An Active Security System Based on AR Smart Classes and Face Recognition Technology

Charles Chen[1], Xiao-Yan Wang[1], Jian Chen[1], Qin Liu[1], Sheng-Lung Peng[2*]

[1] School of Computer Science and Engineering, Minnan Normal University, China
[2] Department of Creative Technologies and Product Design, National Taipei University of Business, Taiwan
charles.chen@mnnu.edu.cn, 1401279303@qq.com, 942258622@qq.com, 1649799152@qq.com, slpeng@ntub.edu.tw

Abstract

How to effectively apply AR (Augmented Reality) new technology to create better safety environment for society and enterprises is the concern of many government and enterprise leaders. This research combines AR smart glasses, multi face recognition technology and control system technology to develop a face recognition active security platform which can effectively improve the arrest of criminals and establish a safer social environment.

Keywords: Augumented reality, Face recognition, Active security

1 Introduction

Our research has developed a new type of intelligent active security system by combining AR smart glasses、face recognition technology and control system technology. Its purpose is to help patrol police to move effectively in the crowd, who can quickly identify fugitives or suspects at a glance and arrest them immediately, without carrying information or photos. Or assist the factory or building security patrol personnel to immediately determine whether there are strangers breaking in at will, and then drive them away immediately to reduce the loss of life and property. Figure 1 is the architecture of proposed system.

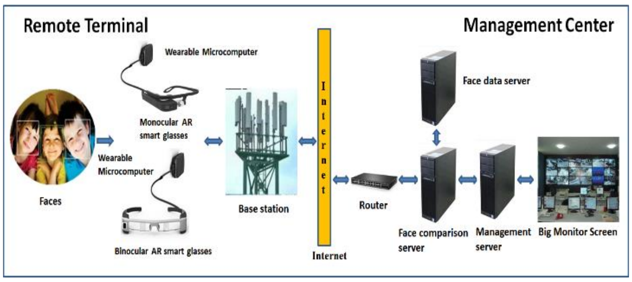

Figure 1. Proposed system architecture

Through the camera on the AR smart glasses, the video of the personnel is transmitted to the wearable microcomputer connected with the smart glasses. The video analysis program on the microcomputer will analyze the transmitted video information, first locate the face, then extract the facial feature value, and compare with local top 10 critical criminal database data. If the comparison is matched, an alarm message will display on the AR smart glass, and patrol police can arrest the critical criminal right away. Otherwise, the extracted facial feature will transmit to the remote management center through the wireless device on the wearable microcomputer (such as 4G/5G SIM card). After comparing with blacklist database data, if matched, an alarm message will send back to wearable microcomputer and display on the AR smart glasses. Then patrol police can take arrest action.

Quick and effective tracking and arresting of fugitives or suspects can exert pressure on criminals' fluke mentality, thus reducing the social crime rate, reducing the social cost of building prisons and increasing police force. A low crime rate, safe and stable development of the social environment, can attract overseas capital and enterprise investment, and talent migration, which is very helpful to the national economy and social development. This is the significance and contribution of this paper.

The structure of this paper is scheduled as follows. Section 2 describes the related works. Section 3 is the research method. Section 4 is the experiemny result and section 5 is the conclusion.

2 Related Work

2.1 AR/VR Technology

In the 1950s and 1960s, Morton Heilig, a philosopher, filmmaker and inventor, invented a Sensorama simulator which is the origin of AR/VR. Sensorrama simulator can use images, sound, fragrance and vibration to let users feel the scene of riding a motorcycle on the streets of Brooklyn, New York. This was an advanced invention at that time. Since then, AR started its development history. Among the most widely accepted definitions, researcher Ron Azuma said that augmented reality (AR) has three key requirements [1]:

(1) It combines real and virtual content
(2) Real time interaction
(3) Register in 3D

Above three characteristics define the technical requirements of AR system. That is, it must have a display that can combine real and virtual images, a computer system that can generate interactive graphics and make real-time response to user input, and a computer system that can determine the user's viewpoint position and make the virtual image display in the real world. Generally speaking, the key of AR technology lies in the perception and understanding of the device to the surrounding environment: the most basic is to

*Corresponding Author: Sheng-Lung Peng; E-mail: slpeng@ntub.edu.tw
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determine the spatial location of the device itself; the more advanced is to reconstruct the environment in real time (Simultaneous Localization and Map Building, SLAM); the more advanced is related to recognition, cognition and interaction [2].

From the perspective of user experience, AR development mainly includes the following four aspects:

(1) From content display to content interaction. Now more and more AR applications begin to transition from display experience to interactive experience. AR is no longer a simple model presentation, but gradually evolving to an interactive system. This trend, especially in AR games, is well reflected.

(2) From entertainment application to practical function. With the deepening of users' awareness of AR, AR applications with entertainment display cannot meet the needs of users. Taking mobile AR products as an example, most of the applications on the market are model display, scene interaction, games, etc. But now, AR real measurement, AR furniture placement, AR real translation, AR navigation, AR remote guidance machine maintenance, AR telemedicine consultation and other functional products are gradually emerging. This kind of functional AR application will become a trend, will become more and more, solve the main point of every aspect of users' daily life.

(3) From single person experience to multi person interaction. AR content experience with a single capability is only an intermediate state under the current technical background. The ideal AR is to build a copy of the real physical world and realize digital AR cloud content sharing, continuous experience and multi person interaction. At present, there are many technical reserves, which can realize multi person interactive experience, including the collaborative technology of ARKit [3] and the cloud anchors capability of ARCore [4].

(4) From camera enhancement to environment enhancement. With the development of SLAM, image recognition and tracking technology, AR based on real environment perception will further realize the matching between virtual information and real physical world, realize environment understanding, realize virtual and real occlusion, and present the corresponding AR information in the appropriate location.

2.2 Face Recognition Technology

Human biological characteristics can be generally divided into three categories: physiological characteristics, behavioral characteristics and autonomous/instinctive characteristics [5].

(1) Physiological modality: refers to the inherent external features not controlled by the brain, such as fingerprint, palmprint, face, retina, iris, etc.
(2) Behavior modality: it refers to the behavior characteristics formed in long-term training and displayed under the control of the brain, such as voice, handwritten signature, etc.
(3) Autonomous/instinctive modality: it is an inborn instinctive trait, which can be affected by psychological emotions, such as heartbeat. It can be known by ECG measurement.

Compared with other biometric recognition technologies, face recognition technology has the advantages of low matching degree, low cost, no contact, wide application and high recognition rate. It is also suitable for remote identity verification and easy to use. It is the best choice for suspect identity verification application. It not only relieves the working pressure of the staff, but also provides a convenient and secure environment for the identification information verification. It is a comprehensive biometric identity authentication system. Table 1 is the comparison table of biometric recognition technology, which shows the advantages and disadvantages of each technology.

Table 1. Comparison table of biometric technology

Recognition technology	FAR	FRR	Ease of use	Processing speed /person	Evaluation
Face recognition	Low	<0.2%	Very Good	<1 second	The best biometric technology
fingerprint identification	Very low	5%	Good	<2 second	Better biometric technology, but easy to copy
Palmprint recognition	Low	5%	Difficult to use	2~12 second	Easy to infect bacteria, difficult to sample, expensive equipment
Pupil scanning	Very low	10%	Need training, difficulty operate	Instrument alignment takes 3-5 seconds	Instrument alignment is expensive, and manual operation is complex
Voice recognition	Common	medium	medium	3 second	Could be spoofed by tape

In the process of face recognition, there are mainly the following parts [4]:

(1) Face image acquisition: input face image or video stream.
(2) Face detection and location: that is to judge whether there are faces in the input image, and if so, give the location and size of each face [6-14].
(3) Preprocessing: to remove unnecessary noise.
(4) Facial feature extraction: to detect the location and shape of the main organs of each face.
(5) Identity confirmation and identity search: finally, the face is compared, and the identity information of the face is determined by comparing with the face in the database according to the result of facial feature location.

Figure 2 is the pipeline of a typical automated face recognition system summarized by Guo & Zhang [15].

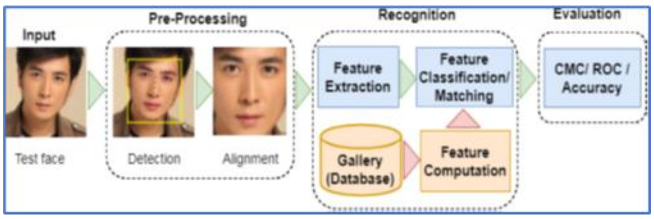

Figure 2. The pipeline of a typical automated face recognition system

The recognition ability of the algorithm mainly uses the false rejection rate (FRR) and false acceptance rate (FAR) as the indicators to evaluate the system performance. False rejection refers to rejecting a real face as a forged face, while false acceptance refers to receiving a forged face as a real face. The two corresponding error rates are defined as follows:

$$FRR = \frac{\text{number of false rejected genuine faces}}{\text{total number of genuine faces}}$$

$$FAR = \frac{\text{number of false accepted forgry faces}}{\text{total number of forgery faces}}$$

In the process of face detection and location, since a person is mobile, the first step is to detect a face and continuously track the person. There are many algorithms and technologies for moving object tracking (as shown in Figure 3). Regarding the aspect of tracking model classification, it can generally be divided into two categories: generative and discriminative [16]. At present, the more popular method is discriminant method, also known as detection tracking by detection. Generative method: the target region is modeled in the current frame, and the similarity between the next frame and the model is measured. The well-known generative methods include optical flow method [17]、Karl particle filter [18]、mean shift [19] and so on. The representative tracking algorithm is ASMS (adaptive scale meanshift) [20]. Discriminant method: using image features and machine learning, in the current frame, with the target region as the positive sample and the background region as the negative sample, and the machine learning method trains the classifier. In the next frame, the trained classifier is used to find the optimal region. The classical discriminant methods, such as SVM (Support Vector Machine) [21]、Struck [22] and TLD (tracking learning detection) [23], have good real-time performance. Guo et al. [24] proposed a practical facial landmark detector, denoted as PFLD, with high accuracy against complex situations including unconstrained poses, expressions, lightings, and occlusions. Liu et al. [25] based on Restricted Boltzmann Machine (RBM) to present a robust facial landmark detection method for image with occlusions. Li et al. [26] proposed a multiple task-driven cascade detection networks based on super-resolution Pyramid, to effectively tackle low-resolution faces under the lens; faces from blur, illumination, scale, pose, expression and occlusion during face detection.

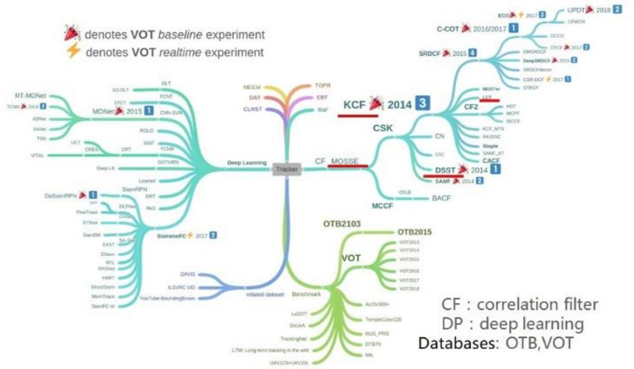

Figure 3. A collection of target tracking algorithms

In the face recognition (comparison), algorithms are classified as follows [27]:

(1) Feature-based recognition algorithms.
(2) Appearance-based recognition algorithms.
(3) Template-based recognition algorithms.
(4) Recognition algorithms using neural network.

There are already a lot of research on the face recognition algorithms such as Liu et al. [27] use weighted kernel sparse representation. Chen et al. [28] propose an improved Random Subspace Linear Discriminant Analysis (SRS-LDA) method to solve makeup face recognition problem. Chen et al. [29] add an adaptive noise dictionary (AND) to the training samples and then use linear regression to do the face recognition. Dai et al. [30] use Bayesian hashing approach to do face recognition. Huang et al. [31] use exponential discriminant locality preserving projection to do the face recognition. Ji et al. [32] use collaborative probabilistic labels for face recognition. Jing et al. [33] use multi-spectral low-rank structured dictionary learning for face recognition. Blauch et al. [34] use face recognition deep convolutional neural networks (DCNNs) that are trained to maximize recognition of the trained (familiar) identities, to model human unfamiliar and familiar face recognition. Zaman [35] use the locally lateral manifolds of normalized Gabor features to do the face recognition. Ríos-Sánchez et al. [36] use deep learning method to do the face recognition. Liu et al. [37] design a multi feature Echo State Network (ESN) fusion method for face recognition. In their method, three invariant features are selected as the basis for face recognition, including Histogram of Oriented Gridients (HOG) features, Local Binary Patterns (LBP) features and Visual Pattern Recognition by Moment Invariants (Hu). These three kinds of features basically cover the illumination, texture, shape and other properties of face images. In order to effectively prevent the spread of COVID-19 virus, almost everyone wears a mask during coronavirus epidemic. Wang et al. [38] proposed a face-eye-based multi-granularity model and three types of masked face datasets, including Masked Face Detection Dataset (MFDD), Real-world Masked Face Recognition Dataset (RMFRD) and Simulated Masked Face Recognition Dataset (SMFRD) to improve currently regular facial recognition technology.

2.3 Control System Technology

The control system based on video monitoring technology is mainly composed of camera part, image transmission part, system control part and display recording part, which is applied in many social places. Through the control operation of the camera host, the images captured by the camera are collected and sorted, and the images are input, stored and played back through a specific processing mode. The following is a brief introduction to the development of video control system.

The first generation of control system, using analog video monitoring technology, also known as closed-circuit television monitoring system, referred to as CCTV. Typical analog video monitoring system generally consists of four parts: image camera part (camera, lens, PTZ, microphone, etc.), image transmission part (cable, optical cable, RF, etc.), system control part (operation keyboard, video distributor, video matrix switcher, PTZ control decoder, character superimposer, etc.) and display recording part. Due to the storage of VCR tape, the capacity is very limited. Therefore, VCR needs to replace the tape frequently to achieve long-term storage, and the degree of automation is very low.

The second generation of control system adopts digital video monitoring technology. With the development of computer technology 、 network technology 、 storage technology and chip technology, the improvement of image data compression coding technology and standards, the continuous decline of chip cost, digital video monitoring system also develops rapidly. The landmark product of the era of digital video monitoring system is hard disk video recorder, referred to as DVR (digital video recorder)。 The essence of hard disk video recorder is a computer system which integrates audio and video coding and compression 、 network transmission、video storage、remote control、decoding display and other functions. Its main components are video capture card、 coding and compression program、storage device、 network interface and software system. In addition to all the functions of the traditional CCTV monitoring system, the digital video monitoring system also has the functions of remote video transmission and playback、automatic detection and alarm、structured video data storage and so on. Digital video signal has the characteristics of high spectral efficiency、strong anti-interference ability、less distortion and so on.

The third generation of control system adopts intelligent network video monitoring technology. The main components of intelligent network video monitoring system are network camera (IPC)、video encoder (DVS)、network video recorder (NVR) 、 video content analysis unit (VCA) 、 central management platform (CMS)、decoder, storage device, etc. The intelligent network video monitoring system adopts a fully distributed architecture. The system is set up on the network and is not limited by geographical space. The use of intelligent management software can realize the management、integration、configuration、transmission、call、storage、alarm、integration of video resources.

Finally, in recent years, the video control system combined with streaming media service technology [39] and wireless remote video technology have made important breakthroughs. It makes wireless IP cameras widely be used in public places and makes outstanding contributions to curb crime、provide evidence and protect people's property.

3 Research Methods

In order to quickly develope our system, the face detection and recognition program are based on the face recognition module of ArcSoft. This model using deep learning method, is facenet series, belonging to CNN (Convolutional Neural Network). Through a large amount of data as the model training support, the model accuracy has been optimized. In addition, the SDK of ArcSoft also supports 1:1 and 1:n face recognition and Android arm64 architecture. It has the functions of face detection, face comparison, witness comparison, face tracking and so on.

Our program uses Json format to exchange data between AR smart glasses and backend system via HTTP protocol. For the management and test purpose, we also develop a simple beckend system to manage AR smart glasses、top 10 criminal database 、 blacklisted person database and blacklist comparison program. All of the programs are coded by Java via IntelliJ IDEA tools. Face recognition technology mainly includes the following aspects: Figure 4 shows the process of face registration and recognition.

(1) Face detection: find the face area in the input image.
(2) Face normalization (preprocessing): correction of face changes in scale, illumination and rotation.
(3) Feature extraction: extract a set of numerical representation samples from face images, which can reflect the face features.
(4) Feature matching: comparing with the known face in the database to get the face recognition result.

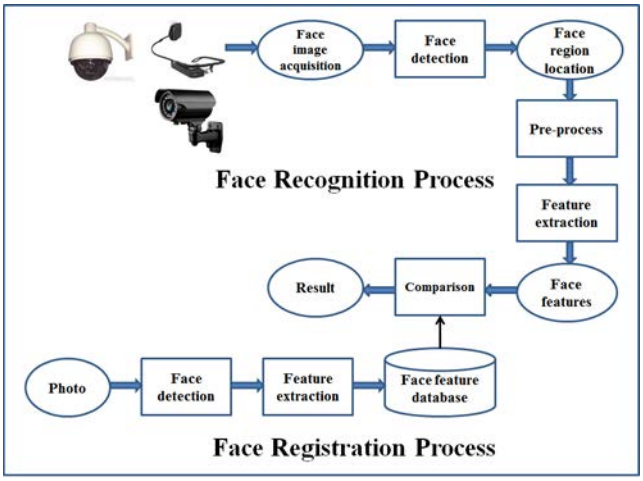

Figure 4. Face registration and recognition process flow

This research plan and implementation process can be divided into the following parts.

3.1 AR Smart Glasses Site

Automatically request and update the latest top 10 criminal information from backend server every time when start up. Figure 5 is part of the source code.

```
new Thread(new Runnable() {
    @Override
    public void run() {
        Response response =
OkHttpUtil.getInstance().getData(reqUrl+"?mac=abc-efg-hij");
        try {
            FaceUserInfo faceUserInfo= new FaceUserInfo();
            File featureDir = new File(ROOT_PATH + File.separator +
SAVE_FEATURE_DIR);
            Gson gson =new Gson();
            String body =response.body().string();
            List<FaceUserInfo> faceList= gson.fromJson(body, new
TypeToken<List<FaceUserInfo>>() {}.getType());
            for(FaceUserInfo faceInfo:faceList){
                FileOutputStream fosFeature = new
FileOutputStream(featureDir + File.separator + faceInfo.getName());
                fosFeature.write(faceInfo.getFaceFeature());
                fosFeature.close();
            }
        } catch (Exception e) {
            e.printStackTrace();
        }
    }
}).start();
```

Figure 5. Source code of updating top 10 criminal database

Figure 6 is the source code of comparative analysis of facial features.

```
new Thread(new Runnable() {
            @Override
            public void run() {
               FaceUserInfo faceInfo = new FaceUserInfo();
               //facename+_+crimetype
               faceInfo.setName(compareResult.getUserName());
               faceInfo.setFaceFeature(frFace.getFeatureData());
               faceInfo.setSimilarValue((int)compareResult.getSimilar()
);
               ResultJson resultJson = new ResultJson();
               resultJson.setSuccess(true);
               resultJson.setMsg(faceInfo);
               Gson gson = new Gson();
               String info =gson.toJson(resultJson);
               try {
                  String response =
OkHttpUtil.getInstance().postJson(reqUrl,info);
               } catch (IOException e) {
                  e.printStackTrace();
               }
            }
         }).start();
```

Figure 6. Source code of facial features comparison

3.2 Backend Site

Build face recognition control system, including building test face database, developing face comparison program and video playback management program. The face matching program compares the face feature data from the front-end with the face database. If it is found that the face recognition reaches the threshold value (which can be set manually) and is a blacklisted person, the system immediately transmits the face related data (such as name, age, gender...) to the wearable microcomputer, and displays it on the display screen of AR smart glasses to instruct the patrol officers to arrest the suspect. At the same time, it will also be sent to the management server to display the face and related information (such as name, age, gender, etc.) on the big screen of the monitoring management center. Figure 7 is the expected example of remote monitoring center.

Figure 7. Expected example of remote monitoring center

In this paper, we will develop a simple beckend system to manage and test AR smart glasses. Figure 8 is the source code of AR smart glasses regerstration. Figure 9 is the source code of face comparison in backend site for blacklist. Figure 10 is the source code of getting face information from AR smart glasses. Figure 11 is the source code of adding criminal information.

```
/***
 *
 * @param device AR Smart Glasses Information
 * @param attributes
 * @return
 */
@PostMapping("/device")
public String addDevice(Device device,
                        RedirectAttributes attributes){
    Integer status = deviceMapper.addDevice(device);
    if (status==1){
        attributes.addFlashAttribute("message","AR Glasses add successful");
    }else{
        attributes.addFlashAttribute("message"," AR Glasses add failed ");
    }
    return "redirect:/";
}
```

Figure 8. Source code of AR smart glasses regerstration

```
@PostMapping("/search")
@ResponseBody
public String json_post(@RequestBody String info){
    System.out.println(info);
    //Android equipment returned faceUserInfo
    Gson gson = new Gson();
    ResultJson resultJson = gson.fromJson(info, ResultJson.class);
    FaceUserInfo faceUserInfo =(FaceUserInfo) resultJson.getMsg();
    System.out.println("face features"+faceUserInfo.getFaceFeature());

    List<CrimeFaceInfo> crimeFaceList =
faceMapper.getCrimeFaceInfoByFaceName(faceUserInfo.getName().split("_")[0])
    //Json sending to management UI crimeFaceInfo
    CrimeFaceInfo crimeFaceInfo = new CrimeFaceInfo();
    if (crimeFaceList.size()==1){
        crimeFaceInfo =crimeFaceList.get(0);
    }else{
        //Prevent duplicate naming, compare feature
        for(CrimeFaceInfo faceInfo:crimeFaceList){

if(Arrays.equals(faceInfo.getFacefeature(),faceUserInfo.getFaceFeature())){
                crimeFaceInfo = faceInfo;
                break;
            }
        }
    }
    System.out.println(crimeFaceInfo);
    crimeFaceInfo.setFacefeature(null);
    //set createtime as current time
    crimeFaceInfo.setCreatetime(new Date());
    recodeFace.add(crimeFaceInfo);
    String crimeJson=new Gson().toJson(crimeFaceInfo);
    sendQueueMessage(crimeJson);
    return "success";
}
```

Figure 9. Source code of face comparison in backend site

```
/****
 * Get face information from AR smart glasses
 * @param mac
 * @return
 * @throws IOException
 */
@RequestMapping("/crimeJson")
@ResponseBody
public String pullFacesInfo(@RequestParam("mac") String mac) throws
IOException {
    System.out.println(mac);
    boolean flag=false;
    List<Device> allDevice = deviceMapper.findAllDevice();
    for (Device device : allDevice) {
        if(device.getMac().equals(mac)){
            flag=true;
            System.out.println("Mac address matched");
            break;
        }
    }
    if (flag==false){
        System.out.println("Illegal request");
        return "error";
    }

    List<CrimeFaceInfo> crimeList = faceMapper.findUserFaceInfoList();
    ArrayList<FaceUserInfo> faceUserInfoList = new ArrayList<>();
    for(CrimeFaceInfo crime:crimeList){
        FaceUserInfo faceUserInfo = new FaceUserInfo();

faceUserInfo.setName(crime.getFacename()+"_"+crime.getCrimetype());
        faceUserInfo.setFaceFeature(crime.getFacefeature());
        faceUserInfoList.add(faceUserInfo);
    }
    Gson gson = new Gson();
    return    gson.toJson(faceUserInfoList);
}
```

Figure 10. Source code of getting face information from AR smart glasses

```
/****
 * add criminal information
 * @param crimeFaceInfo
 * @param file
 * @param attributes
 * @return
 * @throws IOException
 * @throws InterruptedException
 */
@PostMapping("/crime")
public String addCriime(CrimeFaceInfo crimeFaceInfo,
                        @Param("file")MultipartFile file,
                        RedirectAttributes attributes) throws IOException,
InterruptedException {
    System.out.println(crimeFaceInfo);
    String fileName =file.getOriginalFilename();//xxx-criminal.jpg
    String suffix =fileName.substring(fileName.lastIndexOf("."));//.jpg
    String newFileName =
crimeFaceInfo.getFacename()+"_"+crimeFaceInfo.getCrimetype()+suffix;//xxx_Criminal.jpg
    BASE64Encoder encoder = new BASE64Encoder();
    // Using base64 to convert picture
    String data = encoder.encode(file.getBytes());
    byte[] decode = Base64.decode(base64Process(data));
    /* Save to local file path D:\A_IDEA_data\crimePic */
    String absolutePath=abo_path+ File.separator+newFileName;
    File pic = new File(absolutePath);
    FileOutputStream fos = new FileOutputStream(pic);
    fos.write(decode);
    fos.close();
    System.out.println("Successfully save to local database");
    ImageInfo imageInfo = ImageFactory.getRGBData(decode);
    //Get face features
    byte[] bytes = faceEngineService.extractFaceFeature(imageInfo);
    String relativePath =rela_path+File.separator+newFileName;

    /***
     * Add crimeFaceInfo
     */
    crimeFaceInfo.setImgpath(relativePath);
    crimeFaceInfo.setFaceid(RandomUtil.randomString(10));
    crimeFaceInfo.setFacefeature(bytes);
    Integer status = userFaceInfoService.insertSelective(crimeFaceInfo);
    if (status==1){
        attributes.addFlashAttribute("message","Criminal added-Successful");
```

Figure 11. Source code of adding criminal information

4 Experiment Result

4.1 AR Smart Glasses Site

Following pictures are the UI functions of AR smart glasses.

(1) Face registration system login UI (Figure 12)

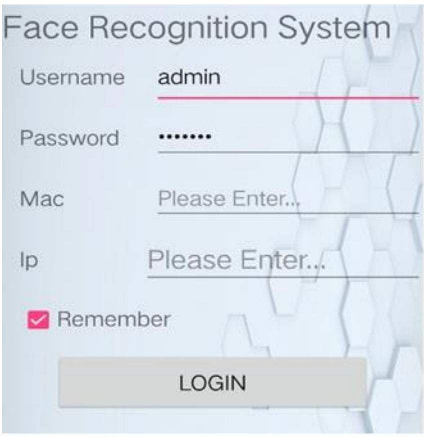

Figure 12. Login UI

(2) Start face detection and recognition (Figure 13)

Figure 13. Face system start UI

(3) Result and warning message UI (Figure 14)

Figure 14. Result & warning message UI

4.2. Backend Site

Following pictures are the UI function of backend management system.

(1) Upload management of criminal information (See Figure 15)

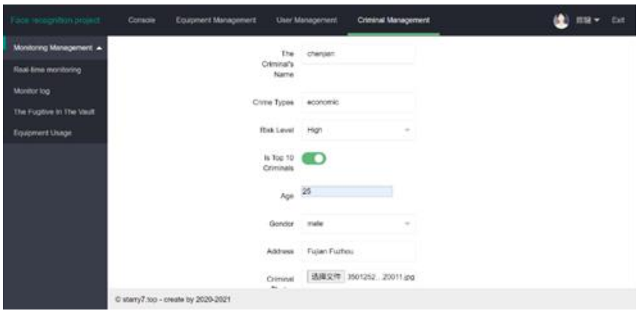

Figure 15. Criminal information upload function

(2) Device registration (See Figure 16)

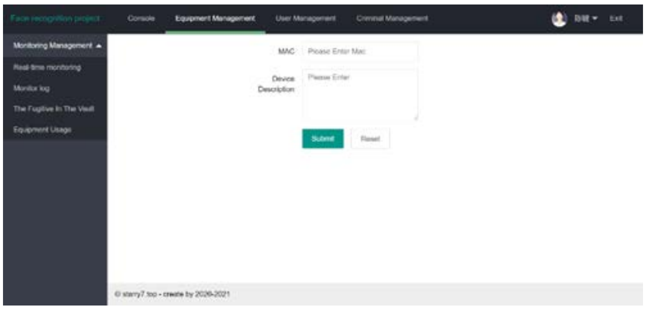

Figure 16. Device registration

(3) User information management (See Figure 17)

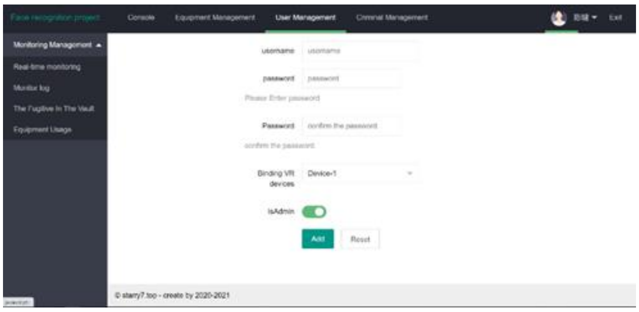

Figure 17. User information management

(4) Real time monitoring (see Figure 18)

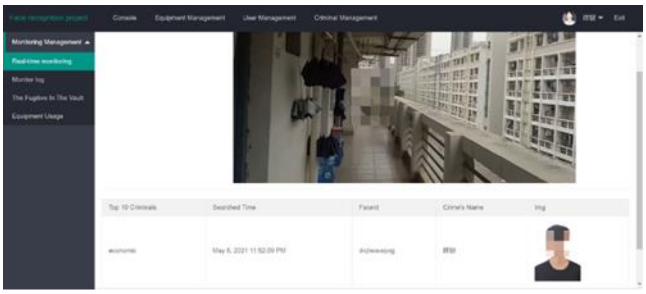

Figure 18. Real time monitoring

(5) Monitoring log (Figure 19)

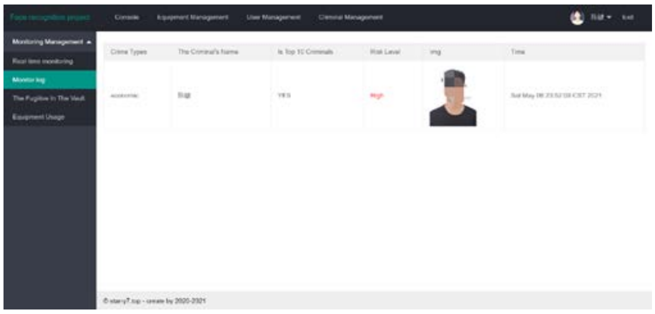

Figure 19. Monitoring log UI

5 Conclusion

The feature of this paper is to develop multi face tracking and recognition technology based on AR smart glasses and face recognition technology. At present, the public security control system for face recognition application on the market is generally based on camera, which only processes one face at a time, and adds a processing box at the front end, which is only responsible for video processing, analysis, capturing face photos, and then throws the photos to the background comparison server for centralized comparison. Our research uses AR smart glasses instead of camera, which is more mobile and initiative. In addition, on the front-end wearable microcomputer, video processing, analysis, capturing face photos and extracting face feature values are carried out. Then the face feature values are compared with local top 10 criminal database or thrown to the background comparison server for blacklists comparison, which can reduce the current network burden. Finally, this study takes one capture of multiple faces, which can identify multiple face blacklists at the same time and improve the capture rate of criminals. These are the characteristics and innovations of this research. The developed technology of this research can be applied to

(1) Traffic management: assist the traffic police to identify and confirm the driver's identity information, and form a joint force with vehicle identification, license plate recognition and other technical means;

(2) Identification and pursuit of street fugitives or suspects: assist patrol police to identify fugitives or suspects at a glance and arrest them immediately without carrying paper or electronic photos;

(3) Factory or building inspection: assist the factory or building security personnel to determine whether there are strange or irrelevant personnel crossing, breaking in and wandering at will, and then drive them away immediately to reduce the loss of life and property and establish new security applications;

(4) Driving school test: confirm the examinee's identity in the subject test, and put an end to the situation of impersonation.

In addition to the technology research and development for AR application, some researcher also do the qualitative research for the application of AR technology such as Rauschnabel et al. [40] who present and empirically test a framework that theorizes how consumers perceive and evaluate the benefits and augmentation quality of AR apps, and how this evaluation drives subsequent changes in brand attitude.

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References

[1] R. T. Azuma, A Survey of Augmented Reality, *Presence: Teleoperators and Virtual Environments*, Vol. 6, No. 4, pp. 355-385, August, 1997.

[2] M. Billinghurst, A. Clark, G. Lee, A Survey of Augmented Reality, *Foundations and Trends in Human-Computer Interaction*, Vol. 8, No. 2-3, pp. 73-272, 2014.

[3] U. Dilek, M. Erol, Detecting position using ARKit, *Physics Education*, Vol. 53, No. 2, pp. 1-4, January, 2018.

[4] X. Zhang, X. Yao, Y. Zhu, F. Hu, An ARCore Based User Centric Assistive Navigation System for Visually Impaired People, *Applied Sciences*, Vol. 9, No. 5, pp. 1-15, March, 2019.

[5] K. K. Tseng, D. Lee, C. Chen, ECG Identification System Using Neural Network with Global and Local Features, *Proceedings of Internet Technology & Society 2016 (ITS 2016)*, Melbourne, Australia, 2016, pp. 3-10.

[6] X. Sun, P. Wu, S. C. H. Hoi, Face detection using deep learning: An improved faster RCNN approach, *Neurocomputing*, Vol. 299, pp. 42-50, July, 2018.

[7] S. Wu, M. Kan, Z. He, S. Shan, X. Chen, Funnel-structured cascade for multi-view face detection with alignment-awareness, *Neurocomputing*, Vol. 221, pp. 138-145, January, 2017.

[8] W. T. Chu, W. W. Li, Manga face detection based on deep neural networks fusing global and local information, *Pattern Recognition*, Vol. 86, pp. 62-72, February, 2019.

[9] J. Yan, X. Zhang, Z. Lei, S. Li, Face detection by structural models, *Image and Vision Computing*, Vol. 32, pp. 790-799, October, 2014.

[10] D. Zeng, F. Zhao, S. Ge, W. Shen, Fast cascade face detection with pyramid network, *Pattern Recognition Letters*, Vol. 119, pp. 180-186, March, 2019.

[11] U. Mahbub, S. Sarkar, R. Chellappa, Partial face detection in the mobile domain, *Image and Vision Computing*, Vol. 82, pp. 1-17, February, 2019.

[12] D. Triantafyllidou, P. Nousi, A. Tefas, Fast Deep Convolutional Face Detection in the Wild Exploiting Hard Sample Mining, *Big Data Research*, Vol. 11, pp. 65-76, March, 2018.

[13] S. Kang, B. Choi, D. Jo, Faces detection method based on skin color modeling, *Journal of Systems Architecture*, Vol. 64, pp. 100-109, March, 2016.

[14] Y. A. U. Rehman, L. M. Po, M. Liu, LiveNet: Improving features generalization for face liveness detection using convolution neural networks, *Expert Systems With Applications*, Vol. 108, pp. 159-169, October, 2018.

[15] G. D. Guo, N. Zhang, A survey on deep learning based face recognition, *Computer Vision and Image Understanding*, Vol. 189, Article No. 102805, December, 2019.

[16] C. Lv, D. Cheng, Q. Kou, H. Zhuang, H. Li, Target tracking algorithm based on YOLOv3 and ASMS, *Opto-Electronic Engineering*, Vol. 48, No. 2, Article No. 200175, 2021.

[17] D. Q. Sun, S. Roth, M. J. Black, Secrets of optical flow estimation and their principles, *Proceedings of 2010 IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, San Francisco, CA, USA, 2010, pp. 2432-2439.

[18] K. Nummiaro, E. Koller-Meier, L. Van Gool, An adaptive color-based particle filter, *Image and Vision Computing*, Vol. 21, No. 1, pp. 99-110, January, 2003.

[19] D. Comaniciu, V. Ramesh, P. Meer, Real-time tracking of non-rigid objects using mean shift, *Proceedings IEEE Conference on Computer Vision and Pattern Recognition. CVPR 2000 (Cat. No. PR00662)*, Hilton Head Island, SC, USA, 2000, pp. 142-149.

[20] L. J. Yan, Y. M. Huang, Y. H. Zhang, T. Tang, Y. Xia, Research on the application of RANSAC algorithm in electro-optical tracking of space targets, *Opto-Electronic Engineering*, Vol. 46, No. 11, Article No. 180540, 2019.

[21] S. Avidan, Support vector tracking, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, Vol. 26, No. 8, pp. 1064-1072, August, 2004.

[22] E. Dong, M. Deng, J. Tong, An Improved Struck Tracking Algorithm Based on Scale Adaptation and Selective Updating, *2019 IEEE International Conference on Mechatronics and Automation (ICMA)*, Tianjin, China, 2019, pp. 2309-2313.

[23] J. H. Wang, M. Zhao, L. Zou, Y. Hu, X. Z. Cheng, X. F. Liu, Fish Tracking Based on Improved TLD Algorithm in Real-World Underwater Environment, *Marine Technology Society Journal*, Vol. 53, No. 3, pp. 80-89, May/ June, 2019

[24] X. Guo, S. Li, J. Yu, J. Zhang, J. Ma, L. Ma, W. Liu, H. Ling, PFLD: A Practical Facial Landmark Detector, *Computer Vision and Pattern Recognition*, arXiv:1902.10859v2, March, 2019.

[25] B. Liu, P. Fu, T. W. Chen, Y. Q. Li, J. S. Pan, Facial Landmarks Detection under Occlusions via Extended Restricted Boltzmann Machine, *Journal of Internet Technology*, Vol. 21, No.5, pp. 1233-1241, September, 2020.

[26] J. Li, J. Wang, X. Chen, Z. Luo, Z. Song, Multiple Task-driven Face Detection Based on Super-resolution Pyramid Network, *Journal of Internet Technology*, Vol. 20, No. 4, pp. 1263-1272, July, 2019.

[27] X. Liu, L. Lu, Z. Shen, K. Lu, A novel face recognition algorithm via weighted kernel sparse representation, *Future Generation Computer Systems*, Vol. 80, pp. 653-663, March, 2018.

[28] C. Chen, A. Dantcheva, A. Ross, An ensemble of patch-based subspaces for makeup-robust face recognition, *Information Fusion*, Vol. 32, pp. 80-92, November, 2016.

[29] Y. Chen, J. Yang, L. Luo, H. Zhang, J. Qian, Y. Tai, J. Zhang, Adaptive noise dictionary construction via IRRPCA for face recognition, *Pattern Recognition*, Vol. 59, pp. 26-41, November, 2016.

[30] Q. Dai, J. Li, J. Wang, Y. Chen, Y. G. Jiang, A Bayesian Hashing approach and its application to face recognition, *Neurocomputing*, Vol. 213, pp. 5-13, November, 2016.

[31] S. C. Huang, L. Zhuang, Exponential Discriminant Locality Preserving Projection for face recognition, *Neurocomputing*, Vol. 208, pp. 373-377, October, 2016.
[32] H. K. Ji, Q. S. Sun, Z. X. Ji, Y. H. Yuan, G. Q. Zhang, Collaborative probabilistic labels for face recognition from single sample per person, *Pattern Recognition*, Vol. 62, pp. 125-134, February, 2017.
[33] X. Y. Jing, F. Wu, X. K. Zhu, X. Dong, F. Ma, Z. Li, Multi-spectral low-rank structured dictionary learning for face recognition, *Pattern Recognition*, Vol. 59, pp. 14-25, November, 2016.
[34] N. Blauch, M. Behrmann, D. Plaut, Computational insights into human perceptual expertise for familiar and unfamiliar face recognition, *Cognition*, Vol. 208, Article No. 104341, March, 2021.
[35] F. H. K. Zaman, Locally lateral manifolds of normalised Gabor features for face recognition, *IET Computer Vision*, Vol. 14, No. 4, pp. 122-130, June, 2020.
[36] B. Ríos-Sánchez, D. Costa-da Silva, N. Martín-Yuste, C. Sánchez-Ávila, Deep learning for face recognition on mobile devices, *IET Biometrics*, Vol. 9, No. 3, pp. 109-117, May, 2020.
[37] S. Liu, D. Chen, Z. Chen, C. H. Ru, M. Pang, Research on Face Recognition Technology Based on ESN Multi Feature Fusion, *Journal of Internet Technology*, Vol, 21, No. 5, pp. 1571-1578, September, 2020.
[38] Z. Wang, G. Wang, B. Huang, Z. Xiong, Q. Hong, H. Wu, P. Yi, K. Jiang, N. Wang, Y. Pei, H. Chen, Y. Miao, Z. Huang, J. Liang, Masked Face Recognition Dataset and Application, *Computer Vision and Pattern Recognition*, https://arxiv.org/abs/2003.09093v2, March, 2020.
[39] F. Yue, L. F. Chen, Y. K. Deng, D. G. Sha, Research of Video Surveillance System Based on Streaming Media Technology, *Application Research of Computers*, Vol. 22, No. 2, pp. 215-216, 2005.
[40] P. A. Rauschnabel, R. Felix, C. Hinsch, Augmented reality marketing: How mobile AR-apps can improve brands through inspiration, *Journal of Retailing and Consumer Services*, Vol. 49, pp. 43-53, July, 2019.

Biographies

Charles Chen is current a Professor in School of Computer Science and Engineering, Minnan Normal University, China. His research interests include knowledge graphics, pattern recognition, machine learning, information system innovation, intelligent manufacturing, image process, intelligent wastewater treatment process control system and cloud computing.

Xiao-Yan Wang is current a student studing in School of Computer Science and Engineering, Minnan Normal University, China. Her research interest include software engineering and artificial intelligence.

Jian Chen is current a student studing in School of Computer Science and Engineering, Minnan Normal University, China. His research interest includes Big Data and Software Engineering.

Qin Liu is current a student studing in School of Computer Science and Engineering, Minnan Normal University, China. His research interest include Artificial Intelligence and System Development.

Sheng-Lung Peng is a Professor and the director of the Department of Creative Technologies and Product Design, National Taipei University of Business, Taiwan. He is an honorary Professor of Beijing Information Science and Technology University, China, and a visiting Professor of Ningxia Institute of Science and Technology, China. He is also an adjunct Professor of Mandsaur University, India. His research interests are in designing and analyzing algorithms for Bioinformatics, Combinatorics, Data Mining, and Networks areas in which he has published over 100 research papers.