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-3

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Analysis of Passenger Detection using SVM Classifier

INTRODUCTION

The goal of this report is to provide a comprehensive analysis of passenger detection in car seat using a Support Vector Machine (SVM) classifier. The study utilizes data collected from the FIUS ultrasonic sensor installed in front of the passenger seat, employing Fast Fourier Transform (FFT) to extract features indicative of passenger presence. The SVM classifier is chosen for its effectiveness in handling high-dimensional data and its ability to find optimal decision boundaries.

Data Collection and Description

The dataset comprises FFT data collected from ultrasonic sensors in car seats under two scenarios: passenger present and seat empty. Each row in the dataset represents a single observation, with features extracted from FFT analysis. The target variable indicates whether the seat is occupied by a passenger or empty.

Data Splitting and Preprocessing

The dataset is randomly split into training and testing sets randomly using an 80-20 ratio. The training set, consisting of 80% of the data, is used to train the SVM classifier, while the testing set, comprising 20% of the data, is reserved for evaluating the classifier's performance. Both the training and testing sets are converted into NumPy arrays for compatibility with scikit-learn's machine learning algorithms.

Classifier Model

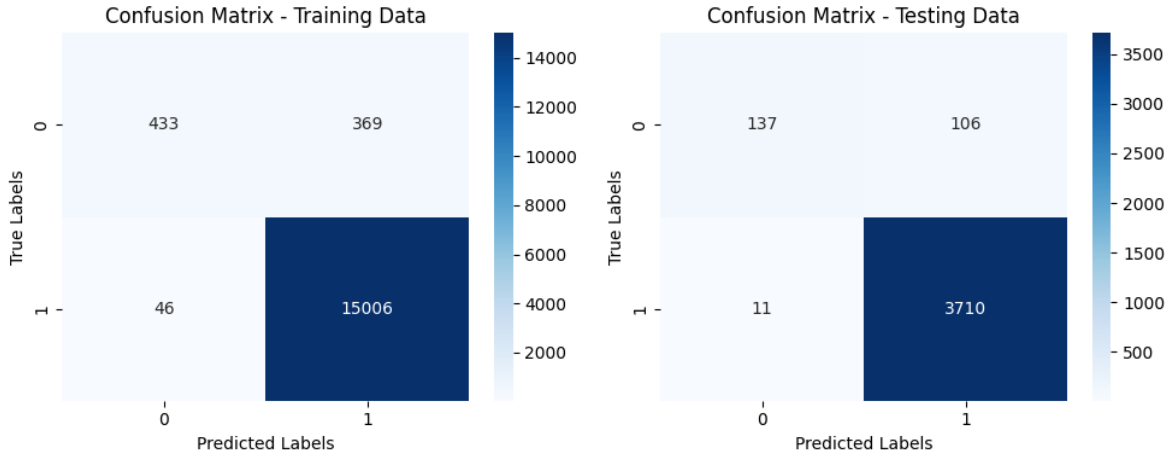
The SVM classifier is employed due to its ability to handle high-dimensional data and find optimal decision boundaries. SVM works by finding the hyperplane that maximizes the margin between different classes while minimizing the classification error. In this study, scikit-learn's **SVC** module is utilized, allowing flexibility in kernel selection and regularization parameter tuning.

Regularization
Regularization is applied to the SVM classifier to prevent overfitting, a common issue in machine learning where the model performs well on the training data but poorly on unseen data. Regularization helps control the complexity of the model by penalizing large coefficient values. The regularization parameter **C** is adjusted to control the regularization strength, with higher values indicating less regularization. We have used a regularization value C as 60.0 to train our model.

Confusion Matrix Creation
Confusion matrices are generated to assess the performance of the SVM classifier on both the training and testing sets. A confusion matrix provides a tabular representation of the model's predictions versus the actual labels, facilitating the calculation of various performance metrics such as accuracy, precision, recall, and F1 score. The confusion matrices are visualized to gain insights into the classifier's performance across different classes.

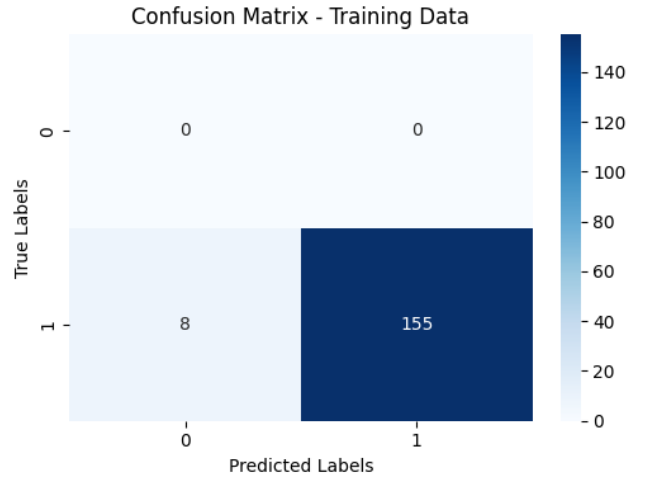
Results
The performance of the SVM classifier is evaluated based on the generated confusion matrices. Performance metrics such as accuracy, precision, recall, and F1 score are computed to assess the classifier's effectiveness in distinguishing between passenger present and seat empty scenarios. The regularization parameter **C** is fine-tuned to achieve the best trade-off between bias and variance, ensuring optimal model performance.

Label 1 shows Passenger Detection
Label 0 shows No Passenger Detection

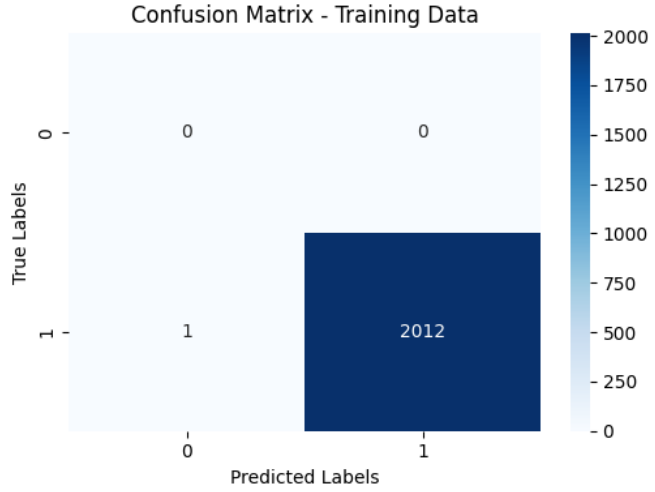


Scenarios

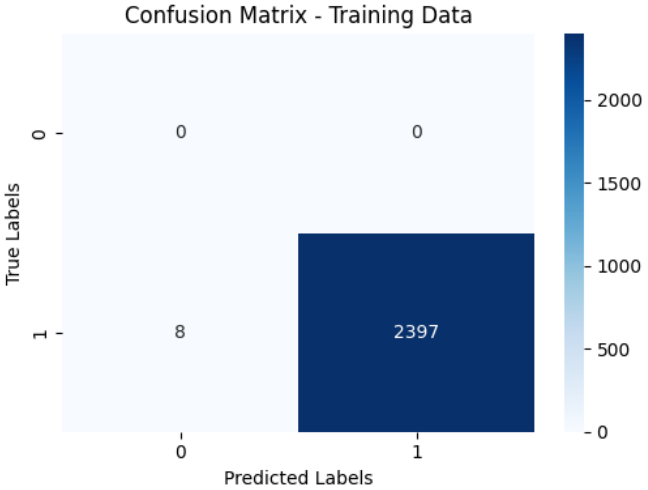
Person 1 - Jacket 1



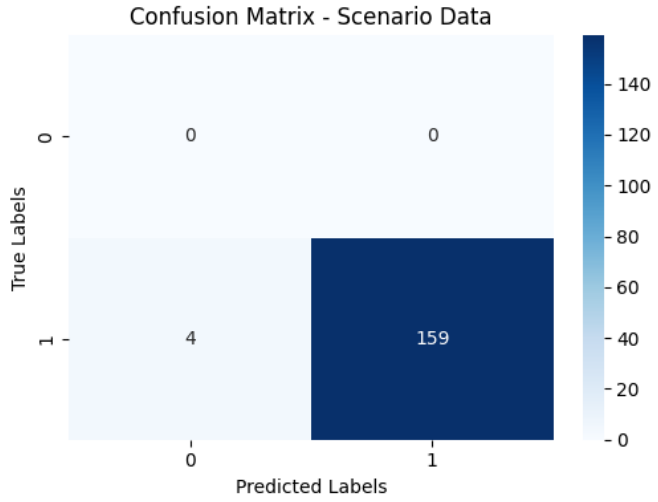
Person 1 – Jacket 2



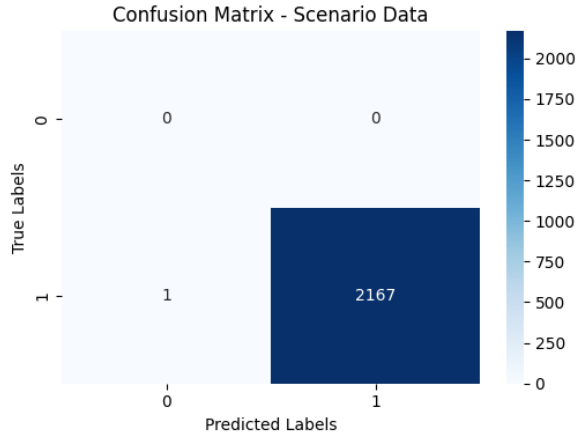
Person 1 – Jacket 3



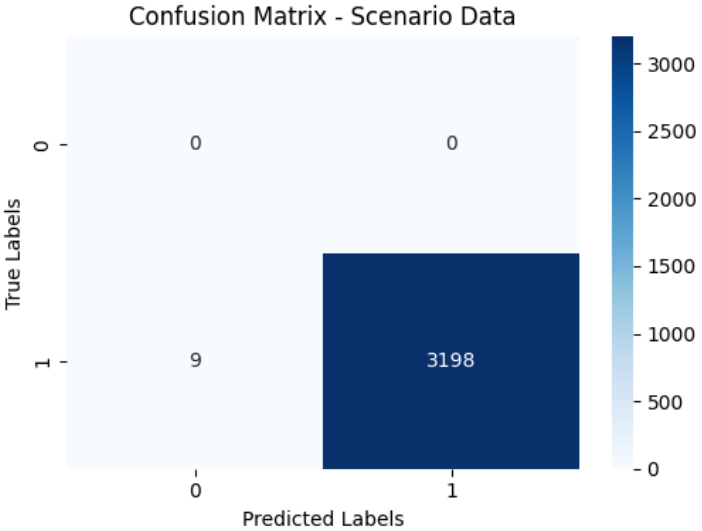
Person 2 -Jacket 1



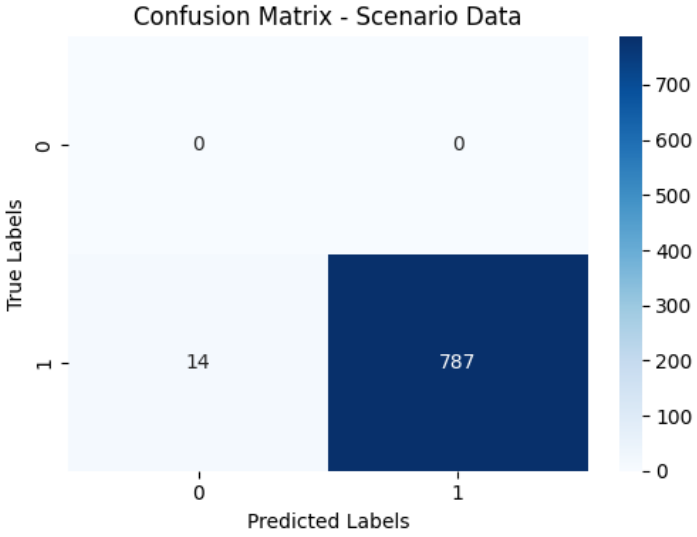
Person 2 – Jacket 2



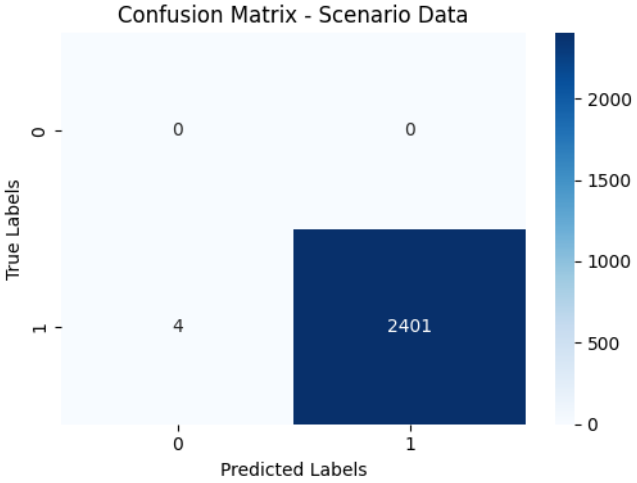
Person 3



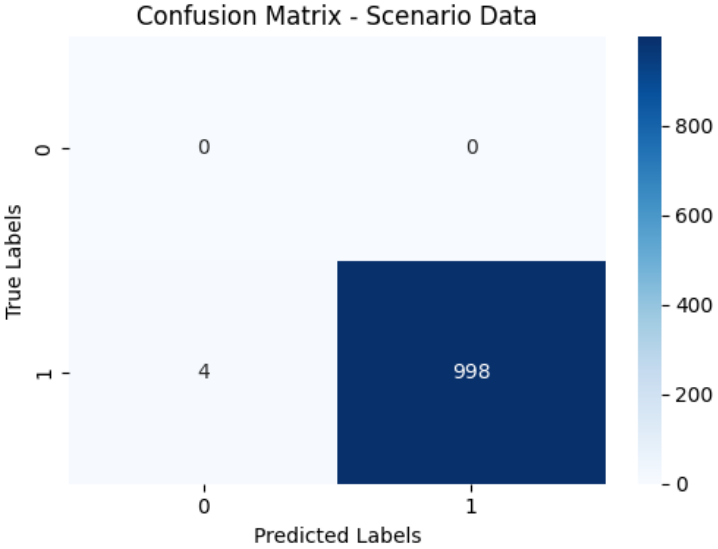
Person 4



Person 5



Person 6



Conclusion

In conclusion, the SVM classifier demonstrates promising performance in detecting passengers in car seats based on FFT data from ultrasonic sensors. Regularization plays a crucial role in preventing overfitting and ensuring that the classifier generalizes well to unseen data. Further experimentation and parameter tuning may lead to enhancements in model performance. The findings of this study provide valuable insights into the application of machine learning techniques for passenger detection in automotive systems.