TSR - Traffic Sign Recognition

Watch a live demonstration of the system here

This project is a Traffic sign recognition and text-to-speech system based on machine learning.

Traffic Sign Recognition

- Utilizes the YOLO (YOLOv11) model for real-time traffic sign detection.
- The model is trained on a dataset specified in the `config.yaml` file and saved in ONNX and PyTorch formats.
- Sign detection with tts is implemented in the `tsr.py` script, which uses a camera to capture images and detect traffic signs and uses the ParlerTTS model to generate voice messages based on the detected signs.
- You can see a live preview in `rt_tsr.py`.

Text-to-Speech

- Uses the ParlerTTS model to generate speech based on detected traffic signs.
- The implementation is found in the `TSR_TTS` class in the `tsr_tts.py` file.

Model Training

- The process of training the YOLO model is visible in the Jupyter notebook `training.ipynb`.
- Training parameters are configured in the `config.yaml` file.

Project Structure

- The `models` folder contains saved models in ONNX and PyTorch formats.
- The `data` folder contains training, testing, and validation data.
- The `audio` folder stores generated audio files and temporary sound files.
- Archives:
  - `old_models` folder contains old models.
  - `old_data` contains old datasets (not uploaded to GitHub).

How It Works

1. **Traffic Sign Detection**: The system captures images from a camera and uses the YOLO model to detect traffic signs in real-time. The detected signs are then classified and labeled.
2. **Text-to-Speech Generation**: Based on the detected signs, the system generates corresponding voice messages using the ParlerTTS model. These messages are then played back to the user.

Usage

1. **Setup**: Ensure you have all the required dependencies installed. Make sure you have the correct versions of Torch and CUDA installed. You can install them from PyTorch's official site.
2. **Running the Traffic Sign Recognition with tts**:

   ```
   python tsr.py
   ```

3. **Running real time preview**:

   ```
   python rt_tsr.py
   ```

Final Model

- The final model is saved in the `models` folder as 'tsrm.onnx' and 'tsrm.pth'.
- It was trained using the YOLOv11 medium model.
- Final model was trained on a dataset of 1060 images of traffic signs/
- The model was trained for 350 epochs.
- The model can recognize 24 classes of Polish traffic signs:
  - **A-1**: Niebezpieczny zakręt w prawo
  - **A-11a**: Próg zwalniający
  - **A-16**: Przejście dla pieszych
  - **A-17**: Uwaga dzieci
  - **A-2**: Niebezpieczny zakręt w lewo
  - **A-30**: Inne niebezpieczeństwo

- **A-7**: Ustąp pierwszeństwa
- **B-1**: Zakaz ruchu w obu kierunkach
- **B-2**: Zakaz wjazdu
- **B-20**: STOP
- **B-21**: Zakaz skręcania w lewo
- **B-22**: Zakaz skręcania w prawo
- **B-23**: Zakaz zawracania
- **B-33**: Ograniczenie prędkości
- **B-36**: Zakaz zatrzymywania się
- **B-41**: Zakaz ruchu pieszych
- **C-12**: Rondo
- **C-2**: Nakaz jazdy w prawo za znakiem
- **C-5**: Nakaz jazdy prosto
- **D-1**: Droga z pierwszeństwem
- **D-18**: Parking
- **D-3**: Droga jednokierunkowa
- **D-6**: Przejście dla pieszych
- **D-6b**: Przejście dla pieszych i droga dla rowerzystów

- You can see the process of training the model in the `training.ipynb` notebook.

Model Performance

The model's performance was evaluated on a validation dataset. Below are examples of the ground truth labels and the model's predictions:

Image	Description
	Labels from dataset
	Predictions

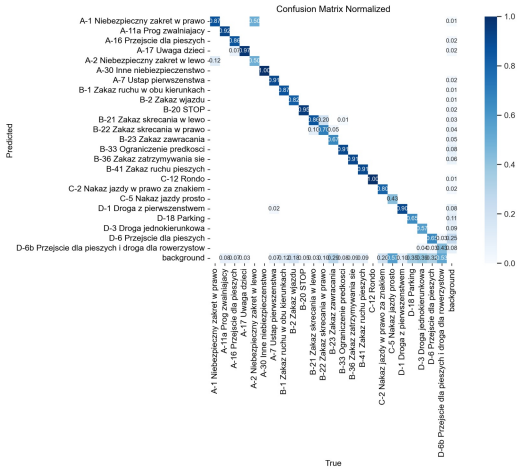
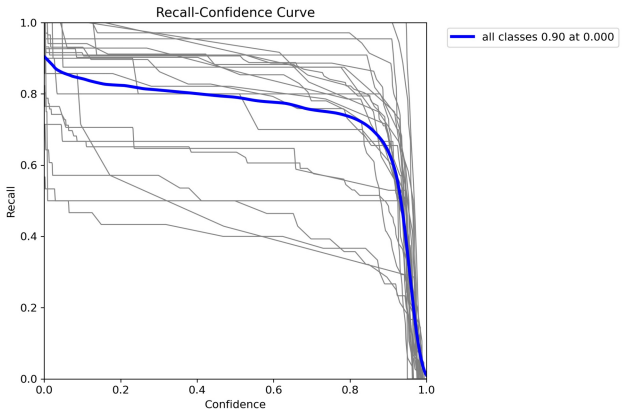
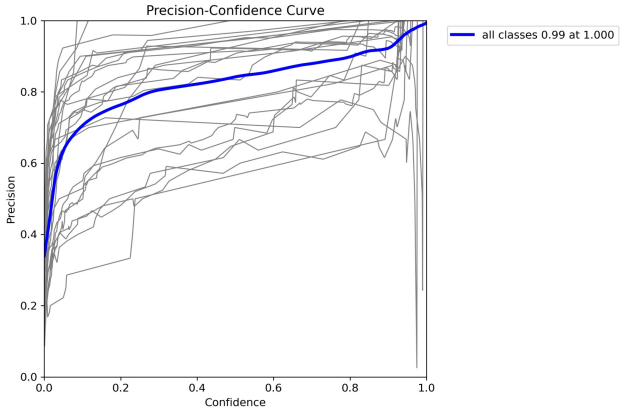
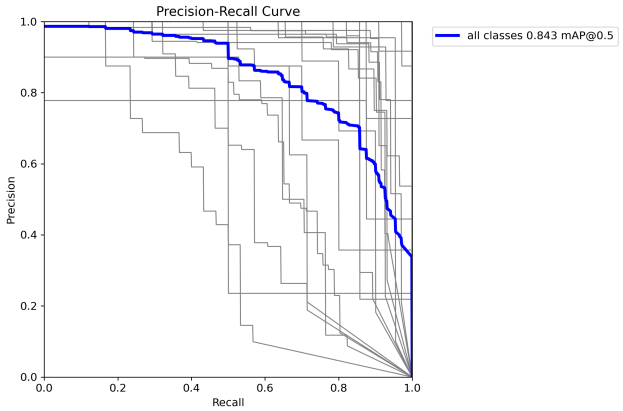
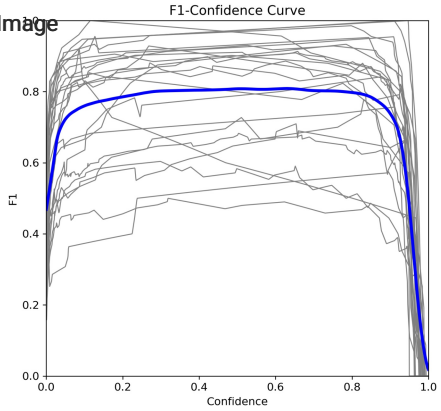
Image	Description
	*Confusion Matrix*
	*R Curve*
	*P Curve*
	*PR Curve*

Image	Description
	*F1 Curve*