# System Design of E-verification in Covid-19 using Bluetooth and Face Recognition Technology

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**Abstract**
The recent COVID-19 pandemic has drastically affected the daily lives of the people across the globe, as strategies such as curfew and lockdowns are being adopted to contain the novel coronavirus spread. Monitoring personnel such as police and field officers in implementing lockdowns and curfews are at high risk of contamination, as they come in contact with various individuals in the process of creating awareness, limiting their movement, verification of their details at checkpoints etc. Verification and validation of travel permits of the individual at checkpoints by the police personnel is one of the challenging process, as the risk of contamination is very high. Therefore, there is a need to implement strict procedures and ensure social distancing practices at checkpoints. However, it is essential police personnel may need to come in close contact for verifying the details. Focusing on this issue, this study proposes a smartphone-based technology intervention, which ensures social distancing practices for verification of travel permits at police checkpoints in Saudi Arabia. Allowing Pass Police Check Point Management System (APPCPMS), a smartphone application is proposed in this study, which ensures customized, automated, and highly secured verification at police checkpoints. The proposed system ensures safe and secure travel permit verification at police checkpoints by ensuring the adoption of social distancing measures to prevent the spread of COVID-19 and facilitation of safe and emergency travel during the curfew and lockdown restrictions in Saudi Arabia. Accordingly, this study explains the purpose and design of APPCPMS systems in detail.

## 1. Introduction

Coronaviruses (CoV) are a family of viruses which can cause result in various illnesses in humans. They are highly contagious, and can result in disease called COVID-19. Due to its novel nature, there is a lack of understanding of its symptoms, which are being updated as the research is progressing. Mild symptoms may include common cold, headache, and vomiting; where as severe symptoms may include Severe Acute Respiratory Syndrome (SARS-CoV) and Middle East Respiratory Syndrome (MERS-CoV) [1]. The coronavirus (SARS-CoV) has appeared in china which was transmitted from civet cats to humans in 2002; and MERS-CoV appeared in Saudi Arabia, which was transmitted from camels to humans in 2012 [1]. However, there is no clarity on the novel coronavirus, which appeared at Wuhan city, China in 2019; but it was identified to be highly contagious. Severe cases of Pneumonia with unknown cause in Wuhan city in Hubei province was reported to World Health Organization (WHO) regional office in China on 31st December, 2019. Accordingly, on 7th January 2020, government authorities in China revealed that they have identified a new virus, which can be related to the rising cases of acute pneumonia in Wuhan city, later identified the disease as COVID-19.

### Worldwide

The virus has rapidly spread across the globe since then, which started with Thailand on 23rd January [2]. The Chinese government, locked down the Wuhan city, with 11 million population under quarantine [3]. However, the virus has spread across the world by then, and WHO has reported 71,249 confirmed COVID-19 cases worldwide on 17th February 2020, out of which 70,635 cases were in China, and remaining 794 cases were identified in 25 countries [4]. Considering its severity, many countries implemented different rules to slow down the spread of virus, such as quarantines, closure of educational institutions, and malls, and lockdowns etc. For instance, India implemented full lockdown on 24th March 2020, which is considered to be the largest with 1.3 billion people asked to stay home and follow social distancing and other preventive measures [5].

### Saudi Arabia

The first COVID-19 case in Saudi Arabia was reported on 2nd March 2020, with a Saudi national returning to Saudi Arabia from Iran through Bahrain [6]. Later, Ministry of Health on 22nd March announced 511 COVID-19 possible cases with 119 confirmed COVID-19 cases, among which 40 cases were identified to be resulting from coming in close contact with individuals detected positive for COVID-19. As a result, the government has implemented curfew and asked the people to stay home, with an exception of nearby travel for essential goods and needs [7].

Manuscript received May 5, 2020
Manuscript revised May 20, 2020

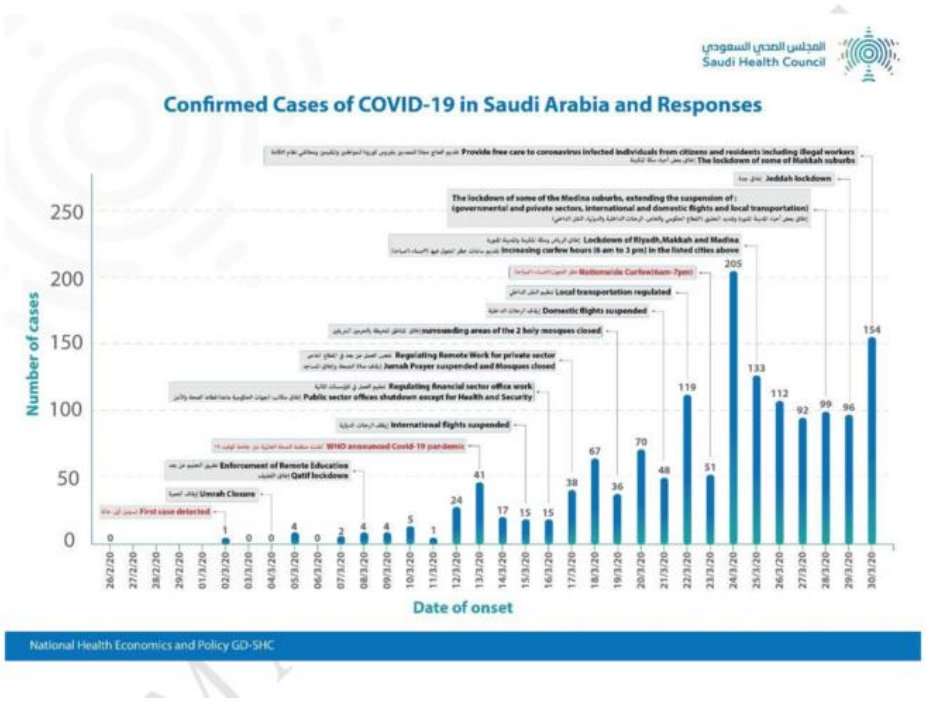


Fig. 1 Conformed cases of coronavirus disease-2019 in Saudi Arabia (adapted from the Saudi Health Council)

Saudi Arabia has implemented various measures to prevent the spread of COVID-19. Operations across government agencies were suspended on 16th March, and all the educational institutions were ordered to shut down and implement remote learning practices through online platforms. In addition, the country has issued a royal decree on 23rd March, limiting movement of individuals between 6 am and 7 pm at two holy mosques, and a curfew was ordered for 21 days [8]. Internal affairs ministry has locked down (24x7) the city of Jeddah on 29th March [5], followed by two holy cities Mecca and Medinah on 2nd April [8]. Accordingly, from 6th April complete lockdown was extended to other major cities including Riyadh, Dammam, Tabuk, Jeddah, Dhahran, Khobar, Hofuf, Al Qatif, and Taif [9]. Inter district travel were restricted and international travel was suspended by cancelling the flights operations, and a complete closure of all entities including mosques, schools, malls, restaurants and others was ordered [10]. In addition, preventive measures such as social distancing, self-quarantine, wearing masks, and washing hands regularly were promoted to prevent the spread of COVID-19.

However, certain exceptions were authorised by allowing travelling with traffic permits for emergency medical services and for procuring essential goods and services. Health sector operations along with media agencies were allowed during the curfew [11]. Police checkpoints were initiated in streets in all the cities to monitor the movement of individuals and ensure the implementation of social distancing and other preventive measures. However, there were some issues identified with operations in police checkpoints, which included:

- fake permits were identified as the permits were given in a paper format
- the verification process was time consuming, as the police need to verify various details, such as citizenship, travel permit, vehicle registration etc.
- high risk of contamination between the travellers and policemen, as the verification process required policemen to come in close contact with travellers for checking the details and documents.
- risk of transmission from travellers to policemen, between travellers, and from policemen to other travellers was very high

## Technology

Mobile technology uses cellular and radio transmission technologies to transfer information between various devices/mobiles. Services such as calls, messaging, GPS (Global Positioning System) for tracking and monitoring, and internet access can be provided through mobile technologies. It uses a single channel of transmission that allows many transmitters to send data at the same time [12]. By ensuring internet access to mobiles, many operations can be simplified and their efficiency and effectiveness can

be improved. For example, traditional paper work, in-person visits for accessing various services can be diverted to online process, where mobile users can process these services on their mobiles. For instance, users can access banking services, e-Health services, and other important services such as paying bills, requesting services etc. using mobile applications. In addition, integration of other technologies such as Wi-Fi capability, Bluetooth etc. can improve the mobile applications operations and usability [12]. For example, Bluetooth enabled devices can be used for connecting diagnosis devices such as blood-sugar monitor or blood pressure monitoring device with mobile phones, using which mobile applications can transmit the diagnosis information to hospitals and care centres. Bluetooth technology can be observed in various aspects of everyday lives, especially for integrating the devices and information transfer over a small area (20 to 60 metres) [14], which uses low-powered, short-range, radio frequencies [13]. Advanced versions such as Bluetooth Smart or BLE (Bluetooth Low Energy) supports a low-power, low-cost, and short-range wireless communication [15,16]. BLE technology can ensure that Bluetooth can be used for longer time, even for a couple of years on a coin cell battery [17]. As a result, it can be used for applications which requires periodic transfers of small data, such as medical, industrial, and consumer applications [17].

### Face Recognition

Face recognition application can be used for identity verification, which may be used to overcome paper-format verification, and ensures no-contact verification process. It is one of the commonly used methods of biometric verification approaches because of its natural and non-invasive methods [18]. Facial recognition technology has been used in various applications, which provides added security layer for identity verification in various industries. In addition, rapid development across technologies has led to the integration of facial recognition technologies in to various systems and devices, and led to the greater users' acceptance of the technology [19]. For example, this technology is being utilised in airports to verify the identity of individuals, track suspects, and for other security purposes [20].

Social networking has been one of the most prominent activities in the past few years. Many individuals are utilizing the online social networking platforms to post their pictures, videos, and other updates. The photos being uploaded can include a set of restrained objects such as faces. Powerful neural network models can be used for analysing the database of varios faces in pictures and can be used for identification of individuals [21]. Advanced techniques such as Machine Learning (ML), Artificial Intelligence (AI), and Deep Learning (DL) have been increasingly used in the recent years in analysis of complex data such as facial recognition to provide effective and accurate results [21]. Introduction of convolutional neural networks (CNNs) for facial features extraction is considered a transformative point when Deep Face was presented in 2014 [22]. However Deep learning models gives a better result than conventional machine learning methods such as Eigenfaces because it's have a good capacity to process large volumes of data [21].

As DL requires high computing efficiency, it may be difficult to apply these technologies in mobile devices with limited memory capacity. Efforts have been put in place to reduce the memory requirements without affecting the performance of these technologies [21]. For example, OpenFace which is modified network model of FaceNet, in which the parameters are reduced [23] so that it can be implemented in mobile devices. OpenFace implements Triplet Loss which arrange input images into triplets and then select certain triplets that falls under the threshold margin [23]. OpenFace uses dlib internally. Dlib is a nice library which is written by C++ program language which could be used for face detection and recognition [14].

Considering these recent developments in the technologies, this study utilises BLE and OpenFace technologies in the proposed APPCPMS system, which ensures facial detection of travellers with permits by policemen by not coming in close contact with the travellers, which can help in practicing social distancing measures.

## 2. Overview APPCPMS System Operation

The aim of the proposed system is to ensure the practice of social distancing measures at police checkpoints, and reduce the need for close contact during verification process of travel permits. Accordingly, the purpose of the system ca be understood from the following points.

- Verification of travel permits without coming in close contact with travellers by policemen
- Verifying if the permits are used for right purposes
- Reducing the dependency on paper-work, and simplifying the process of identity verification

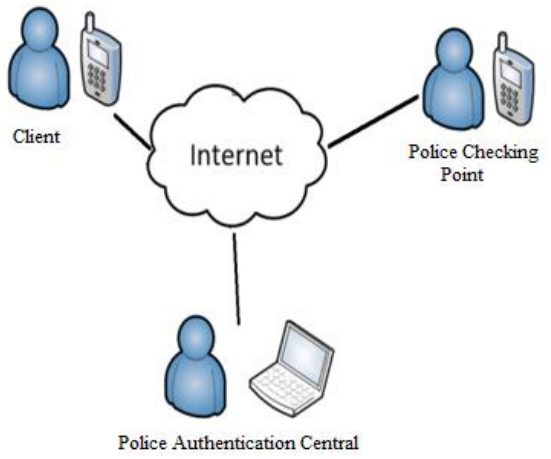


Fig. 2 Propose of APPCPMS system

### Police Authorities Centre

An individual has to submit an online application for police authorities centre for obtaining a travel permit by using the mobile number for online verification process. They need to provide the complete details such as the purpose of travel, travel route or starting point and destination point, and back. Additional details such as vehicle details (Number, capacity), number of persons travelling have to be provided by the clients. Police authorities can verify the individual's details, and has internal verification process to decide whether or not the permit has to be given. Clients information is verified by sending an OTP (One Time Password) to the applicants provided mobile number, which need to be entered by the clients. The OTP is verified by the police authorities, and accordingly, the travel permit can be issued, if internal verification process is completed. Police authorities centre can either accept or reject the application based on their listed rules, and update the information about the clients' request (accept or reject) on APPCPMS system, which will also deliver to clients through SMS on their registered mobiles. This process is demonstrated in Figure 1.

### Clients Module

The clients' registration process into APPCPMS requires basic information such as Saudi-ID, Full name (First, Middle, Last), a face photo and mobile number. The registration has to be approved by the police authorities centre. Once the registration is completed, the clients can request travel permits through online application as explained in the previous section. There are two main operations, which are determined from the client's perspective. Firstly, the client communicates through online application with police authorities centre to request and obtain travel permit. Secondly, the clients communicate with policemen at checkpoints, who verify the identity of clients, the permit is not fake, and ensuring that the travel permit is being used for right purpose, which were allowed.

### Police Check-points Module

At police checkpoints, the policemen verify the travel permit information and also the client's identity by following social distancing measures, i.e. ensuring a distance of at least 1.5 meters from the clients. The operations at police checkpoints can be understood from three aspects. Firstly, the policemen communicates with the client using through Bluetooth enabled mobile devices and verify travel permit details. In this process, the client initially requests communication by using BLE option from APPCPMS system, which needs to be accepted by the policemen by accessing APPCPMS system from their device. Once the connection is established, the policemen receives the details of travel permit. Secondly, the policemen communicate with police authorities centre to verify the travel permit details. Police authorities centre verifies the details and replies to policemen if the travel permit is fake or original. Thirdly, the policemen have to verify if the permit is being used for rightful purpose. They may check the travel routes followed by the clients and verify, if they are moving in accordance with the route details mentioned in the application. Policemen can cancel the permit by communicating with Police authorities centre, if the permit is being misused. If policemen feel there is a need for high-level verification, they may use face recognition technology (OpenFace) by scanning the clients face and compare it with the photo which was submitted in the application. In addition, based on the assessment of clients' needs and emergencies, the travel permits can be updated at checkpoints, and confirm it with police authorities centre, where the details are stored and updated. Accordingly, the log of travel data, historical data of permits can be maintained, which can also help in contact tracing, if a link between COVID-19 spread and the clients is identified.

## 3. Design of APPCPMS system

This section explains the design of APPCPMS system including algorithm and mobile application features and functionalities. System flowchart is presented in figure 3, as it clearly indicates the three processes related to three entities explained in the previous section.

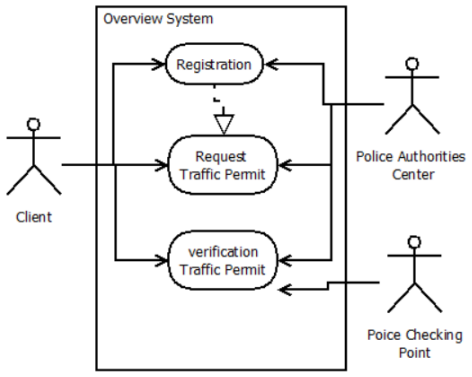


Fig. 3 Overview of APPCPMS system

The input data can be classified in to two types, which includes registration data and travel permit data. The registration data is verified by the polices authorities control according to the procedures established for verifying the identity of a client, and accordingly, the registration can be accepted or rejected. If accepted, the client can apply for travel permit by providing additional details which also includes travel permit data, which will be checked by the police authorities centre and decide if the travel permit has to be allocated to the client or not.

Similarly, the communications between clients, police authorities centre and policemen at checkpoints can be analysed from two perspectives. Firstly, the communication using BLE module between client and policemen at checkpoint, using which policemen can access the travel permit details and verify the permit details using APPCPMS mobile application. BLE module is programmed and calibrated so that mobile application transmits and receives accurate data. In addition, the application is also used for verifying if the permit is being used for the rightful purpose by verifying the travel route details accessed through BLE from clients mobile. Secondly, using OpenFace module which transmits the data between clients, policemen, and police authorities centre for comparing the clients face with the face presented in travel permit at the checkpoints. Initially, the policemen establish communication through OpenFace module which scans the clients face at police checkpoints; and then, the policemen establish communication with police authorities centre for validating the scanned face with the face provided in travel permit. OpenFace module is used for comparing the two faces and based on the comparison output, it can be verified if the person at checkpoint is the same person who applied for travel permit. As a result, misuse of travel permits by other persons can be prevented.

## 4. Discussion

The purpose of this study is to propose a system for verifying the travel permits during the lockdown restriction for preventing the spread of COVID-19, which can ensure the implementation of social distancing policies. In addition, it also ensures implementation of preventive measures by catching the lockdown violators who are purportedly travelling without any need during curfew. Information and communication technologies have been increasingly adopted in the past few years. Accordingly, various technologies are integrated with different platforms and devices for improving the efficiency of operations, the device being aimed at. For example, BL E technology was proved to be effective connection technology, which can last for long hours and can be implemented over a radius of 60 metres. Accordingly, it can be effective for establishing communication between clients and policemen at checkpoints without requiring close contact for communication. Travel permit and identification of travel permit being used for rightful purpose can be verified using BLE technology. In addition, OpenFace module in mobile application is designed to provide high-level verification to ensure the identity of the client by comparing the client's face at checkpoint with the face provided during the application. Using this operational background, the researcher has proposed a design: APPCPMS for reducing the contamination of novel coronavirus at checkpoints during police verification of travel permits.

The design of APPCPMS has three main entities, which include the clients, police checkpoints, and the police authorities centre. This system can benefit clients, policemen, and governments in controlling the spread of COVID-19. In the context of police authorities centre, issues such as fake travelling, illegal transportation, and fake travel during curfew and lockdown restrictions can be monitored and identified. In the context of police checkpoints, the system will ensure the safety of policemen and the clients by allowing the social distancing measures to be followed and restricting close contacts between the clients and policemen. Similarly, from the client's perspective, it ensures safe travel, and reduce the risk of contamination at checkpoints by following social distancing measures, and helps them in accessing emergency services and essential goods and services by ensuring a safe travel.

## 5. Conclusion

The aim of this paper is to propose an effective system for monitoring travel during lockdown restrictions at police checkpoints in Saudi Arabia, ensuring the practice of preventive measures such as social distancing. Adopting the latest technology interventions, BLE and OpenFace

modules were used for enabling no-contact communication through Bluetooth enabled mobile devices for verifying the travel permit details of the clients at checkpoints, and ensuring if the travel permit is being used for rightful purpose, Such practices can enable smooth implementation of social distancing policies and prevent the spread of virus at checkpoints. In addition, OpenFace module can be used for enhanced verification: facial recognition, if the policemen feel that it is essential, which gives an added security layer to prevent the misuse of travel permits. This paper has practical implications, whereby the proposed APPCPMS system can be effectively used at police checkpoints in Saudi Arabia during the curfew, while ensuring the safety and preventive procedures are fully. implemented.

## References


[1] Ministry of health. (n.d). Novel Coronavirus (COVID-19). Retrieved from https://www.moh.gov.sa/en/HealthAwareness/EducationalContent/PublicHealth/Pages/corona.aspx.

[2] world health organization. (April, 2020). WHO Timeline - COVID-19, Retrieved from https://www.who.int/news-room/detail/27-04-2020-who-timeline---covid-19.

[3] Secon, H., Woodward, A., & Mosher, D. (May 4, 2020). A comprehensive timeline of the new coronavirus pandemic, from China's first COVID-19 case to the present. Retrieved from https://www.businessinsider.com/coronavirus-pandemic-timeline-history-major-events-2020-3.

[4] world health organization. (April, 2020). Coronavirus disease 2019 (COVID-19) Situation Report –28. Retrieved from https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200217-sitrep-28-covid-19.pdf?sfvrsn=a19cf2ad_2.

[5] Kaplan, J., Frias, L., & McFall-Johnsen, M. (April,2020). Countries around the world are reopening — here's our constantly updated list of how they're doing it and who remains under lockdown. Retrieved from https://www.businessinsider.com/countries-on-lockdown-coronavirus-italy-2020-3#china-implemented-what-was-then-the-largest-quarantine-in-human-history-to-try-to-contain-the-coronavirus-locking-down-at-least-16-cities-at-the-end-of-january-the-lockdown-on-wuhan-ended-on-april-8-19.

[6] Khalid, T. (March, 2020). Saudi Arabia reports first coronavirus case, a Saudi national coming from Iran. Retrieved from https://english.alarabiya.net/en/News/gulf/2020/03/02/ Saudi-Arabia-reports-first-coronavirus-case-state-media.

[7] MOH News. (march2, 2020). COVID-19 Follow-up Committee Calls on Public to Stay Home. Retrieved from https://www.moh.gov.sa/en/Ministry/MediaCenter/News/Pages/News-2020-03-22-001.aspx.

[8] saudi gazette. (march23, 2020). King Salman orders partial curfew for 21 days. Retrieved from https://saudigazette.com.sa/article/591136/SAUDI-ARABIA/King-Salman-orders-partial-curfew-for-21-days.

[9] Nereim, V. (April 6,2002). Saudi Arabia Puts 24-Hour Lockdown on Big Cities to Curb Virus. Retrieved from https://www.bloomberg.com/news/articles/2020-04-06/saudi-arabia-puts-24-hour-lockdown-on-big-cities-to-curb-virus.

[10] Bhatia, N. (march 29, 2020). Closures extended to curb Covid-19 in region. Retrieved from https://www.meed.com/closures-extended-to-curb-covid-19-in-mena.

[11] saudi24 (April,2020). Saudi Arabia: Continuing the activities exempted from the curfew. Retrieved from https://www.saudi24.news/2020/04/saudi-arabia-continuing-the-activities-exempted-from-the-curfew-3.html.

[12] Macwan, U. (April, 2017). Mobile Technology, Its Importance, Present And Future Trends. Digital Marketing Expert at Hyperlink Infosystem. Retrieved from https://www.finextra.com/ blogposting/14000/mobile-technology-its-importance-present-and-future-trends.

[13] Karty, S. (2000). Bluetooth Personal Area Network Technology. Office of the Manager National Communications System Techinical Notes, 7.

[14] Pretorius, D., Jeong, J., & Kanvinde, N. (n.d). Fixed- Mobile Convergence in the UK.

[15] Bluetooth Smart. (n.d.). bluetooth-technology-basics. Retrieved from https://www.bluetooth.com/what-is-blue-tooth-technology/bluetooth-technology-basics/low-energy.

[16] C.Gomez,J.Oller,andJ.Paradells,"Overviewandevaluationof bluetooth low energy: an emerging low-power wirelesstechnology,"Sensors,vol.12,no.9,pp.11734–11753,2012.

[17] Paek, J., Ko, J., & Shin, H. (2016). A measurement study of BLE iBeacon and geometric adjustment scheme for indoor location-based mobile applications. Mobile Information Systems, 2016.

[18] Ben Aoun N, Mejdoub M, Ben Amar C. Graph-based approach for human action recognition using spatio-temporal features. J Vis Commun Image Represent. 2014;25(2):329–38.

[19] Ríos-Sánchez, B., Costa-da-Silva, D., Martín-Yuste, N., & Sánchez-Ávila, C. (2019). Deep Learning for Facial Recognition on Single Sample per Person Scenarios with Varied Capturing Conditions. Applied Sciences, 9(24), 5474.

[20] Heitmeyer R. Biometric Identification Promises Fast and Secure Processing of Airline Passengers. Int Civ Aviat Organ. 2000;55.

[21] Santoso, K., & Kusuma, G. P. (2018). Face recognition using modified OpenFace. Procedia Computer Science, 135, 510-517.

[22] Taigman, Y.; Yang, M.; Ranzato, M.; Wolf, L. DeepFace: Closing the Gap to Human-Level Performance in Face Verification. In Proceedings of the 2014 IEEE Conference on Computer Vision and Pattern Recognition, Columbus, OH, USA, 23–28 June 2014; pp. 1701–1708.

[23] Schroff F, Kalenichenko D, Philbin J. FaceNet: A unified embedding for face recognition and clustering. In: Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition. 2015.