Parameter Setting and Reliability test of a Sensor System for Person Detection in a car wearing winter wear.

Course: Information Technology

Modules: Autonomous Intelligent Systems
and
Machine Learning

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Milestone-5

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Report on Passenger Detection with different Threshold using RandomForestClassifier with ADC Data when Car Engine is running (Car Shaking)

Link to Dataset#3

https://drive.google.com/file/d/1o3b_hj7_nGWbJS3STBWaIXmtSYwp1ZuE/view?usp=sharing

Introduction

This report introduces a novel approach for passenger detection in car seats using RandomForestClassifier applied on ADC (Analog-to-Digital Converter) data processed through Fast Fourier Transform (FFT). Due to constraints in taking readings with the car engine running, we simulated engine vibrations by manually shaking the car. This method aligns with our objective to explore the RandomForestClassifier's performance under simulated conditions with Dataset#3, applying the same threshold of -t 160 9000 used in Milestone4 for data preprocessing.

Data Collection and Description

For Milestone5, we employed Dataset3, consisting of ADC data collected from sensors installed in car seats. The dataset captures analog signals, simulating passenger presence through manual shaking of the vehicle to mimic engine vibrations. These signals were digitized using ADC and then FFT was applied to extract meaningful features representing passenger occupancy

Data Splitting and Preprocessing

The dataset was divided into training and testing sets with an 80-20 ratio. The training set, comprising 80% of the data, was used to train the RandomForestClassifier. The testing set

served to evaluate the classifier's performance. Data transformation into NumPy arrays ensured compatibility with the machine learning algorithms of scikit-learn.

Classifier Model

We continued with RandomForestClassifier due to its ability to manage high-dimensional data and leverage the power of ensemble learning. This classifier improves generalization performance by mitigating overfitting, crucial for our simulated scenario.

Data Preprocessing with Threshold Adjustment

Maintaining the threshold of -t 160 9000, as in the previous milestone, we processed the data to enhance the signal-to-noise ratio. This step is pivotal, considering our simulation approach, ensuring that the features extracted are relevant and robust against the noise introduced by manually shaking the car.

Model Evaluation and Performance Metrics

The evaluation of the RandomForestClassifier's performance remains consistent with Milestone4, employing accuracy, precision, recall, and F1 score. Confusion matrices will illustrate the model's predictive accuracy, offering insights into its capability to distinguish between occupied and empty seats under simulated conditions
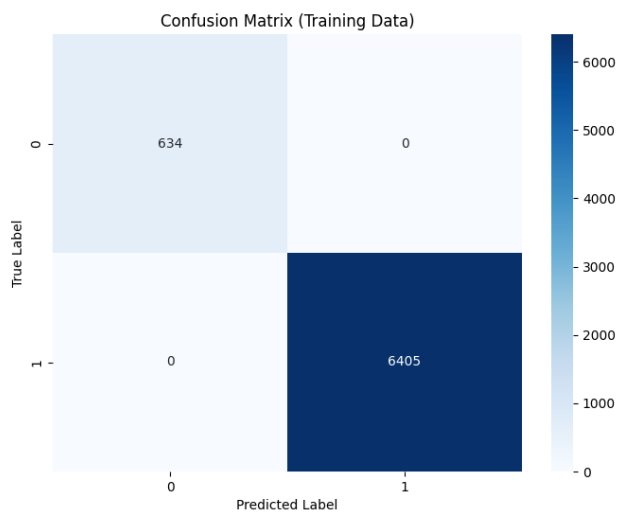
Results
The analysis focuses on evaluating the classifier's effectiveness in a simulated environment using Dataset3. We will report on accuracy, precision, recall, and F1 score, supported by confusion matrices for a detailed performance breakdown.
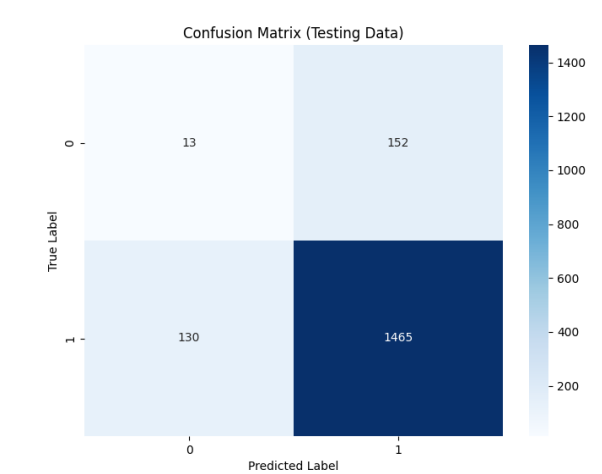**Label 1 shows Passenger Detection**
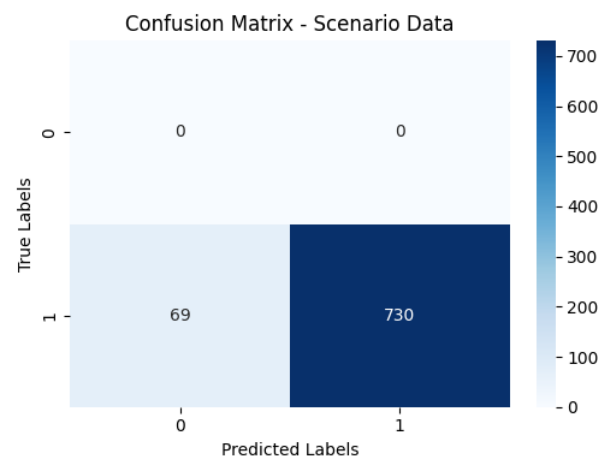**Label 0 shows No Passenger Detection**
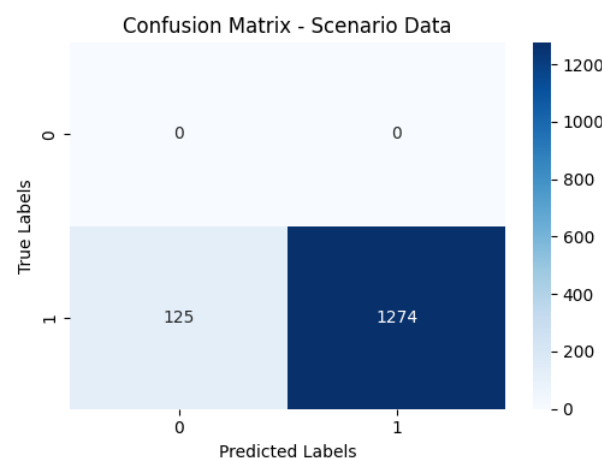
Training Data

Testing Data

Confusion Matrix (Testing Data)

	Predicted 0	Predicted 1
True 0	13	152
True 1	130	1465

Scenarios
Person 1 – Jacket 1

Confusion Matrix - Scenario Data

	Predicted 0	Predicted 1
True 0	0	0
True 1	69	730

Person 1 – Jacket 2

Confusion Matrix - Scenario Data

	Predicted 0	Predicted 1
True 0	0	0
True 1	125	1274

Person 1 – Jacket 3 Constant Seated

Confusion Matrix - Scenario Data
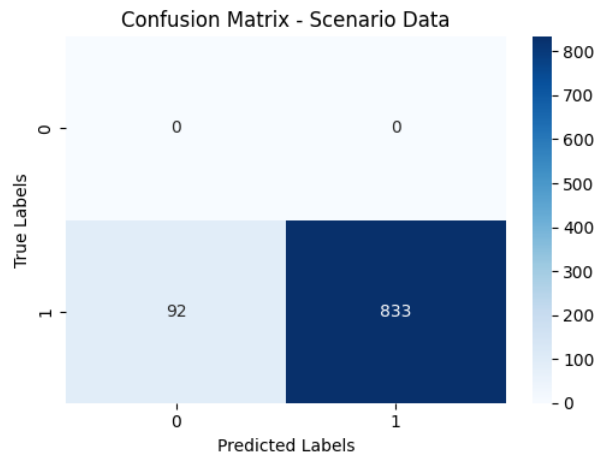
Person 1 – Jacket 3 Always Moving

Confusion Matrix - Scenario Data
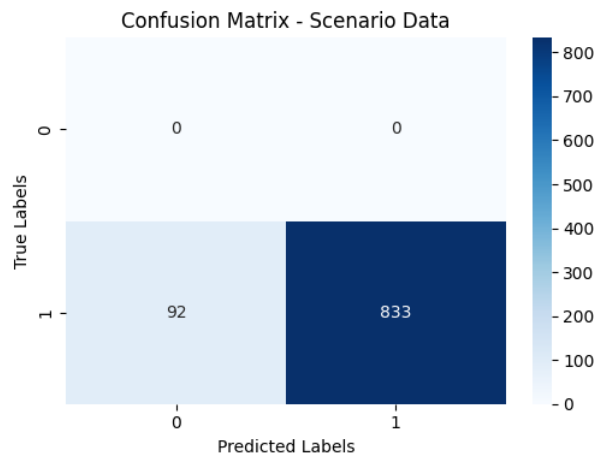
Person 2 – Jacket 1 Constant Seated

Confusion Matrix - Scenario Data
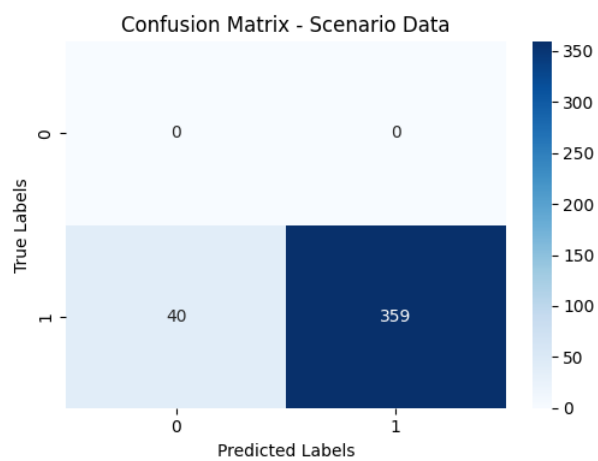
Person 2 – Jacket 1 Always Moving

Confusion Matrix - Scenario Data
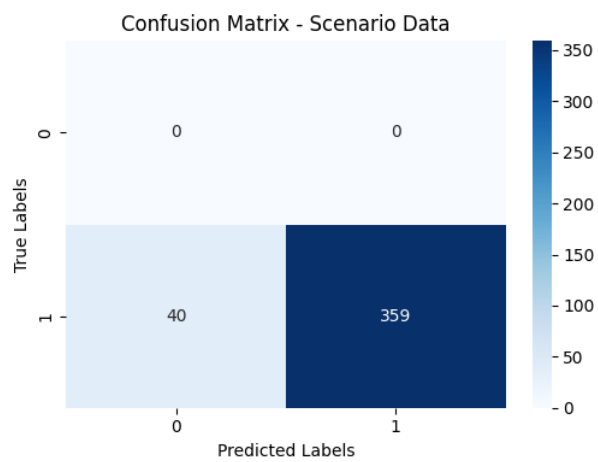
Person 2 – Jacket 2 Constant Seated

Confusion Matrix - Scenario Data
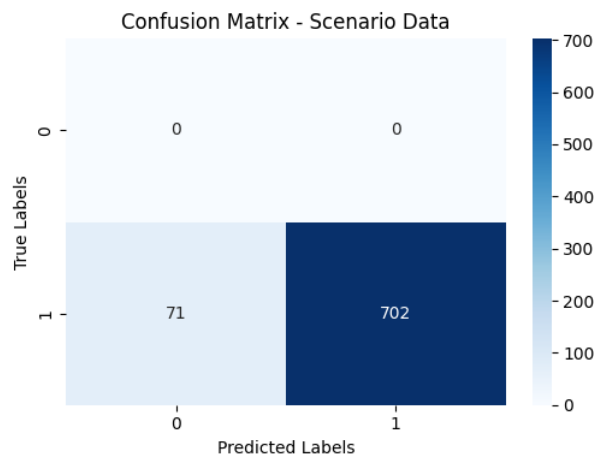
Person 2- Jacket 2 always Moving

Confusion Matrix - Scenario Data
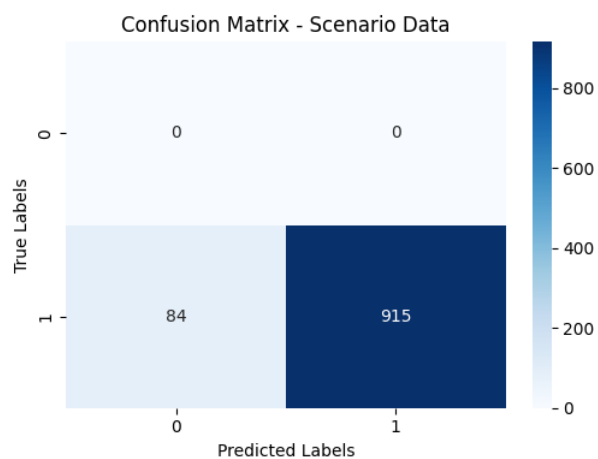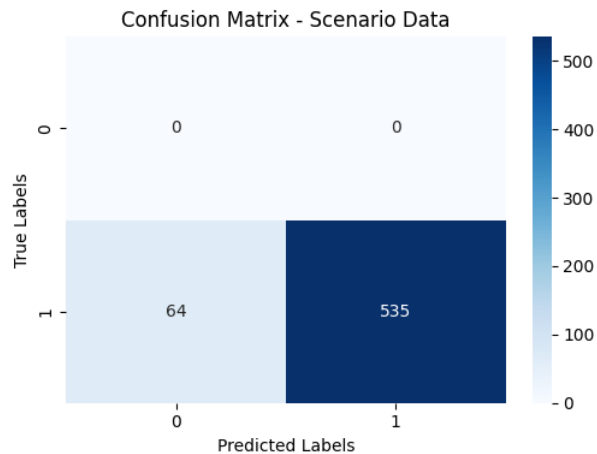
Person 2 – Jacket 3 Constant Seated
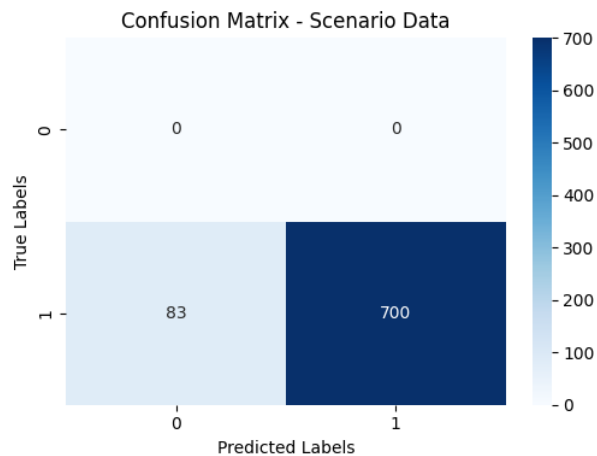
Person 2 – Jacket 3 Always Moving

Conclusion

Milestone5 explores the adaptability and performance of the RandomForestClassifier under simulated engine vibration conditions for passenger detection. Our innovative approach to data collection and preprocessing, alongside the consistent application of a specified threshold, underpins our findings, contributing to the ongoing development of reliable passenger detection systems in automotive applications.