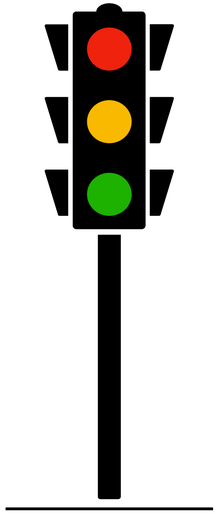
Team Project



Adaptive Traffic Light Using Sensor Fusion

RAI2 - Group 4

Pyae Htoo Khant - 65011497
Rachata Raktham - 65011500
Sippaphat Pitiwan - 65011525
Sirawut Veeraviwat - 65011531
Sittipon Kumda - 65011539
Tanakorn Youngmeesuk - 65011563

When I came to Thailand, a beautiful country 🇹🇭, ...

Ref: https://images.app.goo.gl/7Am2JRsWYyjHn5Nx8

One Disturbing Problem ⛳

Ref: https://images.app.goo.gl/6K6zAhFRqo8g1KC77
3

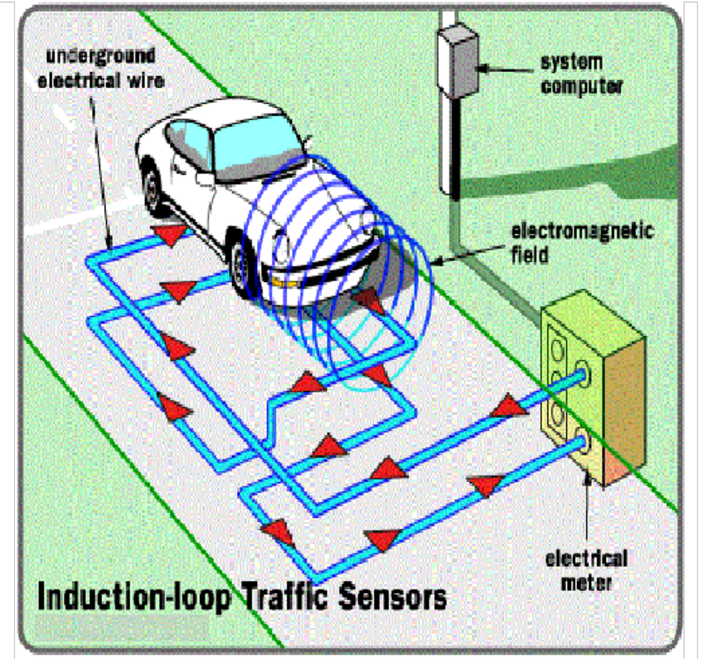
How Can We Make It Better?

- Develop traffic control system dynamically based on the density of the road
- Use sensor fusion method to measure vehicle density with the help of sensors and AI technology

Ref: https://images.app.goo.gl/yj5WkrQbF27us3hT9

What do We Research?

- Existing Solutions in Thailand : Fixed Timer, Semi Actuated Timer and Full Actuated Timer - uses Induction sensors
- The Manchester University (ATLCS) traffic lights control system to **synchronize traffic lights** by **dynamically creating delays**



Ref: https://images.app.goo.gl/b4EjEVymqTZ4N1Nu7

How do we Build our model?

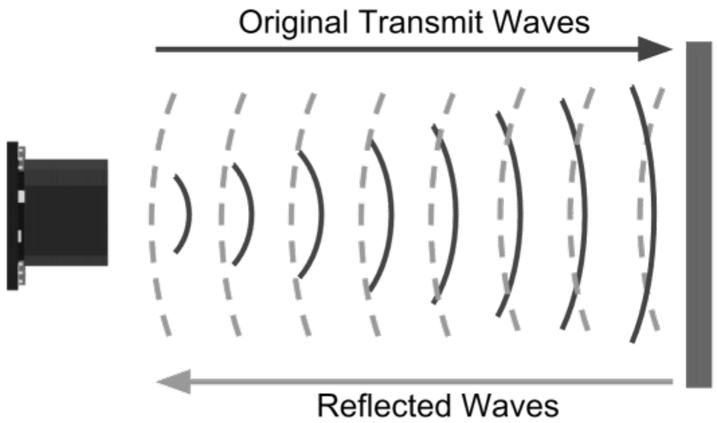
Components we use

- Sensors to detect the vehicles (Ultrasonic Sensors)
- AI Camera for precise detection
- Cross Intersection Road model
- Traffic light Signals
- ESP8266 microcontroller

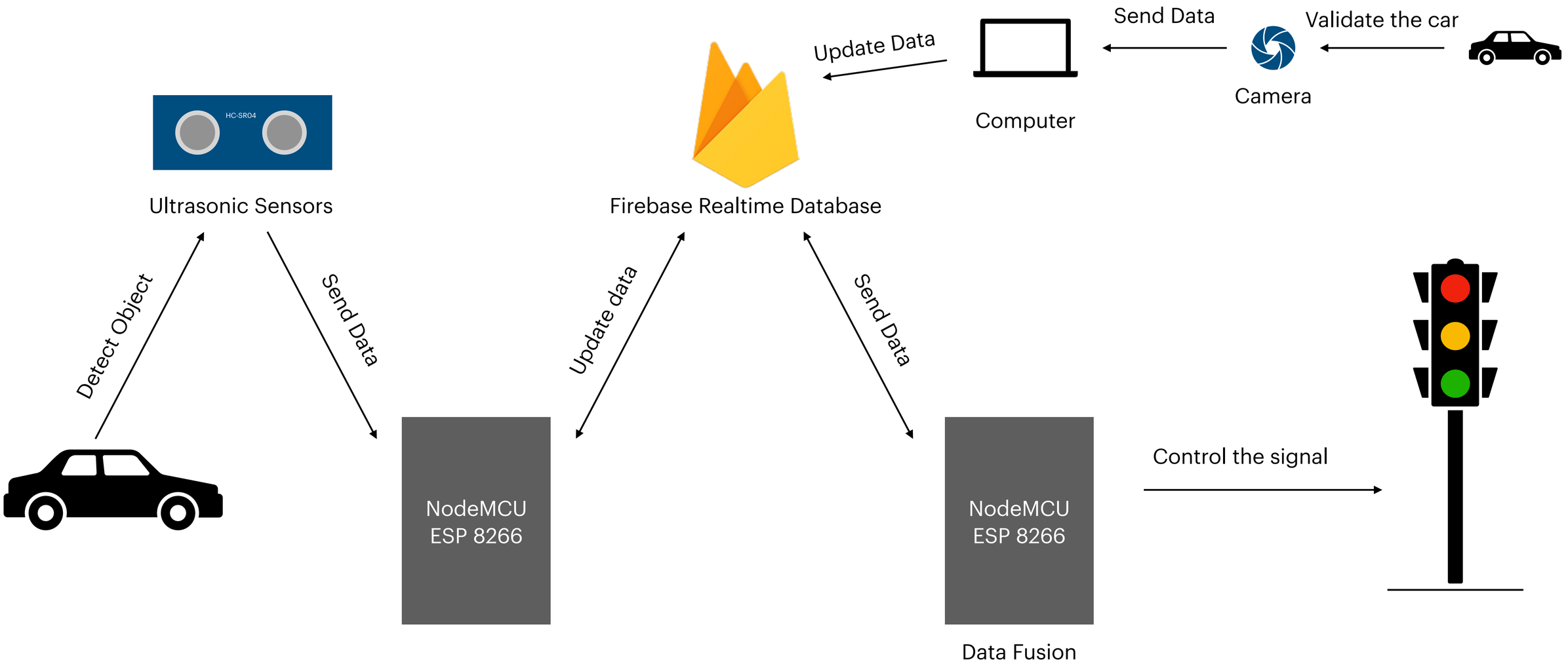
How do we Build our model?

Fusion method

- Sensor detect the object in front
- The AI camera validates the object is the car
- Determine dynamically the delay timer of the traffic based on the validated data

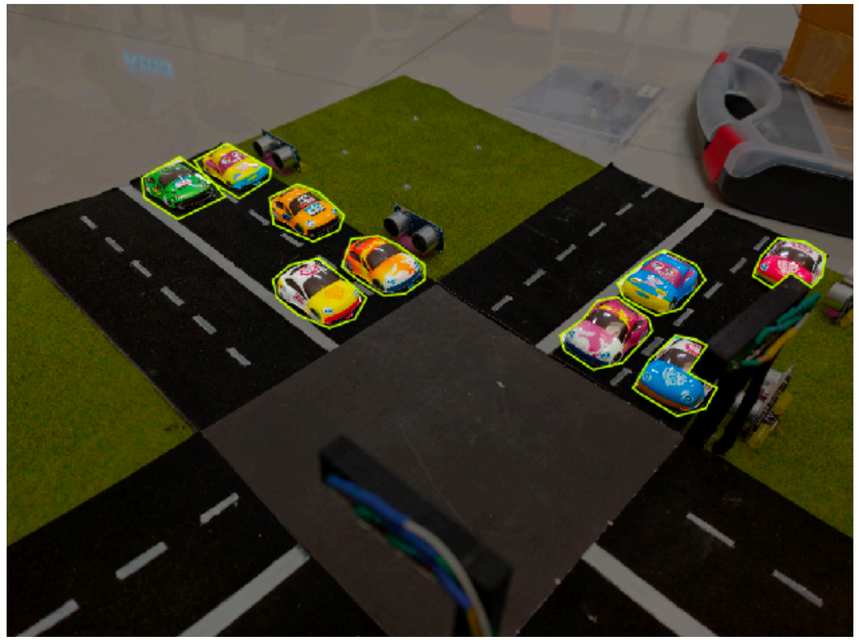


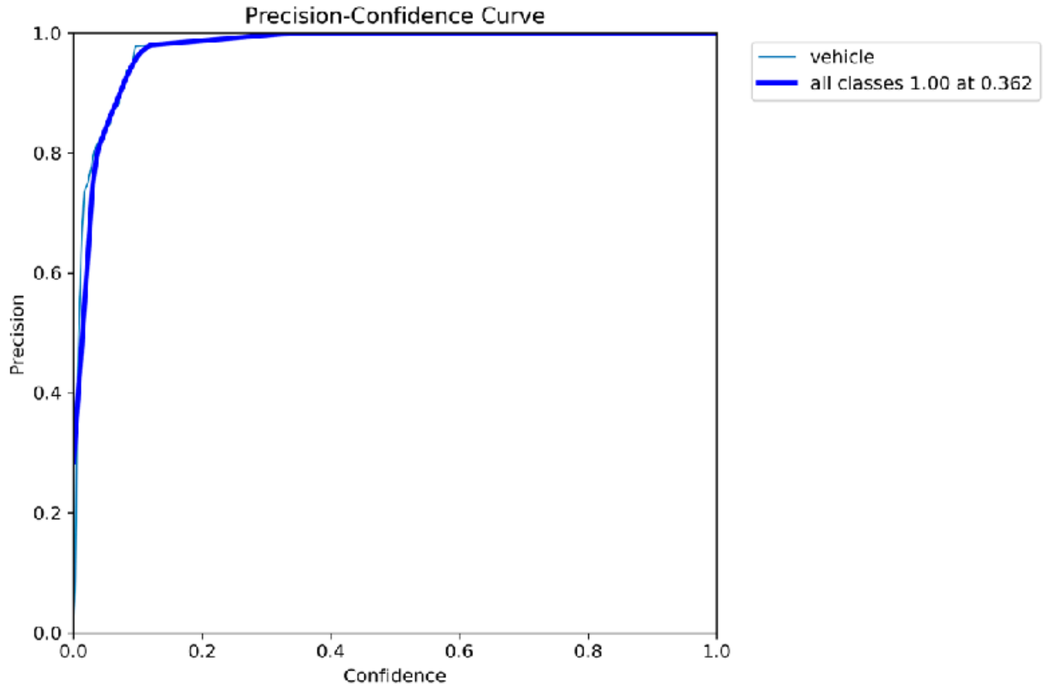
Circuit Control System



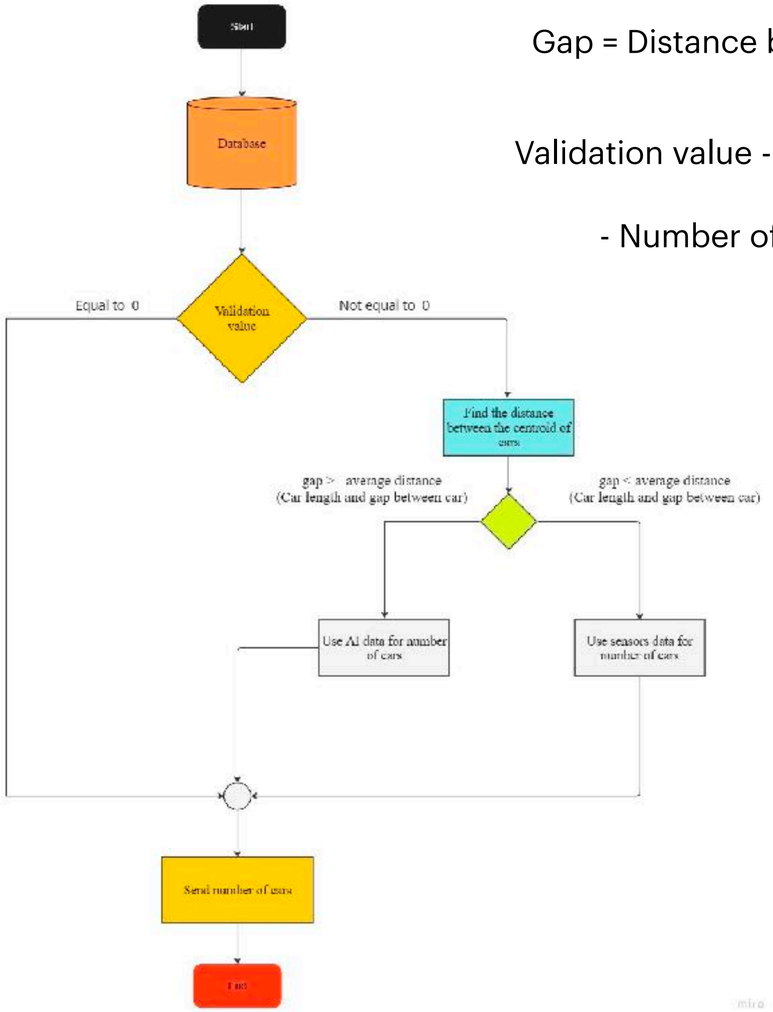
AI Methodology

- Dataset preparation
- Model training YOLO V8



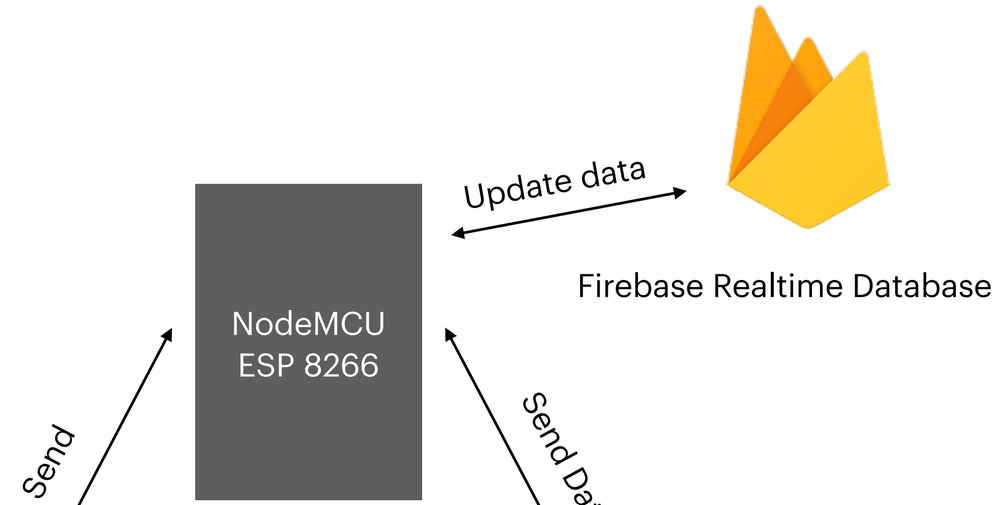


Flowchart



Gap = Distance between the centroid of cars

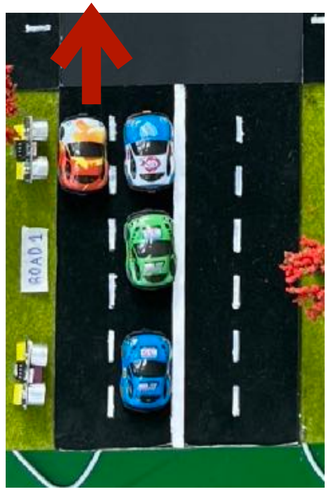
Validation value - Number of vehicles detected by sensors
- Number of vehicles detected by AI



Count +1

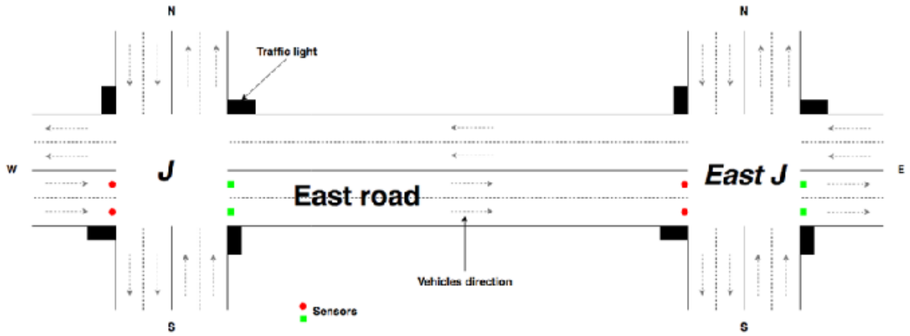
Comes into the range of detection

Count -1



Go out of the range of detection

Simulation Methodology



$$t_{v_L} = \frac{v_L - v_0}{a}.$$

The Manchester University (ATLCS) traffic lights control system to synchronize traffic lights by dynamically creating delays

Car	
Average acceleration rate (m/s^2)	Average deceleration rate (m/s^2)
0.51	2.51
0.485	0.640

(The estimation of acceleration and deceleration rates in mixed traffic conditions, 2021)

A formular to find the required time of the car at i position in queue to pass the intersection.

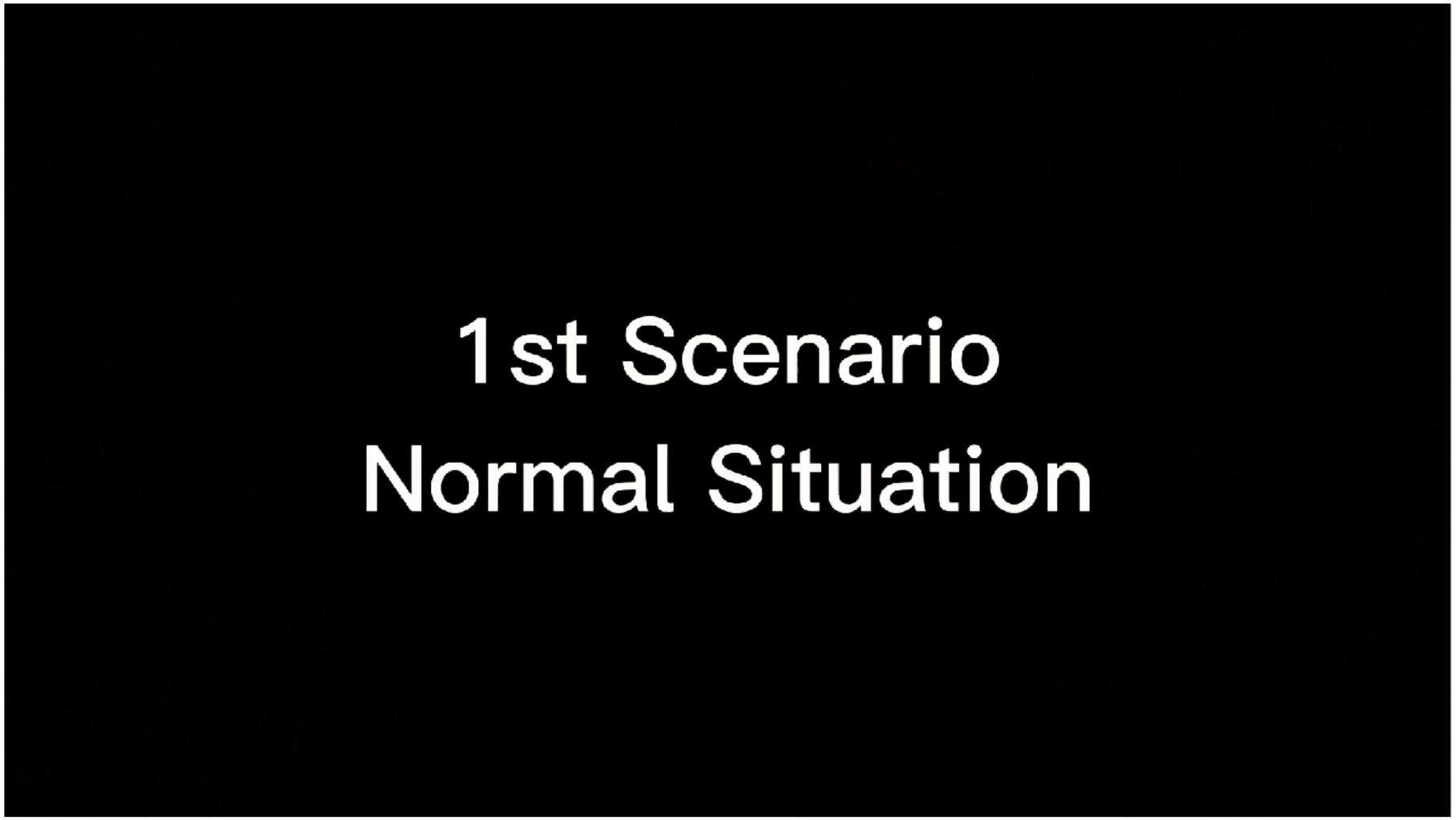
$$t_i = \frac{\sqrt{{u_i}^2 + 2a((i * 5) + c)} - u_i}{a}$$

- t_i is the time required to pass the intersection.
- u_i is the initial velocity of the car.
- a is acceleration of the car.
- i is the index of the car in the queue.
- c is the length of the center area of the intersection.

Parameter	From Kapiolani Boulevard				From McCully Street			
	From East		From West		From North		From South	
	Thru	Left	Thru	Left	Thru	Left	Thru	Left
Average Vehicle Count (veh)	26.47	7.13	32.20	3.60	9.93	1.67	11.57	4.33
S.D. (veh)	4.14	1.94	5.62	1.30	3.00	1.18	2.96	1.95
Arrival Rate (veh/s)	0.221	0.059	0.268	0.030	0.083	0.014	0.096	0.036
Average Existing Queue Length (veh)	13.67	5.47	16.64	2.76	6.13	1.42	7.13	3.68

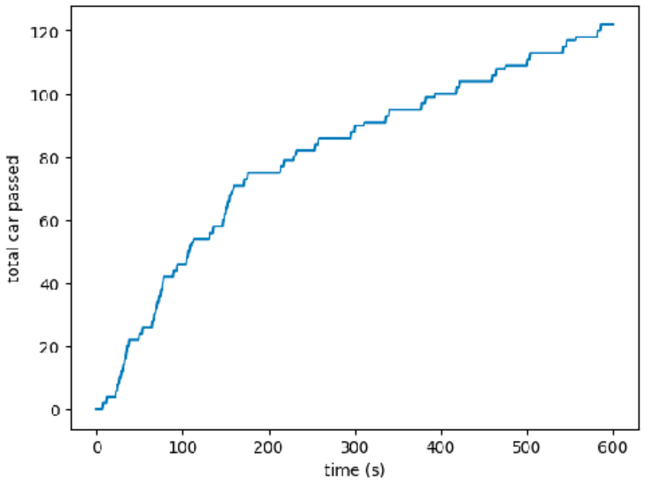
(Ref: Natural Study of Vehicle at an intersection, 2018)

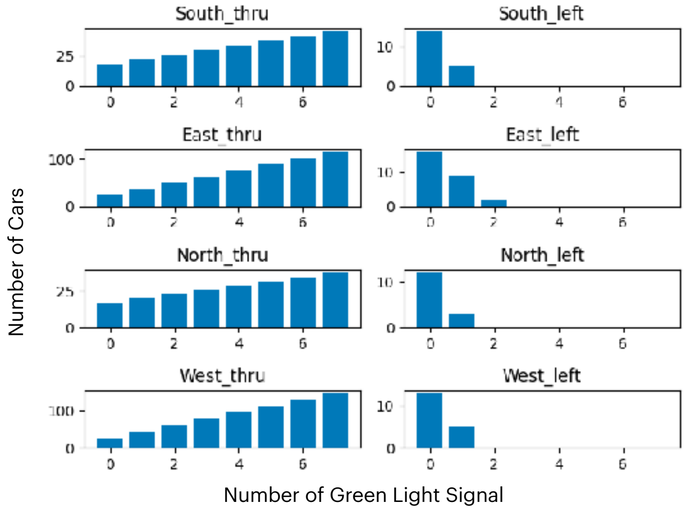
Testing our Result...



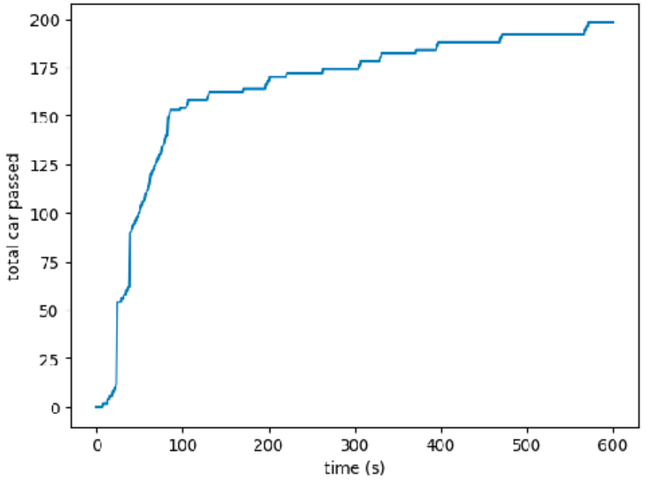
Simulation Result

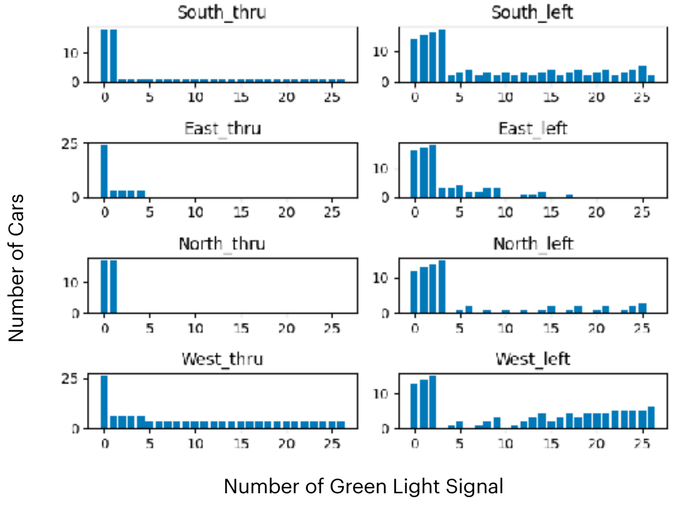
Fixed Time Loop





Our Adaptive Algorithm





What Shall We Do Next?

- Add more complex techniques in fusion data method
- Add more scenario into the intersection model
- Use more input information for the model to predicts
- Apply filtering method to the model for filter out and predict the noise that might happen
- Combine FCD(Floating car data) into evaluation model

References

- Shanawi, I., Yi, P., & Khilefat, I. (2018, April 13). Automated intersection delay estimation using the input–output principle and turning movement data. International Journal of Transportation Science and Technology. https://www.sciencedirect.com/science/article/pii/S2046043017300771
- ALEKO, D. R., & Djahel, S. (2020, February 21). An efficient adaptive traffic light control system for urban road traffic congestion reduction in Smart Cities. MDPI. https://www.mdpi.com/2078-2489/11/2/119
- Ramireddy, S., Ala, V., KVR, R., & Mehar, A. (2021, December 8). Acceleration and Deceleration Rates of Various Vehicle Categories at Signalized Intersections in Mixed Traffic Conditions. View of acceleration and deceleration rates of various vehicle categories at signalized intersections in mixed traffic conditions. https://pp.bme.hu/tr/article/view/16796/9272
- Olfat, S. (2022, February 9). Connecting Arduino to Firebase to send & receive data [by esp8266]. Electropeak. https://electropeak.com/learn/connect-arduino-esp8266-firebase-send-receive-data/
- Faye, S., Chaudet, C., & Demeure, I. (2012, September). A distributed algorithm for adaptive traffic lights control - researchgate. A Distributed Algorithm for Adaptive Traffic Lights Control. https://www.researchgate.net/publication/261307591_A_Distributed_Algorithm_for_Adaptive_Traffic_Lights_Control
- Altintasi, O., Yaman, H. T., & Tuncay, K. (2017, May 17). Detection of urban traffic patterns from floating car data (FCD). Transportation Research Procedia. https://www.sciencedirect.com/science/article/pii/S235214651730193X
- CanuHi, S. (2021, October 26). Speed detection from CCTV with opencv and Deep Learning. Pysource. https://pysource.com/2021/10/26/speed-detection-from-cctv-with-opencv-and-deep-learning/