Module Name: KF7029 – MSc Computer Science & Digital Technologies

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MSc Programme Title: MSc Data Science

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Title of your Project: Facial Emotion Recognition Using Deep Learning: Optimization and Data Augmentation techniques.

Research Questions:

1. How can Convolutional Neural Networks (CNNs) be optimized to improve the accuracy and efficiency of facial emotion recognition systems?

2. What are the most effective data augmentation techniques for enhancing the performance of deep learning models in facial emotion recognition tasks?

Related Literature:

Some of the key words I intend to use for the literature review includes:

- Facial Emotion Recognition

- Deep Learning optimization techniques

- Convolutional Neural Networks (CNNs)

- Data Augmentation

- Machine Learning

Key research conferences/journals/publication venues:

- IEEE Transactions on Affective Computing

- Journal of Medical Internet Research

- Computers in Human Behavior

- International Conference on Affective Computing and Intelligent Interaction
- Conference on Human Factors in Computing Systems

Research Aim Scope and Impact:

Aim:

This study aims to develop a robust Facial Emotion Recognition (FER) system utilizing deep learning techniques. These techniques involve optimizing CNNs and applying different data augmentation strategies effectively to improve accuracy, robustness and efficiency of FER systems, for them to be more applicable and reliable in real-world situations.

Scope:

Corporate: Enhances employee wellness programs by assessing emotional states, identifying those needing support, and fostering a productive work environment. Improves customer service by training staff to respond to customer emotions effectively.

Education: Supports students' emotional health by monitoring expressions, identifying those struggling emotionally, and providing early intervention, leading to better academic performance and a positive learning environment. Helps educators gauge students' emotional engagement during lectures.

Military and Veteran Services: Monitors emotional well-being of military personnel and veterans, identifying distress early and enabling timely support. Integrates into rehabilitation programs to tailor support based on emotional states, enhancing effectiveness.

Public Health and Community Initiatives: Supports community by monitoring emotional health, identifying at-risk groups, and providing targeted interventions. Informs public health policies and resource allocation to address community emotional health needs. Supports emotional health monitoring and intervention strategies within communities, enhancing overall community well-being.

Impact:

The research promotes emotional well-being across sectors by providing a non-invasive, efficient method for recognizing and responding to emotional states. FER technology enables timely interventions, enhances communication, and improves outcomes. In corporate settings, it boosts employee satisfaction and productivity; in education, it supports student success; in military services, it provides crucial support to personnel and veterans; in public health, it informs better policymaking and resource allocation. Additionally, FER improves customer service interaction quality and supports community emotional health monitoring and interventions.

Research Approach

Data Collection and Utilization:

- **Datasets:** The FER2013 dataset, JAFFE dataset, Bosphorus database for 3D face, BU_3DFE_database_sorted. which contains labeled facial images categorized into seven basic emotions (angry, disgust, fear, happy, sad, surprise, and neutral), will be utilized.

- **Focus:** The primary focus will be on improving the overall accuracy and robustness of the facial emotion recognition system through optimization and augmentation.

Data Preprocessing:

- **Preprocessing:** The facial images will be preprocessed by cropping, resizing, and normalizing pixel values to ensure consistency and prepare them for model training.

- **Augmentation:** Effective data augmentation techniques such as rotation, translation, flipping, and adding noise will be applied to increase the diversity of the dataset, making the models more robust to variations in facial expressions and environmental conditions.

Model Development:

- **Training:** Convolutional Neural Networks (CNNs) will be used to train models on the preprocessed FER2013 dataset. The models will learn to map facial expressions to corresponding emotional states.

- **Hyperparameter Tuning:** Various network architectures and hyperparameters will be experimented with to find the optimal configuration that maximizes model performance. Techniques such as grid search and random search will be employed for tuning.

- **Validation:** The trained models will be evaluated using performance metrics including accuracy, precision, recall, and F1-score. A confusion matrix will be used to visualize the models' ability to correctly classify different emotional states.

Ethical Considerations:

- **Data Management:** All data will be anonymized, and secure storage protocols will be implemented to prevent unauthorized access and ensure data privacy.

- **Ethical Compliance:** The research will adhere to strict data management protocols and obtain necessary ethical approvals. This includes following guidelines set by Northumbria University to ensure responsible and ethical use of data throughout the research process.

Ethics Risk and Related Issues:

Key Ethics Consideration:

The main objective of this research is to develop a system for facial emotion recognition (FER) using deep learning technologies. Given the sensitive nature of facial recognition data, it is crucial to address ethical considerations to safeguard privacy and data security. This research does not involve

human participants directly, as it utilizes publicly available datasets that are already anonymized. According to (Katirai, 2023) several ethical concerns regarding FER including data sensitivity, potential misuse and biased outcome, my research will mitigate this as it involves no human participation.

Informed Consent:

Since this research does not involve the recruitment of new participants, informed consent is not applicable. However, should there be any future need for participant data for accuracy testing, ethical procedures will be closely adhered to, including filling out an ethics form and obtaining supervisor approval. Participants would be fully informed about the study's nature, including objectives, methods, potential risks, and benefits, ensuring voluntary participation and respect for their autonomy.

Privacy and Confidentiality:

The privacy and confidentiality of any data used in this study are paramount. Although this research will utilize the anonymized FER2013 dataset, strict data management protocols will be followed to ensure secure storage and processing. Any additional data that might be gathered in the future will be anonymized using advanced software to blur identifiable features and remove metadata. Adherence to Northumbria University and module guidelines will be maintained, with detailed informed consent obtained from participants concerning data anonymization and usage protocols if participant involvement becomes necessary.

Compliance and Ethics:

Adherence to Northumbria University's ethical guidelines will be ensured throughout the research process. This includes seeking necessary approvals, maintaining transparency in research methodologies, and ensuring integrity in reporting findings.

Data Security:

Ensuring data security is critical to prevent unauthorized access, breaches, or misuse of sensitive information. All data and code, whether from the FER2013 dataset or any future participant involvement, will be securely stored and accessible only to authorized personnel directly involved in this research. This approach safeguards against potential threats and maintains participant trust in the research process.

Participant Distress:

Since the current research does not involve human participants, the risk of participant distress is not applicable. However, comprehensive information about research objectives and potential emotional impacts will be provided if future participant involvement becomes necessary. Participants will be assured of their freedom to withdraw at any time without repercussions.

Data Misuse:

To protect against unauthorized access, sharing, or misuse of sensitive data, stringent data security measures will be implemented. All data will be securely stored and accessible only to authorized personnel.

Professional Legal Social Security and Sustainability (PLSSS) Issues:

Professional Standards:

Adherence to Northumbria University's ethical guidelines will be ensured, including seeking necessary approvals, maintaining transparency in research methodologies, and ensuring integrity in reporting findings.

Legal Compliance:

Compliance with data protection regulations, such as the Data Protection Act, will be ensured. All aspects of data collection, storage, and processing will adhere to relevant laws to protect data rights and mitigate legal risks.

Social Implications:

The social implications of this research focus on ensuring that the facial emotion recognition system is fair and unbiased. Although this research will utilize the FER2013 dataset alone, efforts will be made to minimize biases that might arise from the data. This includes applying fairness techniques during the system's development to ensure it works accurately for people from different backgrounds. The goal is to create a technology that is inclusive and does not favor or discriminate against any demographic group, promoting fairness and equality in its application.

Security Measures:

Encryption and secure authentication protocols provided by the University will be implemented to protect against data breaches and unauthorized access. Regular cybersecurity assessments and updates will be conducted to ensure the highest level of data protection.

Sustainability Considerations:

Energy-efficient computational resources and responsible management of electronic equipment will be used to reduce environmental impact. Thorough documentation of methodologies and data management practices will ensure the study can be reproduced and improved upon.

Publication Venue & Template:

Target Publication Venue:

- IEEE Transactions on Affective Computing

Submission Template and Reference System:

Submission Template: Identified from the IEEE Author Center.

Reference System: IEEE citation style.

Katirai, A. (2023) 'Ethical considerations in Emotion Recognition Technologies: A review of the literature', *AI and Ethics* [Preprint]. doi:10.1007/s43681-023-00307-3.

Pranav, E. *et al.* (2020) 'Facial emotion recognition using deep convolutional neural network', *2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS)* [Preprint]. doi:10.1109/icaccs48705.2020.9074302.

R, S., G, S. and V, A. (2022) 'Facial emotion recognition using deep learning approach', *2022 International Conference on Automation, Computing and Renewable Systems (ICACRS)* [Preprint]. doi:10.1109/icacrs55517.2022.10029092.