**ECE 579 Intelligent Systems, Winter 2024**

**Project Progress Report**

**Project title: Facial Expression Recognition System for Personalized Vehicle Settings.**

**Students in the project group: Luis Castaneda-Trejo (Team Leader) and Julio C Murillo**

1. **What has been completed, who did what parts?**

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| --- | --- | --- | --- | --- |
| **Item** | **Name** | **Description** | **Responsible** | **Status** |
| 1 | Dataset | Review and preparation of the dataset intended for implementation. | JM | Done |
| 2 | Model Development | Developed Initial codebase for the machine learning model. Implemented initial DNN algorithm. | JM | Done |
| 3 | Scenario Analysis | Conducted a comprehensive study of different scenarios to understand model’s performance. | JM | Done |
| 4 | Deployment target | Research about the best MCU and development board to deploy the developed model. | LCT | Done |
| 5 | Deployment dependencies | Explore options for deployment (PC with LabVIEW and Python vs STM32 MCU) | LCT | Done |
| 6 | User Interface | Created a demo UI to call the model and show initial results | LCT | Done |

1. **What needs to be done, Whose responsibilities?**

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| **Item** | **Name** | **Description** | **Responsible** | **Due Date** |
| 1 | Model Training | Training and refinement of the DNN model to increase performance (P). | JM | 3/1/2024 |
| 2 | Model Integration | Integrate model into item 6 from Table 1. | LCT | 3/15/2024 |
| 3 | Document Experiments | Register the findings and evaluate the performance of the models while reviewing their performances. | JM | 3/15/2024 |
| 4 | Evaluate ST AI toolkit | After a successful deployment in the PC, we need to evaluate the model in the MCU using ST FP-AI-Vision1 | LCT | 3/31/2024 |
| 5 | Create a CANoe demo | Create a CAN vehicle demo using Vector CANoe and connect the MCU with the deployed model to it | LCT | 3/31/2024 |
| 6 | Test and Validation | Verify, validate and troubleshoot the whole system and document results in the final report | JM / LCT | 4/15/2024 |

1. **Time schedule for completing the project.** -> See table from question number 2.
2. **Project Description**: In this project, we aim to develop a facial expression recognition system that can be installed inside a vehicle. The system will monitor the driver’s facial expressions and, if the user exhibits extraordinary or unstable behavior, it will send alerts to the entire vehicle network via the Controller Area Network (CAN) protocol.
   1. **System Flowchart**

**A diagram of a diagram

Description automatically generated**

* 1. **Data Description:** The FER-2013 dataset consists of grayscale images of faces, each labeled with one of seven emotion categories: anger, disgust, fear, happiness, sadness, surprise, and neutral. The dataset contains 35,887 grayscale samples of human faces, each sized at 48x48 pixels. The dataset is free and available on Kaggle as part of the "Challenges in Representation Learning: Facial Expression Recognition Challenge."
  2. **Proposed/Modified Method**: Our project employs a deep neural network (DNN), designed with multiple hidden layers to learn features at different levels of abstraction, utilizing the non-linear activation function ReLU (Rectified Linear Unit). The model training uses an Adam optimization algorithm. The performance is evaluated using relevant metrics such as accuracy, precision using mean absolute error, mean squared error.
  3. **Experiment Design/ Case Study**:
     + Data Augmentation Experiments: rotating, flipping, scaling, cropping images.
     + Architecture Experiments:
     + Hyperparameter Tuning: modify learning rates, dropout rates, batch sizes, and numbers of layers and neurons.
     + Real-world Usability Tests: Conduct experiments in real-world conditions.
     + Data Modification: eliminating one of the emotions from dataset due to imbalance.