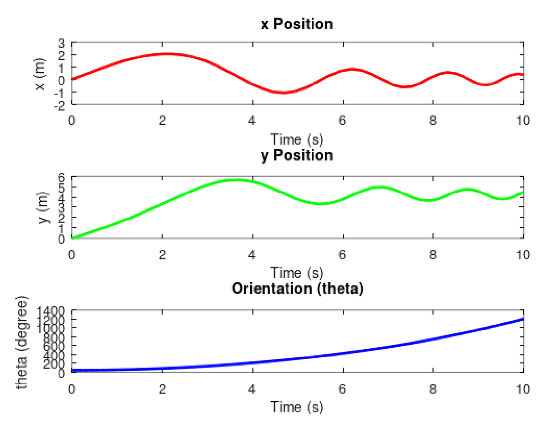
$$v_{wheel}\cos\phi = v_{car}$$
$$v_{wheel}\sin\phi = v_{tangent}$$

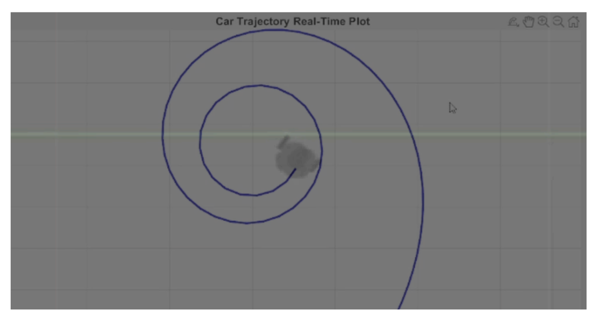
$$\frac{v_{car}}{\cos\phi}\sin\phi = v_{car}\tan\phi = v_{tangent}$$

$$\dot{\theta} = v_{car}\frac{1}{L}\tan\phi = u_1\frac{1}{L}\tan\phi$$

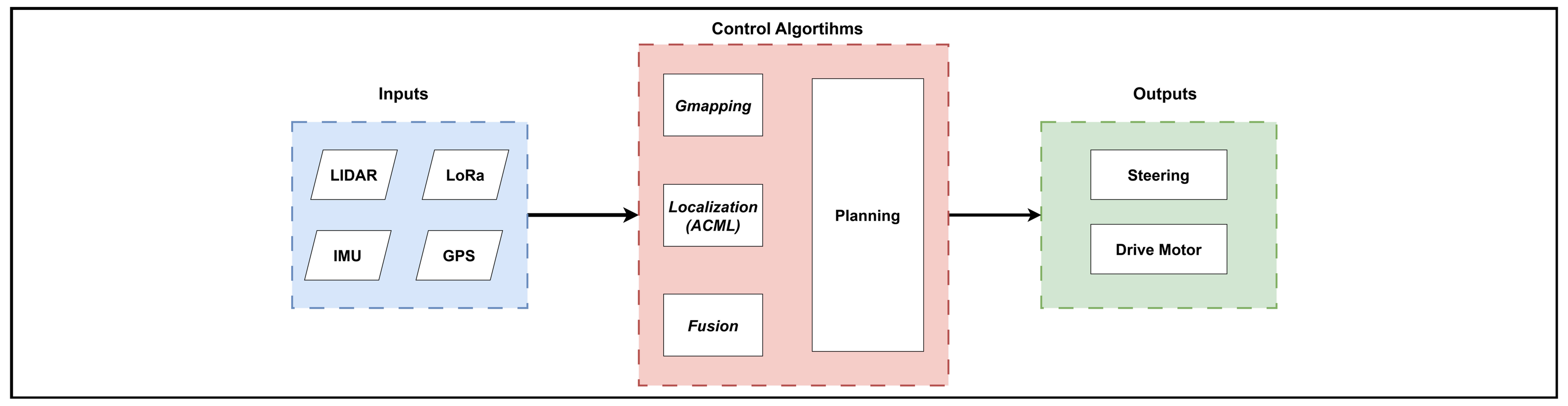
$$\begin{bmatrix}\dot{x}\\ \dot{y}\\ \dot{\theta}\\ \dot{\phi}\end{bmatrix} = \begin{bmatrix}\cos\theta\\ \sin\theta\\ \frac{1}{L}\tan\phi\\ 0\end{bmatrix}u_1 + \begin{bmatrix}0\\0\\0\\1\end{bmatrix}u_2$$

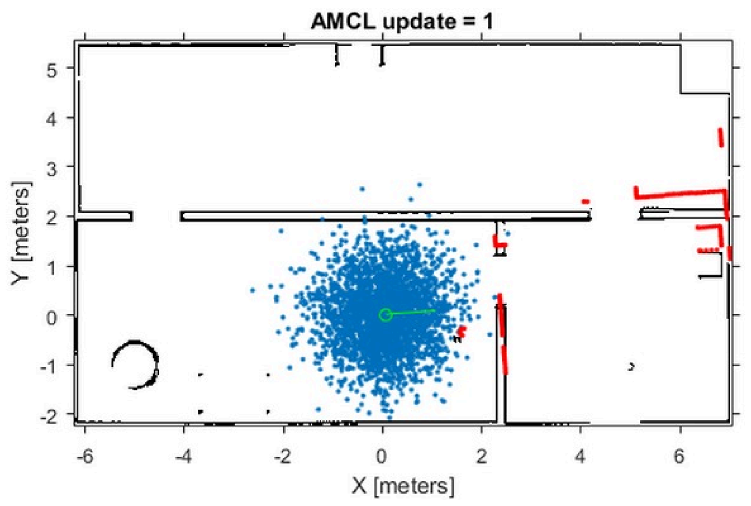
- $u_1 = v_{car}$, the linear speed of the car, and
- $u_2 = \dot{\phi}$, the turning rate of the virtual front wheel.

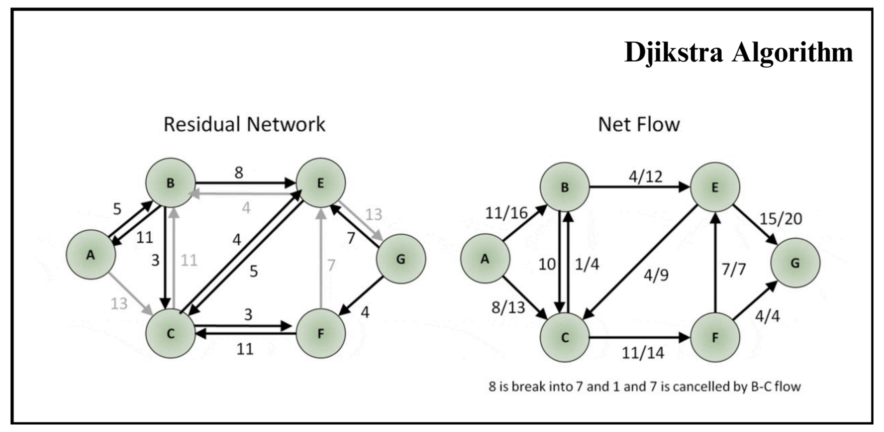


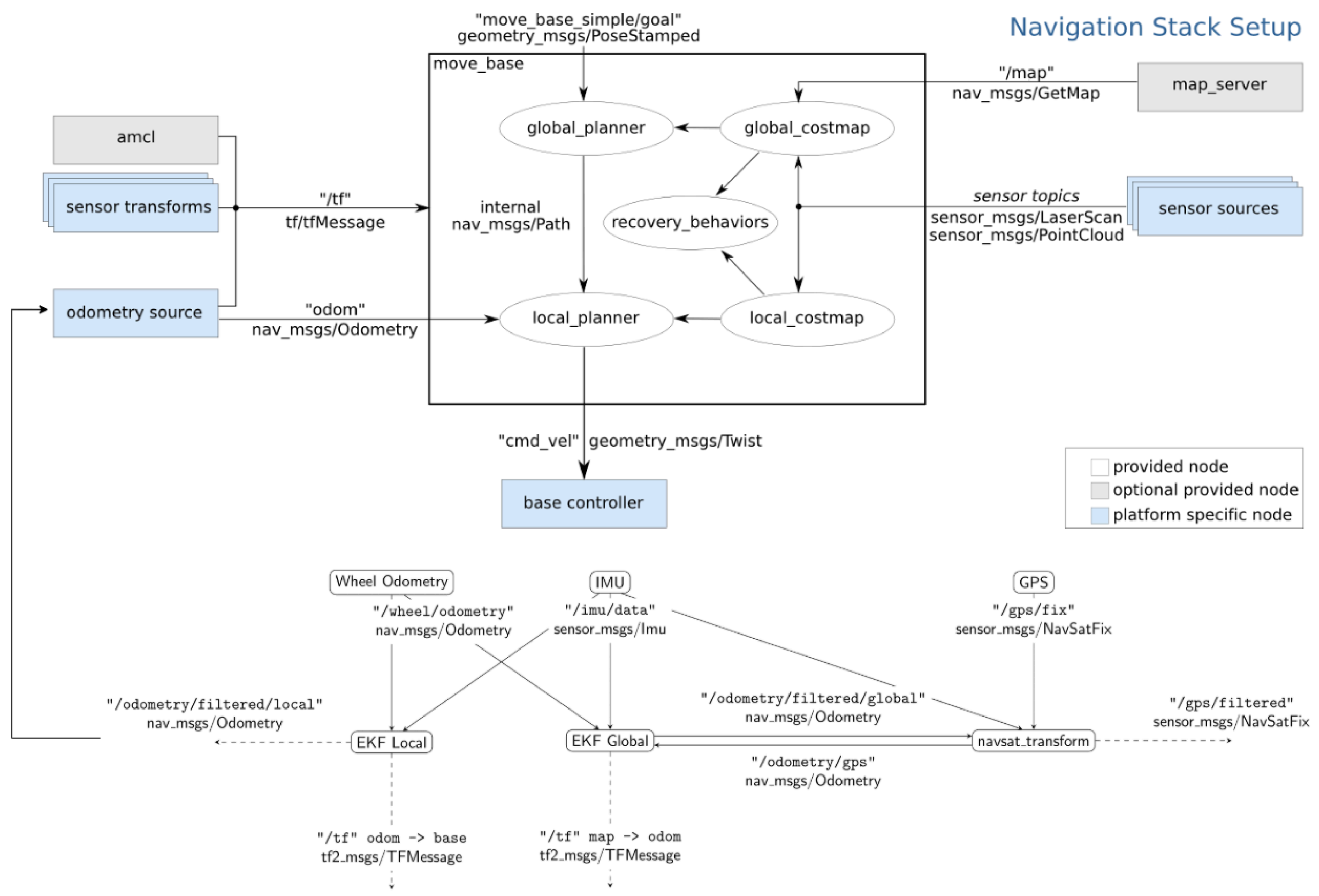


SOFTWARE DESING

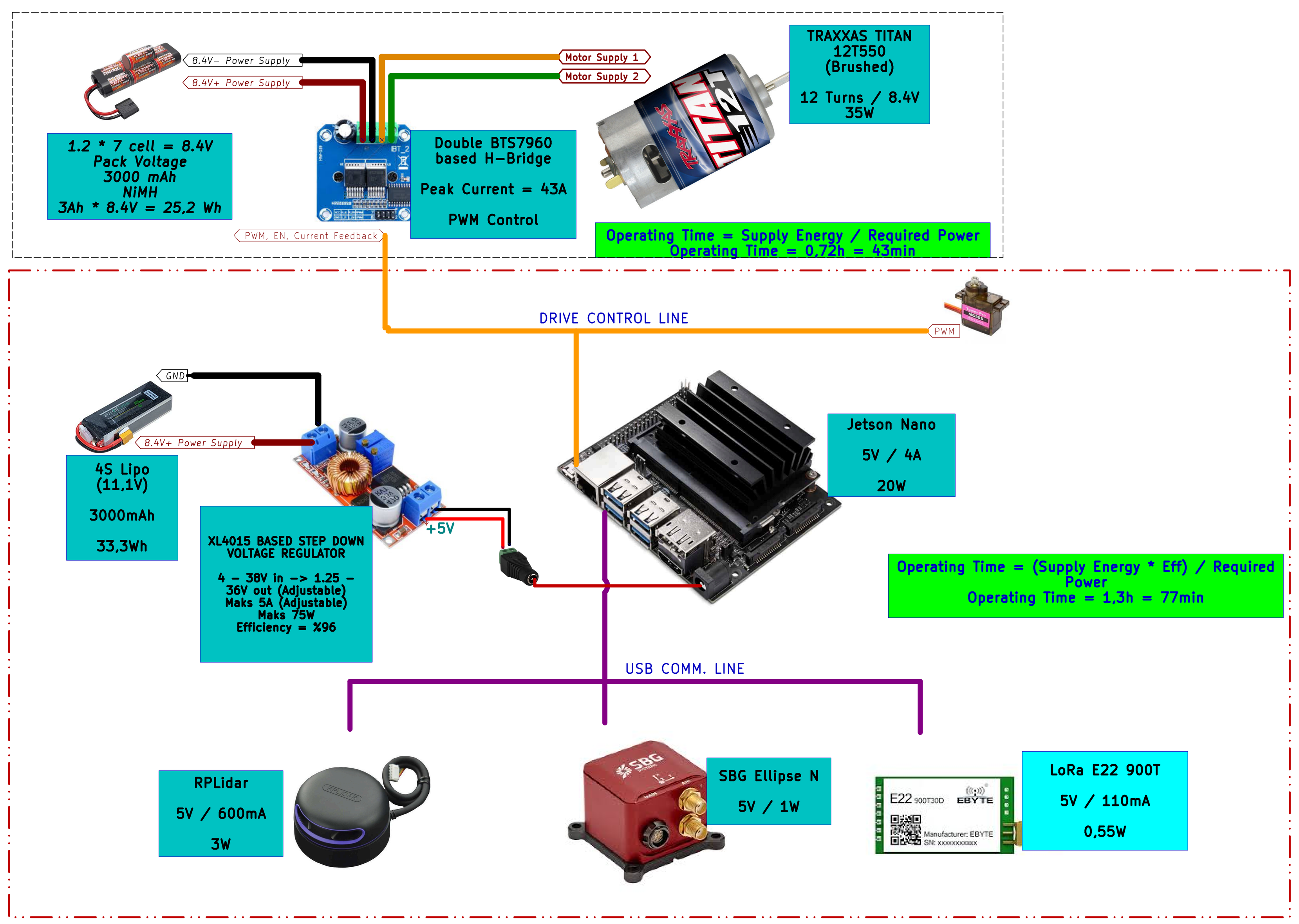




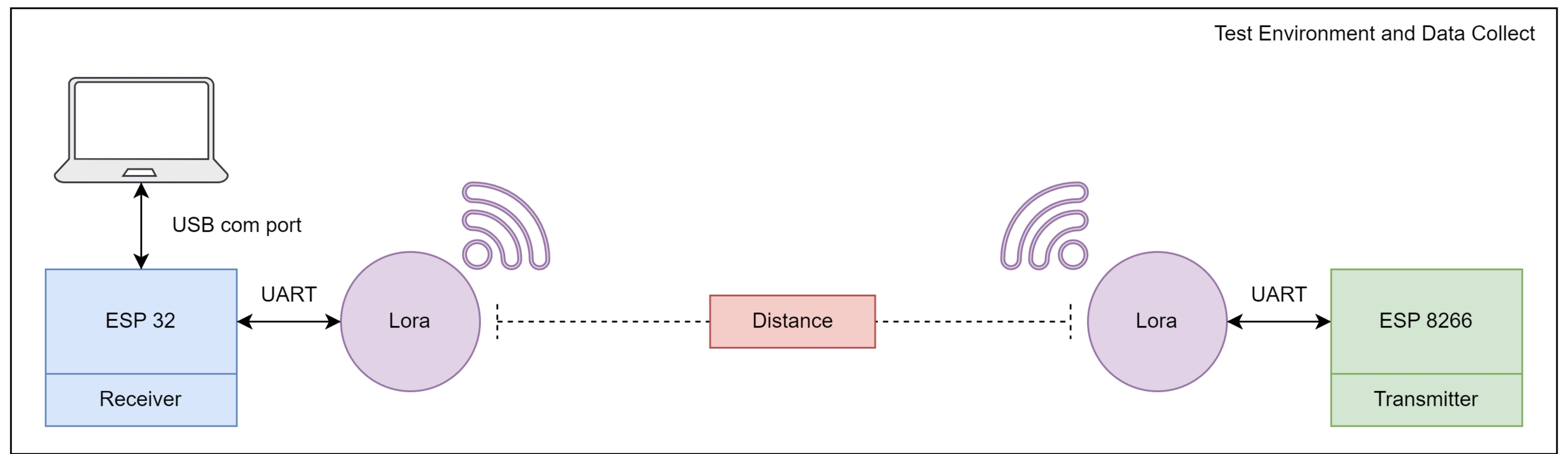


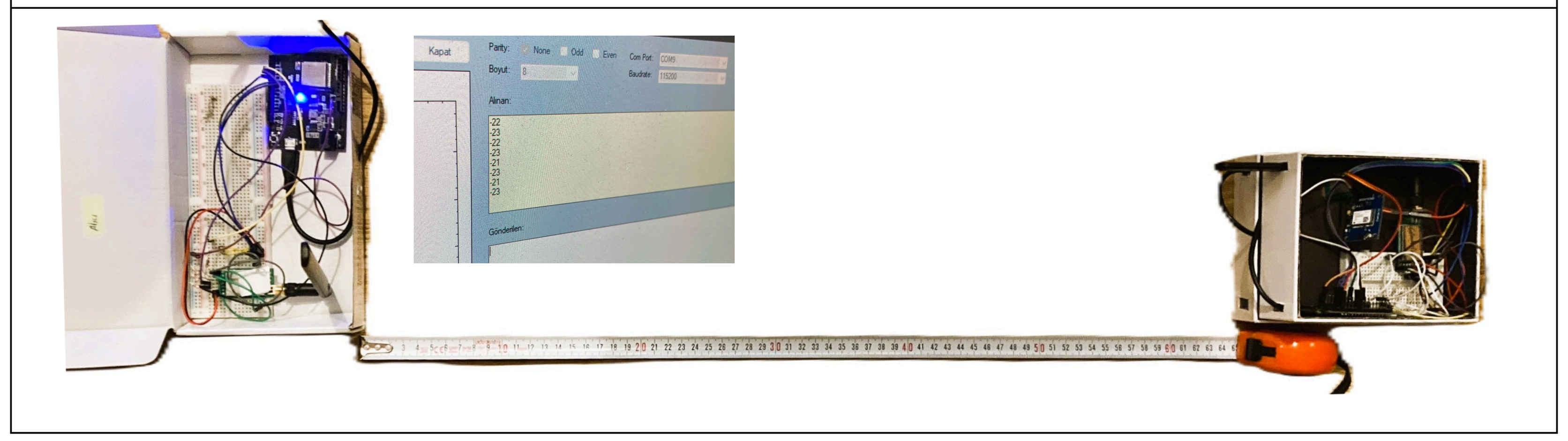


ELECTRICAL SYSTEM

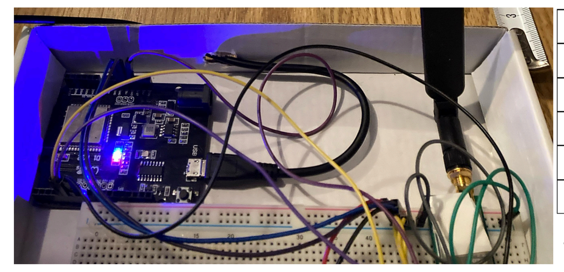


TEST ENVIRONMENT AND DATASET COLLECTION





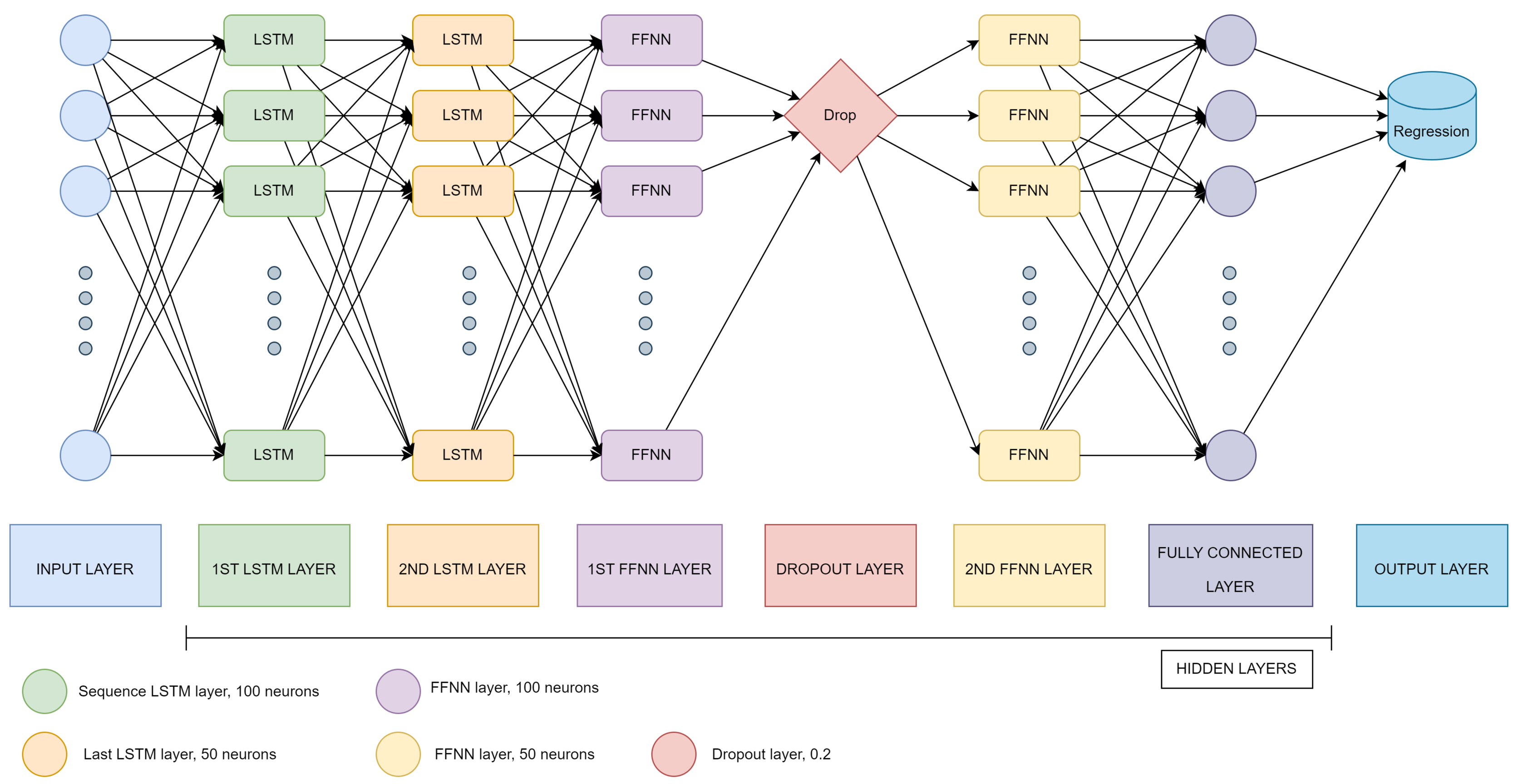
- Data collected from the test environment and it was used to train the Neural Network model.



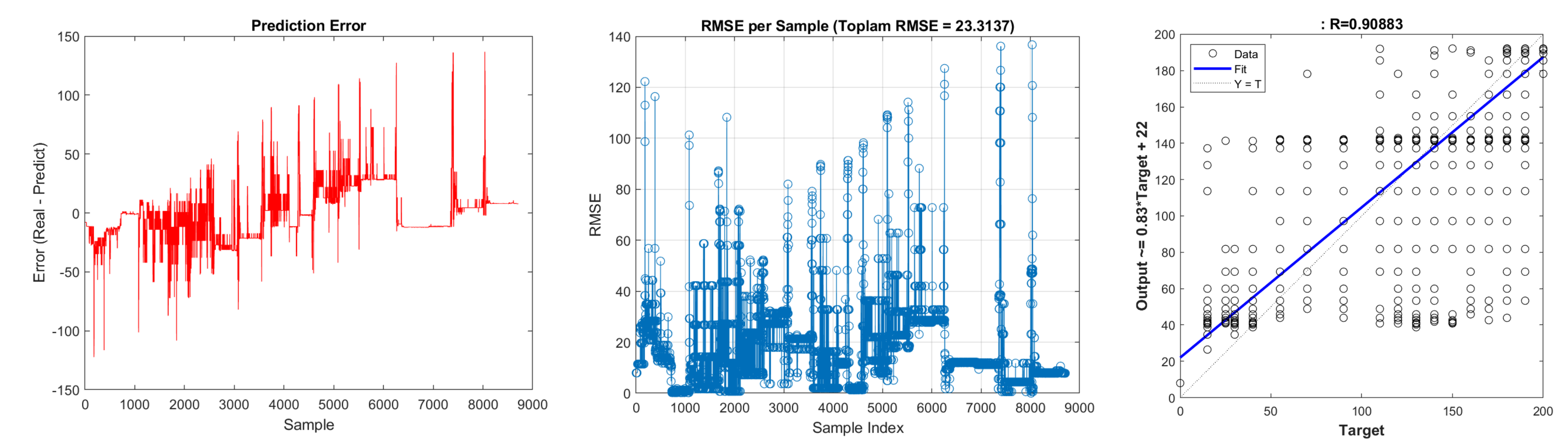
	Transmitter	Receiver
Power	22 dBm	22 dBm
Addres	1	2
Channel	23	23
Air rate	62 Kbps	62 Kbps
Package size	64 Bytes	64 Bytes

- Lora nodes configured with Fixed transmission mode, these only communicate with the exact address.

MODEL DESIGN



- Hybrid Neural Network flow diagram. This model contains Long Short Term Memory and Feed Forward Neural Network.



The obtained MAE value is 17.3745365 and the RMSE value is 23.3137. In the light of these error calculations, it is seen that the model does not achieve the desired performance. It will be re-trained with a larger data set (currently ~9000).

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|Y_i - \hat{Y}_i|$$ Mean Absolute Error < 5

$$RMSE = \sqrt{\sum_{i=1}^{n}\frac{(\hat{y}_i - y_i)^2}{n}}$$ Root Mean Square Error < 10