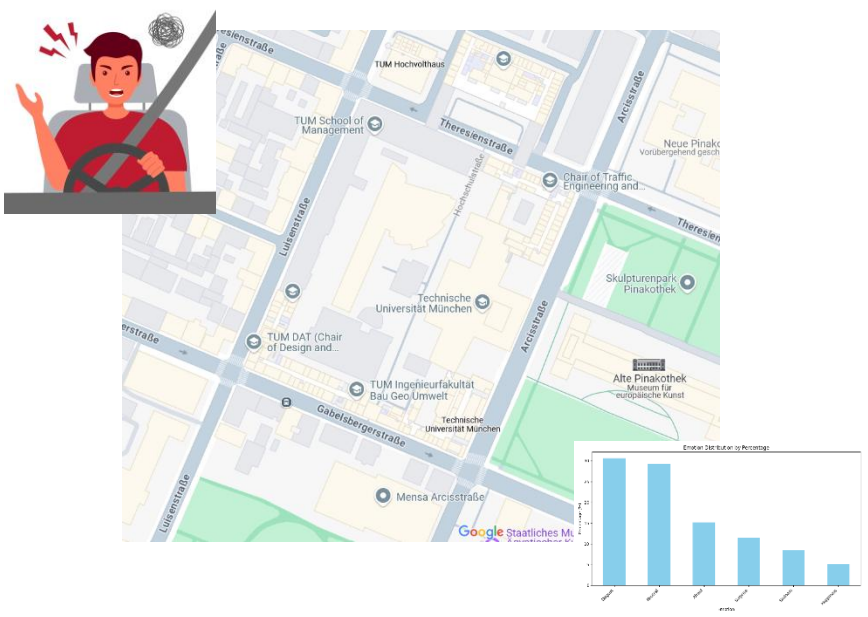
Facial Emotion Recognition using Convolutional Neural Networks

Master‘s Thesis of Ekaterina Vostokova

Mentoring:
Dr.-Ing. Mathias Pechinger,
Dr.-Ing Anna Takayasu



Facial Emotion Recognition is a crucial element in various fields, such as human-computer interaction, surveillance, and healthcare. In the context of traffic systems, human behaviour significantly influences road safety and vehicle interactions. Traffic can be characterized by vehicle parameters, road characteristics, and human factors. As direct road users, understanding human behaviour is essential for a comprehensive analysis. Therefore, accurately interpreting human emotions from facial expressions is vital for deeper insights and further application in traffic theory and practice.

In order to make the safety assessment system more manageable and predictable, an accurate real-time assessment of human emotional states is needed. The aim of this study is to apply convolutional neural networks for facial emotion recognition to further investigate the relationship between stress, emotion and road safety.

Three methodologies were used for this work: programming, experimentation and data analysis.

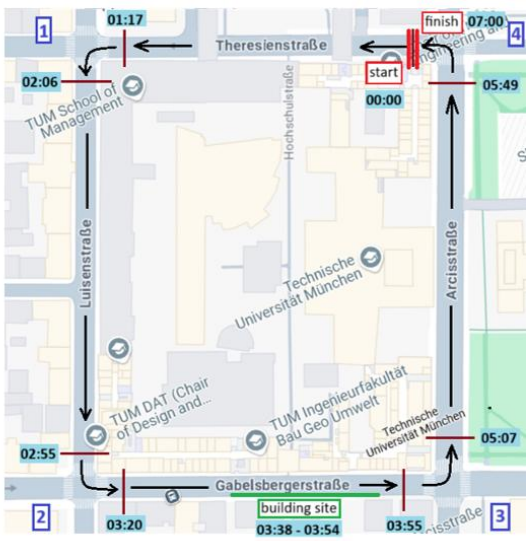
The aim of programming is to solve the facial emotion recognition problem and select a suitable neural network architecture. Python was chosen as the programming language because it is easy to use and has a wide range of libraries that are necessary for machine learning and data processing.

The purpose of the experiment is to collect sufficient data for adequate testing. The design of this experiment is simple: the person rides a bicycle on a pre-selected route in traffic, while the frontal face camera is recording the face.

Data analysis is done for interpretation of the results of emotion recognition. The purpose of this methodology is to evaluate the correctness of the model for the emotion recognition task and their respective relationship with the stress state of the subject.

Methodology	Task	Tools
Programming	FER model	python 3.10 (tensorflow)
Experiment	test FER model	bicycle, 3 cameras, participants
Data analysis	stress detection, feedback, plotting	python 3.10 (matplotlib, pandas, numpy, cv2)

Road part	Stress [%]
	Participant 1.1
Int. 1	15% (7,35 / 49 sec)
Int. 2	34% (8,5 / 25 sec)
Int. 3	17% (12,24 / 72 sec)
Int.4	10% (7,1 / 71 sec)
Ther	33% (25,41 / 77 sec)
Lui	35% (17,15 / 49 sec)
Gab	4% (1,4 / 35 sec)
Arc	45% (18,9 / 42 sec)
Building site	5% (0,8 / 16 sec)
Whole trip	25% (105 / 420 sec)



In this thesis, a study was conducted to train a convolutional neural network for emotion recognition and subsequent stress identification. VGG16 neural network was selected and trained on FER2013 dataset. As the result, key points are suitable for facial recognition, but not for emotion recognition. For this task models that works with raw pixel data should be used.

Based on the results of the study, it can be concluded that the trained model has shown preliminary reliable results for further research, but it requires refinement and a more thorough evidence base. The result of this stage suggests that ground truth could not be determined due to the lack of data from the experiment.

The results of the study show that in order to analyse the stress state of an individual, several markers of body systems response are needed. For further development, a model that analyses emotions in real time can be created to reduce the subjectivity of human judgement.