Presented by:

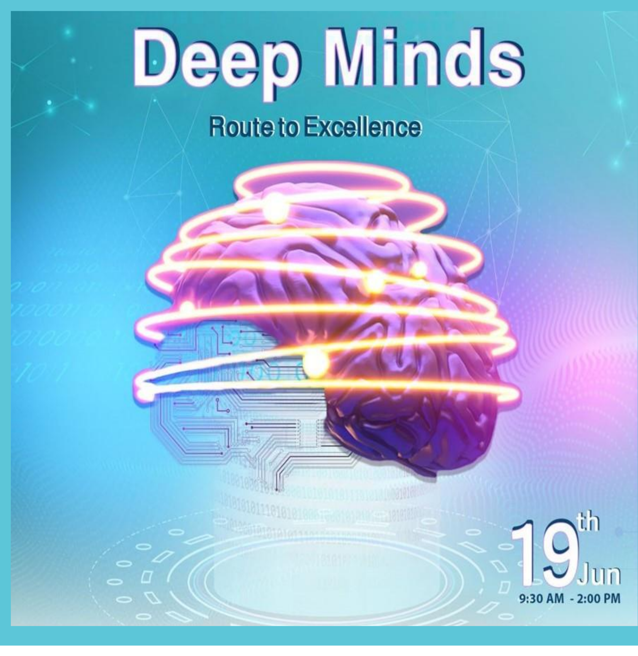
Ahmed Diaaeldin

Under Supervision of:

Supervisor: Dr. Islam Elsharawy

CO-Supervisor: momen zaher

A cross platform fleet management app offering a driver behavior tracking system



ABSTRACT

Recognizing the importance of driver behavior is essential for enhancing road safety and optimizing traffic management systems. This study employs advanced deep learning techniques, specifically CNN-LSTM and Bi-LSTM models, to refine the prediction of driver behaviors using sensor data from the Honda Research Institute Driving Dataset (HDD). Our approach integrates a robust dataset encompassing a broad spectrum of sensor inputs, from vehicle dynamics to driver operational parameters, propelling advancements in driver behavior detection. The methodologies utilized enable the discernment of subtle and complex driving patterns, contributing to the reduction of road safety hazards. Our findings indicate that these models significantly improve the detection of hazardous driving behaviors, surpassing previous state-of-the-art methodologies with notable gains in mean average precision (mAP). These advancements affirm the potential of deep learning technologies in crafting sophisticated predictive safety systems, paving the way for future innovations.

We have implemented our best model (CNN-LSTM) in our fleet management system to provide the fleet manager (admin) with driver behavior tracking metrics. This system utilizes driver behavior data predicted from each trip bus sensor's data to enhance road safety within the fleet. The final system offers fleet managers a suite of features, including driver and bus management, driver behavior tracking, and organizational bus sign-in and sign-out logs, all within a secure and reliable MERN stack web application. Additionally, we developed a Flutter mobile app to record trip traces and enable live tracking of the trips.

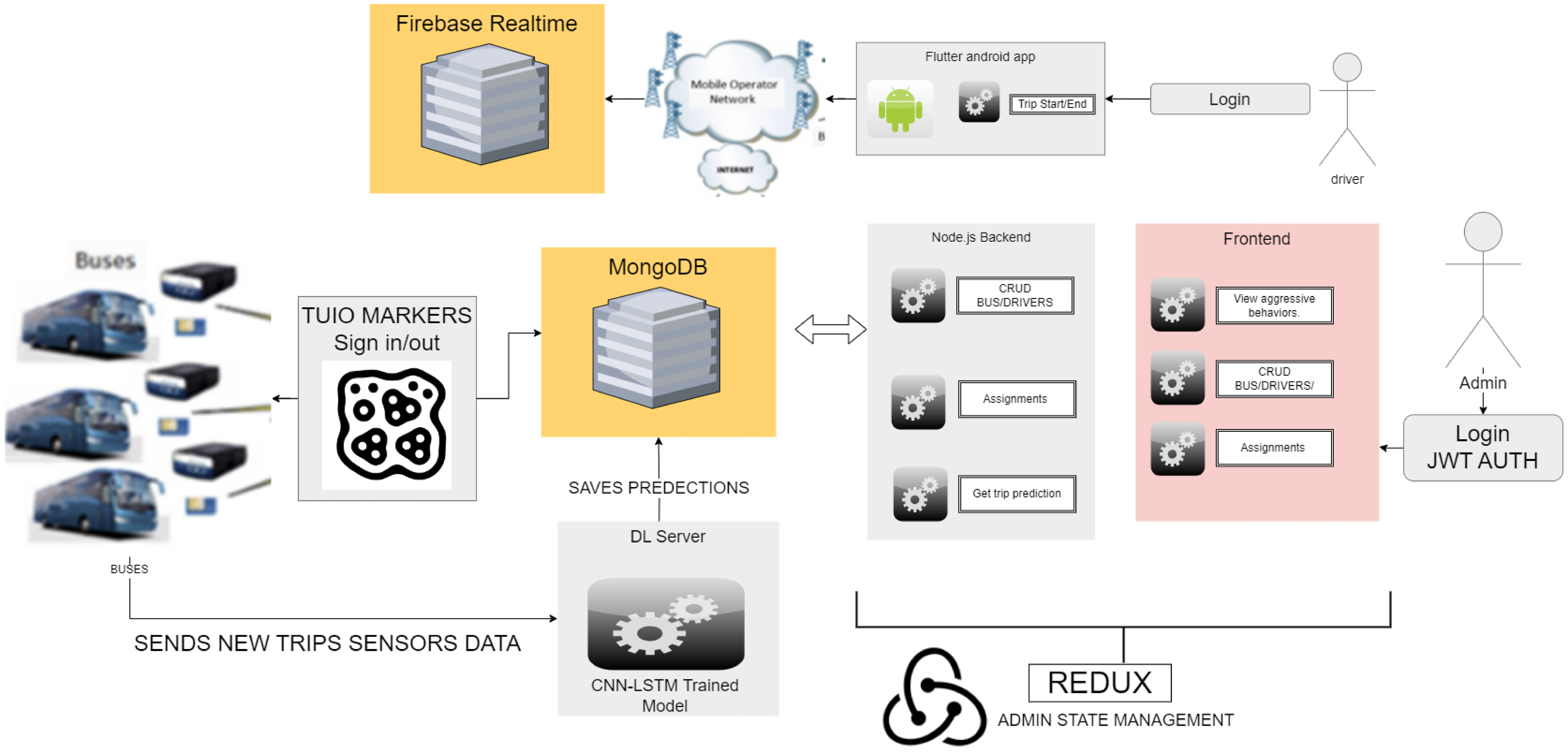
Aim of the work

The aim of this project is to enhance road safety and optimize fleet management cost-effectively while ensuring driver and pedestrian privacy. This is achieved by using advanced deep learning techniques to predict and monitor driver behaviors from bus sensor's data only. By integrating this data with DL models, the project detects hazardous driving patterns, improving safety outcomes. Additionally, it provides fleet managers with comprehensive tracking and management tools through a secure web application and a mobile app for real-time trip monitoring.

3 GOOD HEALTH AND WELL-BEING

8 DECENT WORK AND ECONOMIC GROWTH

SYSTEM OVERVIEW



PUBLISHING

IMSA IEEE Egypt Section

IMSA Conference 2024

Paper Title: Enhancing Road Safety: Leveraging CNN-LSTM and Bi-LSTM Models for Advanced Driver Behavior Detection

RESULTS

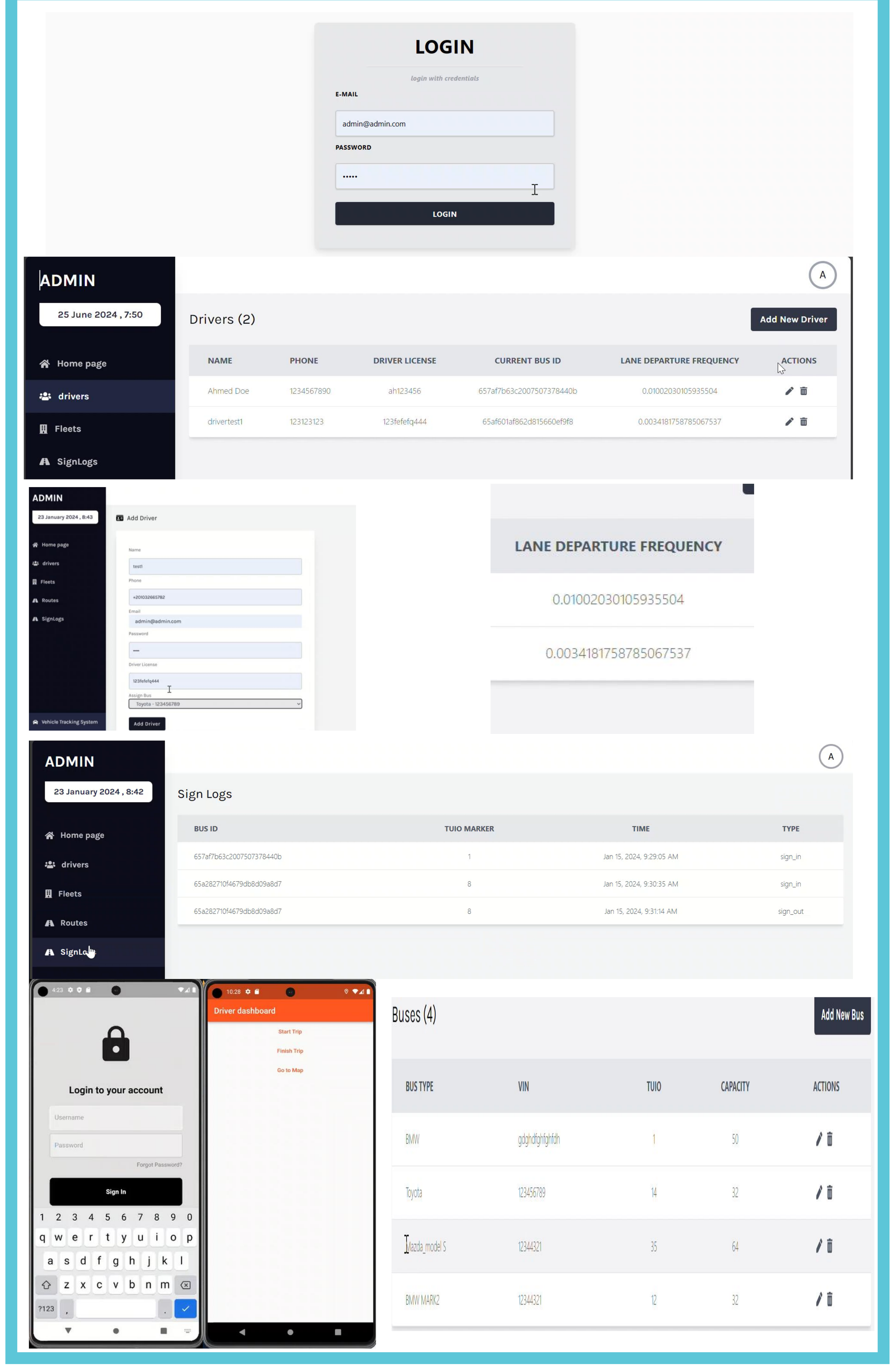
Comparison of proposed models overall mean average precision with state-of-the-art results

Method	mAP
CNN [32]	22.7
LSTM [31]	23.8
ED [32]	27.4
TRN [32]	29.2
OadTR [33]	29.8
Colar [34]	30.6
GateHUB [35]	32.1
MAT [36]	32.7
LSTM (Ours)	28.8
BI-LSTM (Ours)	**33.1**
CNN-LSTM (Ours)	**36.7**

Comparison between proposed models overall mean average precision when using 6 and 8 sensors

Features	Method	mAP
6	LSTM	28.8
	BI-LSTM	33.1
	CNN-LSTM	**36.7**
8	LSTM	38.4
	BI-LSTM	36.0
	CNN-LSTM	**40.1**

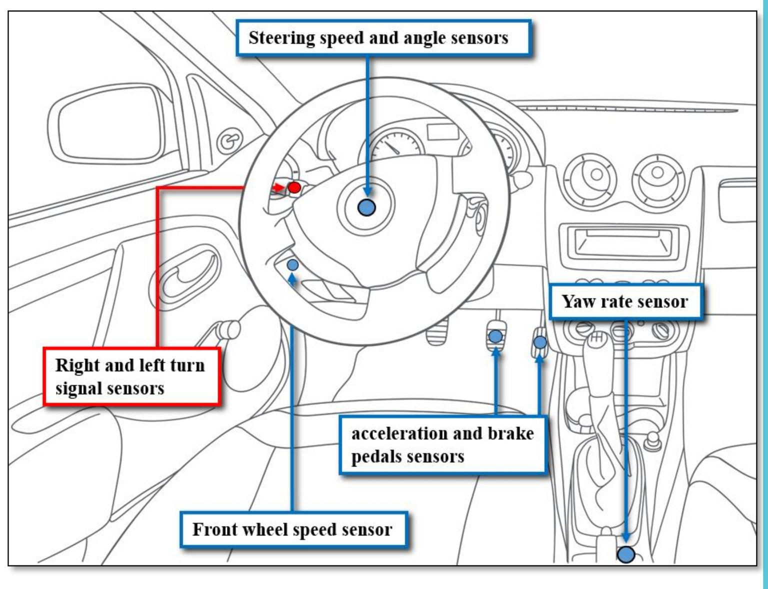
Demos, and Presentation.



DATASET

Honda research institution Dataset

- The dataset has 9 sensors:
  - Related work used 6 sensors colored blue (they discarded the GPS and turn signals)
  - The dataset had 8 sensors (excluding GPS) ready at 3hz and mapped to labels
- It contains 11 goal-oriented normal driver actions classes (which can be used of anomaly detection), namely:
  (intersection passing, left turn, right turn, left lane change, right lane change, left lane branch, right lane branch, crosswalk passing, railroad crossing, merging, and U-turn)



USED TOOLS

M E R N

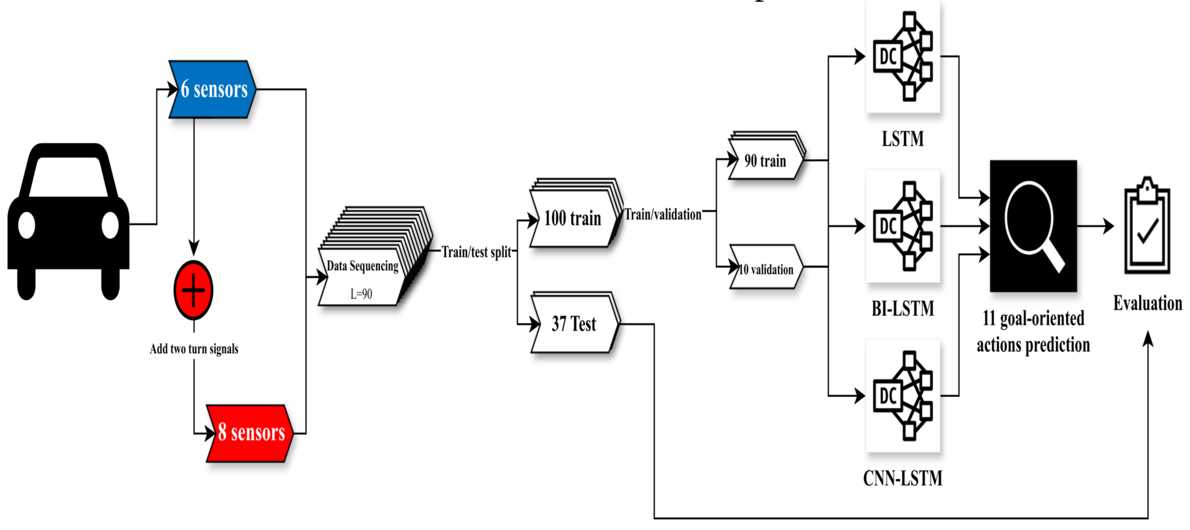
Redux

TensorFlow + Keras

Firebase

METHODOLOGY

We used firstly LSTM as the data is time series and following Honda's published paper.
Then following the state-of-art:
CNN-LSTM, as it was used widely in the field of driver behavior detection.
Also we tried BI-LSTM as it was used in similar problems.



As well we used the same sequence length, batch size and finally evaluated the results using MAP (mean average precision) to match up with prior work

Batch Size	80
Learning Rate	Reduce Learning Rate on Plateau with an initial value of 0.001 with a patience of 4
Loss	Categorical Cross-Entropy
Number of Epochs	50 with Early Stop Callback with patience of 8
Loss Optimizer	Adam
Output layer Activation	Softmax

Conclusion

- The CNN-LSTM model outperformed previous models with a 4% increase in mean average precision (mAP) using six sensors, showcasing its robustness in handling complex, multi-dimensional data.
- The Bi-LSTM model showed a modest 0.4% increase in mAP over state-of-the-art models, while the CNN-LSTM model proved superior in performance, model size, and testing time.
- Adding two turning signal sensors improved the LSTM model's accuracy by 9.6%, and the CNN-LSTM model achieved a 3.4% improvement in mAP, confirming its effectiveness in complex sensor integrations and reinforcing its suitability for advanced driver assistance technologies.

Future Work

- extending the dataset to drivers from various countries and cultures to provide a broader assessment of driver behaviors.
- Integrating GPS data, available in the Honda Research Institute Driving Dataset (HDD) but not currently mapped to annotated session videos, could enhance prediction accuracy by adding spatial context.
- Investigating the effectiveness of GPS data alone for prediction might offer a low-cost, simpler solution for monitoring driver behaviors. These advancements could improve the models' applicability and robustness in diverse settings.