Project Report: CBR3A – UB Site

Activity 1

Developing a Predictive Model for ETA (Estimated Time of Arrival) at RSUs

Design

The goal is to predict the ETA of the bus at each RSU (Roadside Unit) using real-time beacon data. The prediction will focus on optimizing bus schedules and ensuring accurate timing for RSU detection. Two routes—Morning and Evening—are considered, with some RSUs being visited multiple times in a single route. Data collection and model development are guided by the performance of the BLE scanner.

Method

- Data Collection:

  Daily data is collected from the BLE scanner at each RSU, recording timestamps when the bus passes by. Expected detection counts are assigned based on the planned route frequency:

  RSU 01: 2

  RSU 02: 3

  RSU 03: 3

  RSU 04: 1

  RSU 05: 1

  RSU 06: 2

RSU 07: 2

- Analysis of Detection Rates:

  Most RSUs achieve over 85% monthly detection accuracy, except RSU 01 (Tlogomas). Investigation revealed that the bus might alter its route near Tlogomas, turning back prematurely without closely approaching the RSU.

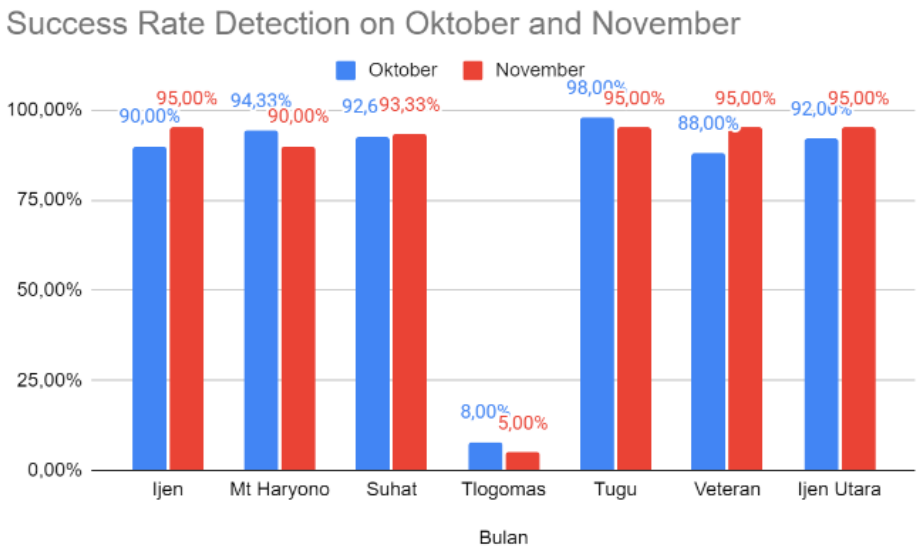
- Model Selection:

  The LightGBM model is employed for predicting the time differences (ETA) to each RSU.

Implementation

The RSU locations and routes were mapped to ensure accurate tracking and data collection. Morning and evening routes were defined, with each RSU assigned an expected detection count based on route frequency. Collected data includes geolocation, timestamps, and beacon signal strength. The LightGBM model was trained using these inputs to predict ETA at each RSU, focusing on time differences in seconds. Model evaluation revealed an RMSE of 104.65 seconds, MAE of 53.41 seconds, and an R^2 score of 0.55, indicating reasonable prediction accuracy with room for improvement. Further refinements and additional features will be explored to enhance the model's performance.

Experiment



	sin_hour	stopOrder	nextStopOrder	Minute	weekDay
162	6	5	6	12	2
203	6	7	8	24	6
78	6	6	7	16	4
1	5	2	3	59	4
139	6	5	6	12	2
..	...	...	...	...	...
75	6	6	7	17	2
295	5	2	3	59	2
241	6	7	8	21	6
104	6	8	9	27	3
64	6	3	4	1	2

[64 rows x 5 columns]

	Actual	Predicted
0	239	287.073359
1	148	161.832116
2	431	437.383464
3	738	103.130929
4	290	287.073359
5	114	421.136236
6	100	137.298283
7	300	361.117192
8	186	170.595451
9	520	496.166848
...		
17	352	367.002887
18	345	369.559324
19	147	133.175528

MSE:10950.75256786938, RMSE: 104.64584349981101, MAE: 53.409660945317455, R²: 0.5499390971408178

Detection Accuracy: RSU 01 consistently underperforms due to route deviations near Tlogomas. Further investigation and adjustments to route adherence are needed.

Model Performance: The LightGBM model demonstrates moderate accuracy. While RMSE and MAE indicate predictions are generally within one to two minutes of actual values, the R^2 score (0.55) shows room for improvement.