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3D FACE RECOGNITION USING TRIPLET POINT CLOUD NETWORK FOR THE IDENTIFICATION OF A PERSON WITH A FACE MASK

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ABSTRACT

The coronavirus disease 2019 (COVID-19) outbreak urges authorities to manage pandemic outbreaks effectively. One of the most efficient ways to stop the COVID-19 virus from spreading is by requiring citizens to wear face masks properly. The fact that a portion of the face has been obscured makes the two-dimensional (2D) face recognition algorithm more challenging during the pandemic. Researchers proposed approaches to tackle these difficulties, such as a face-eye-based multi-granularity model, three-dimensional (3D) face reconstruction, synthesising a masked face and heterogeneous face recognition for deep neural networks. Nonetheless, 2D face recognition using deep neural networks to utilise 3D data requires converting data format, which results in the loss of geometric properties. The increasingly popular research of Deep Learning 3D face recognition using point clouds directly as input has produced promising results over the past few years. However, it required a lot of 3D point cloud data, which current 3D databases lacked, especially masked face databases. To address these problems, this study proposed a pipeline of works such as collected 3D masked face dataset and combined with the existing 3D dataset for train and evaluating networks, designed a triplet 3D face masked point clouds-aware deep network using triplet loss function, and evaluated the performance of 3D face recognition using Deep Learning model for identification of a person with a face mask. Experimentation has been carried out on the D415 3D face dataset (in-house dataset) and the Bosphorus 3D face dataset. A novel data augmentation using Poisson disk subsampling was implemented to enlarge the dataset. A triplet framework was proposed using the triplet loss function. It learned discriminative facial features on the masked face dataset. The extracted feature embedding was used to calculate distance-based scores representing the similarity among the 3D faces. By implementing the architecture of the PointMLP, PointNet++ as a core feature extractor for the triplet network, a novel triplet PointMLP, PointMLP-Elite, PointMLP-Elite8, PointNetSSG and PointNetSSG-Elite were created to compare with other state of the art. The performance was reported in terms of verification rate, Receiver Operating Characteristics (ROC) curve and inference time using the proposed networks. The highest verification rate model was PointNet++ SSG with 92.7%, the best area under the ROC curve was PointNet++ SSG with 97.4%, and the fastest inference time was PointNet++ SSG Elite with 7 seconds per validation dataset. The study also found that 3D face recognition had higher embedding dimensionality than 2D face recognition. All models were trained using a GTX 1660ti, an Intel 10400 CPU, and 32GB of RAM.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

The outbreak of coronavirus disease 2019, known as COVID-19, has caused a significant impact on the way of life of people around the globe. The unprecedented pandemic scenario in Malaysia, especially considering the unexpected spike in new cases tied to an international mass gathering, urges authorities to manage disease outbreaks effectively. The increased number of new Covid-19 cases resulted in the Movement Control Order (MCO) on 18 March 2020, requiring all businesses to close except those that provide essential services and goods [1]. MCO's abrupt implementation also had a significant impact on the local open markets' food supply chain [2]. In specific markets, it was challenging to practise social distancing. Thus, they were prohibited from opening during the lockdown [2]. Since 27 March 2020, specified places have been subjected to a more stringent order known as the Enhanced Movement Control Order (EMCO) [1]. There was a notable decrease in daily new COVID-19 cases after the MCO concluded that the MCO has been effective if compliance with the MCO is maintained [3]. Since the government mandated the use of face masks and hand sanitisers, enforced social distancing, and then enacted lockdown during MCO, it put a high economic cost on Malaysia of approximately RM2.4 billion[4].

Then, the Ministry of Health (MOH) Malaysia took a series of actions for post-pandemic spread prevention that named standard operating procedures (SOPs) to reopen the economic sector and businesses starting May 4, 2020 [1]. These SOPs include enforcing the appropriate use of face masks in public areas, social distancing in public transport, and allowing sick persons with symptoms to undertake health screening [1]. The government also developed and promoted technology in mobile phone apps to assist in the COVID-19 outbreak management and facilitate contact tracing of people who may become infected individuals, namely the MySejahtera and MyTrace apps [1]. This technology of contact tracing has evolved into a significant part and core activity for mitigating disease spread, resulting in more essential services and goods opening during the lockdown. The government should implement technology to