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Research and Application of Online Product Display Technology Based on Augmented Reality

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Abstract: With the rapid development of e-commerce, more and more products are sold through the internet. But the current online shopping websites are still using the traditional 2D animation, pictures and text information to display their products which can't satisfy the current consumer's needs to fully understand the product. Based on the analysis of display technologies of existing e-commerce systems, this paper studied virtual product display technology based on augmented reality and applies it to a prototype system of online display for glasses. This technology can be used in the e-commerce system well. It can strengthen traditional display, enhance the consumers' shopping experience and increase consumers' desire to buy things and finally brings good benefit to businesses.

Key words: Augmented reality, e-commerce, display technology, facial recognition, consumer's desire

INTRODUCTION

According to CNNIC (2011) released twenty-eighth statistics, to the end of June, 2011, the number of internet user in China reaches 485 million; the internet penetration rate has gone up to 36.2%. The report shows that most business application maintained the trend of steadily rising, such as users of online shopping have increased by 7.6% within six months. Among business application, the application of group-buying is a highlight, the utilization rate has risen from 4.1-8.7% and astonishing growth rate is to 125%. E-commerce is a commercial activity that won't be influenced by space or time but it must rely on the internet and on the basis of internet users fair operation. Limited to online product display technology and other reasons, consumers can only see the text information pictures and 2D animations which are lack of further information and interaction. Those technologies are unable to give the information about characteristics, functions and structure of the actual items, thus cause the difference between products displayed online and the actual ones (Lu and Smith, 2007).

In recent years, along with the development of computer graphics, human-computer interaction and computer network, the new display technology such as virtual reality, augmented reality technology are developing rapidly and widely used. The technology of virtual reality has improved when compared to the traditional ones. In e-commerce, virtual reality can provide a virtual product of 3D models which can only zoom-in and zoom-out but Augmented Reality can provide a shopping experience which is closer to consumers. It can combine virtual object with real-world scenarios, this can not only solve the traditional way's deficiencies by fully displaying an online goods' general view and characteristic but can also fill the gap between the consumer and seller by using augmented reality which make the consumer feels immersing. The advantage of this technology is even greater when the consumer wants to try out the product, it can enable the consumer to have an over-view as well as sense of trust and security (Zhang *et al*., 2000; Lu and Smith, 2007).

Although, currently augmented reality has been applied in many areas but its applications in e-commerce are comparatively limited. Zhang *et al*. (2000) put forward and developed a direct marketing system based on augmented reality. Lu and Smith (2007) developed e-commerce assistant system with the central principle of users. Park and Lee (2004) put forward augmented reality e-commerce system with less marker based on laser projection tracking . Li and Chen (2009, 2010) put forward the solution to accurately register with less mark in the electronic commerce application in two papers.

Based on the analysis of existing electronic commerce system of display technology, this study puts forward a framework of an online product display system based on augmented reality, studies the key technologies of augmented reality in online product display and applies it to a prototype system of online display for glasses.

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FRAMEWORK OF ONLINE PRODUCT DISPLAY SYSTEM BASED ON AUGMENTED REALITY

Classification of products: The current products sold online can almost cover all that in real life. Because different kinds of products have their different characteristics, this study takes the corresponding way to use augmented reality technology to display the product. Therefore, this study classifies the products first and then takes into account of the classification while designing the system framework. Xie *et al.* (2011) has put forward the principle of goods classification as follows:

- **Principle 1:** whether the product is worn?
- **Principle 2:** whether the product is rigid object?

According to the two principles above, products can be divided into three. The first kind of products called the marker less (hereinafter referred to as ML class) is in conformity with the two principles above. The second is called the marker less special (hereinafter referred to as the MLS class), this kind of products are in conformity with the principles one but not the principle two. The third kind which do not meet neither of the two principles, is called the mark (hereinafter referred to as M class). It can be seen, if the product is in conformity with principle one, it is then in conformity with principle two; if the product isn't in conformity with principle one, then it is not in conformity with principle two. According to the classification of above the goods on the market can be roughly classified. For example, the apparel and accessories belong to MLS class; watches and glasses belong to ML class; books, electronic goods, food and home appliance belong to M class.

System framework: According to the requirements of the system objective, this study puts forward a framework of display system based on augmented reality for online product as shown in Fig. 1.

As Fig. 1 shows the framework is divided into four layers: the access layer, interface layer, service function layer and system support layer.

- **Access layer:** It is mainly for providing human-computer interface for consumers who browse the web through computers or portable mobile devices
- **Interface layer:** Interface layer includes an access interface of the entire system. Interface layer's main function is to set up a logical separation between the external system and the internal functions system to

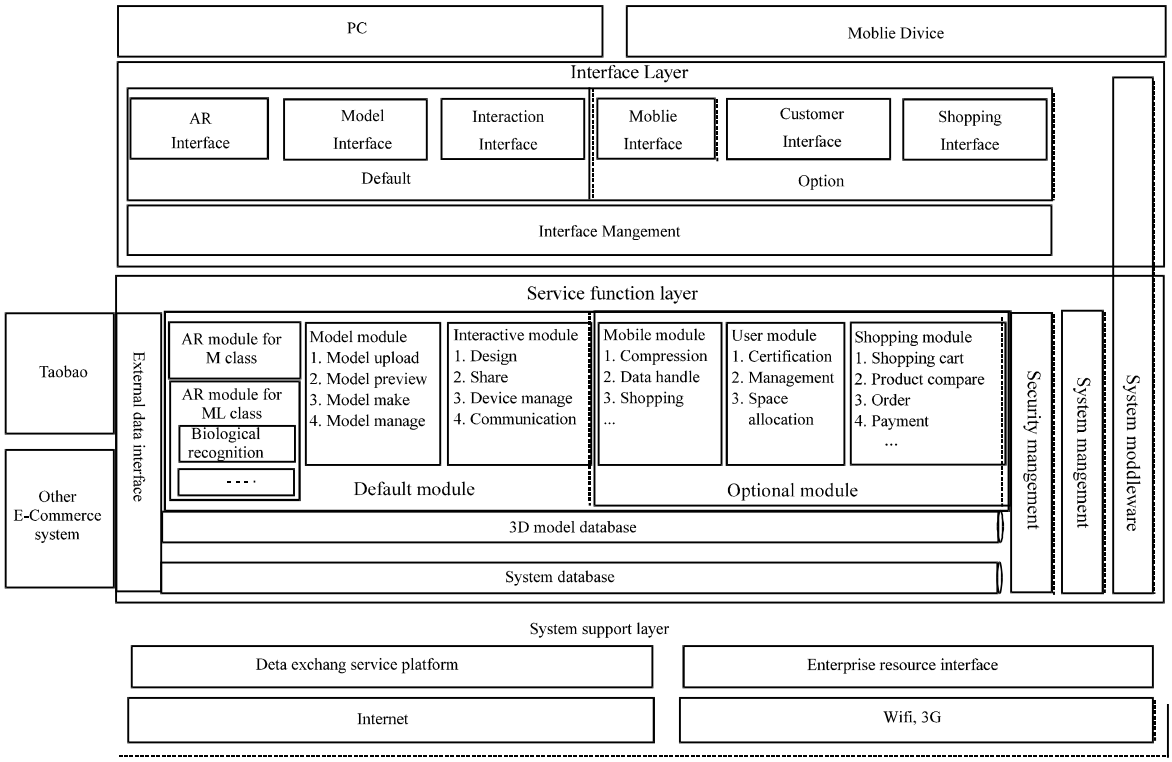

Fig. 1: Online product display system based on augmented reality

which portable mobile devices access and establishes the logic isolation belt. It also assures safety and load balancing. Because the layered design of the system, it is easy to maintain and manage. As Fig. 1 this layer has the default and the optional two parts, this is a flexible setting for the convenience for users. The flexible setting can be decided according to whether the consumer needs this system to provide the function of user management, shopping, mobile shopping and so on, thus realizes the mutual compatibility between the optional part and the existing platform

- **Service function layer:** This layer is the core layer of the system, including the system database, 3D model database and the implementation modules of each interface's function, such as the default module: Augmented Reality module, model module, interactive module and optional modules such as moving module, shopping module, user management module. It also includes external interface, security management, system management, etc. External interface is primarily designed to be compatible with existing e-commerce platform
- **System support layer:** It includes basic network and its system and platform for data exchange, providing a basis for the operation of service function layer's system

Module introduction

Model module: This module mainly controls the 3D model, including the upload, preview and relevance. The current system-supported 3D models are dependant on external 3D library, supports the common formats of 3D model such as .3ds, .dae, .ase, .kmz, etc. The making of models mainly relies on external modeling software, such as 3dsMax, SketchUp, etc. Model interaction is the relationship between products which are set on the e-commerce platform and the model associated. In addition, it is also being equipped with the enhanced recognition which is based on the way of marking or the identification of unmarked human body etc. The upload model's final enhancing effect can be observed by the preview window.

User management module: This module has the function of user authentication, user management, space distribution of the users' model etc. When the e-commerce platform which has the function of user authentication and user management does not necessarily need to choose this module, so this module is optional. It is mainly for the third party platform and for the users who needs it to manage the system.

Shopping module: This module is optional module too. This module includes shopping cart, products comparison, products purchasing, payment and other functions. Users can also customize this function.

Mobile module: The module is also optional. It is mainly for needs of mobile shopping users. When using the module, the system optimizes the display of the content to adapt to the requirements of the mobile bandwidth and screen and optimize correspondently to adapt to different mobile devices. These make high quality and smooth performance possible in the high-performance portable devices. This module has the function of model compression, mobile image data optimization, mobile shopping and communication optimization etc.

Interactive module: This module is mainly for the interaction between consumers and the content displayed. The user can achieve interaction through the unconventional way such as gesture recognition, eye identification and speech recognition. Some of these interaction needs specialized equipment. This module has the function of equipment management, when the new interactive devices appear it could join the system. This significantly increases the interactivity extensibility of the system. In addition, it also includes Internet share function; the user can send the augment reality image or video to the micro blog and other sharing platform. This not only increases interaction but also advertises the product. In addition, the communicate function between the system and electronic commercial platform is also very important which is the hub to connection the system and the platform.

Augmented reality module: This module includes two kinds of augmented reality function: The marker and the marker less. This module sets correspondently according to users' classification of products when upload models.

For M class, this study takes the augment reality technology based on marker. This system uses FLARToolKit which is a real-time video detection library based on rectangular markers. It applies the technology of computer vision to calculate position and posture to the observer that is, by using the coordinate of camera, rectangular markers, display screens and then using the transformation matrix to get rectangular position and posture of the objective, so as to realize the tracking and overlaying of virtual object.

For MLS class and ML class, this study takes augmented reality technology based on the maker less. The display of these two kinds of products is relatively difficult when compared to M class. The products of MLS class and ML class need biometric identification of specific parts of the human body. For the ML class, the biological recognition technology can be used but the products to wear must be rigid, such as glasses, earrings

and other commodities. Because of its properties, characteristics can be restored well through 3D modeling and the final fusion of the real scene and the virtual objects can be pretty realistic. The glasses display system introduced in the following two sections, is the system using cameras equipped computer to carry on the face recognition and "wear" 3D glasses model. This system is a positive application in the e-commerce which combines the biological recognition technology and augmented reality technology. Users can enjoy the auditioning in the "real" optical shops without even leaving home which greatly enhances the user's shopping experience and stimulate users' desire to shop.

For the products of MLS class, wearing those have a series of deformation, so 3D products also need to have certain changes when the human body changes the posture. Only in this way the system have a real effect. So this kind of products' augment reality application not only needs biological recognition technology but also needs special equipment to response to human body' posture. This study does not discuss this aspect.

DESIGN OF AUGMENTED REALITY MODULE

Augmented reality for the products of M class: For display of products of M class based on augmented reality, the most used tool is FLARToolKit (http://nyatla.jp/nyartoolkit/wp/) developed by Hirokazu Kato. Except the original version of the C language, it also has the version of C No., ActionScript 3.0 (AS3), JAVA language and so on. It can be said that this tool is the most popular open source library based on markers (Ren *et al*., 2006). This study uses the FLARToolKit library of AS3 to implement online display of marked products.

FLARToolKit is a real-time video detection library based on rectangular markers. It applies the technology of computer vision to calculate position and posture to the observer that is, by using the coordinate of camera, rectangular markers, display screens and transformation matrix to get rectangular position and posture of the objective, so as to realize the tracking and overlaying of virtual object. FLARToolKit is a function library implemented by AS3 language. Its composition is as the following Fig. 2 shows augmented reality program tracks the scene by using the WEB cameras, then after using the tools in Utils to convert the image, it detects the marker by FLARToolKit marker detector. The detector uses FLARToolKit core packages' calculation to get the eventual register position of virtual products. And finally by using the 3D library of the flash, such as PV3D/Away3D, etc, it completes the integration of virtual and reality.

FLARToolKit Capture tool is a library obtains image data through the Flex's own cameras capture tool.

FLARToolKit Utils is the tool library to communicate with external module. It has the function to convert the image data obtained from FLARToolKit capture tool to intermediate form of RGBRaster. It also has the function to convert FLARToolKit and camera's coordinate system into all kinds of corresponding 3D library coordinate system, etc.

FLARToolKit Processor lib is management library of one or more markers.

FLARToolKit Detector lib coordinate with FLARToolKit core lib's operation function, it is a library that can test out the specific marker. It can identify individual markers and multiple markers in image as well. FLARToolKit Core lib is a combination library of many operations. It includes matrix computation, pattern recognition, image filtering, label operation, etc. The class in this library also can be used alone. It is usually invocated by using FLARToolKit Detector.

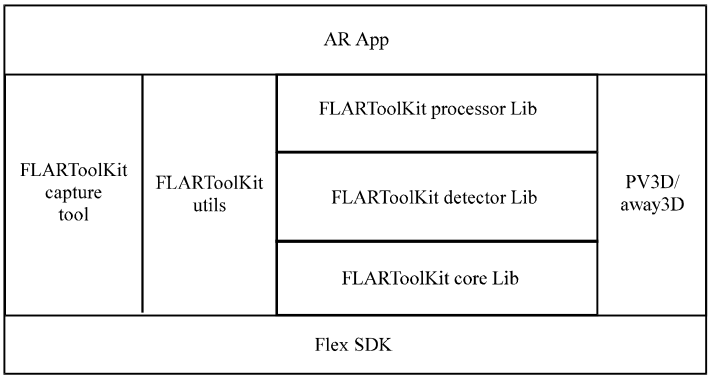

Fig. 2: FLARToolKit's system

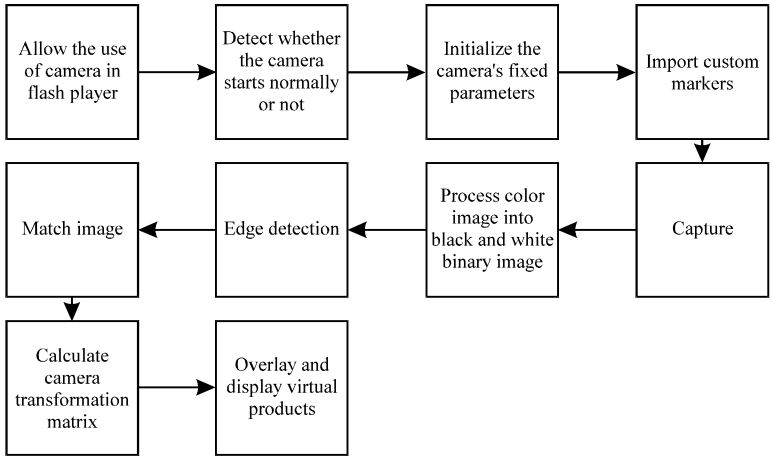

Fig. 3: Display process of M class

Fig. 4: Marker of product

The display process of products of M class is as Fig. 3 shows. First, users need to print a special FLARToolKit objective which meet sellers' standard (similar to Fig. 4's marker), the size is adjusted to the actual products. Then open the corresponding product page, click the flash player to allow the use of camera. FLARToolKit detects whether the camera starts normally or not. If normal, the camera's fixed parameters are initialized and at the same time imports custom markers. It makes the comparison with the after marker possible. After this, video cameras starts to catch scenes. According to the custom threshold value, a frame of color image is binary processed into black and white binary image and be processed with reverse color (Zon and Li, 2007). After that binary image goes through edge detection and connected component analysis which screen all the candidate rectangular areas which meet standards. And then these candidates area are matched to custom markers and similar probability can be calculated. If it is higher than the custom reference value, the match is successful. After that a marker is found and camera transformation matrix is calculated by using the shape change of marking areas. Finally, the position and posture relative to camera is calculated and the virtual products' overlaying is finished.

Augmented reality for products of ML class: For MLS class and ML class this study takes method of marker less augmented reality. The display of these two classes is more difficult compared to M class. MLS class and ML class need the biometrics of specific parts of the human body.

According to the principle of goods classification, it needs to recognize the physiological characteristics of head, hand or human body to apply to different goods when detecting, such as hat, glasses, earrings and other commodities of head; watches, bracelets and other commodities of hand or clothes, pants etc.

For the products of ML class this study uses the biological recognition technology but the products to wear must have a rigid body, such as glasses, earrings and other commodities. Because of its properties, characteristics can be restored well through 3D modeling and the final fusion of the real scene and the virtual objects can be pretty realistic.

The glasses display system based on augmented reality in the following sections, is the system using cameras equipped computer to carry on the face recognition and "wear" 3D glasses model. This system is a very good application in the e-commerce which combines the biological recognition technology and augmented reality technology. Users can enjoy the auditioning in the "real" optical shops without even leaving home which greatly enhances the user's shopping experience and stimulate users' desire to shop.

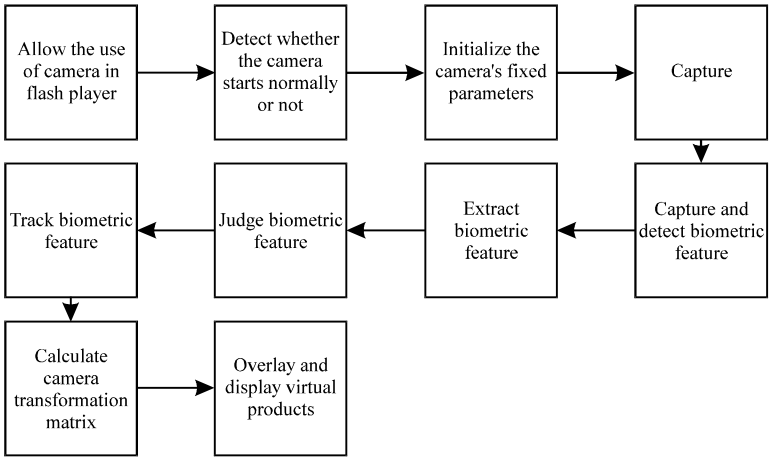

Fig. 5: Display process of ML class

For the products of MLS class, wearing those have a series of deformation and their 3D also needs to have certain changes when the human body change the posture, only in this way it have a real effect. So this kind of products' augment reality application not only needs biological recognition technology but also needs special equipment to response to human body' posture.

For display technology based on marker less augment reality, this study proposes a general flow of biometrics augment reality as Fig. 5 shows. Since the system is designed to be applied to flash therefore, the uses first need to click on "allowed to use camera", then the system test whether camera normal starts nor not and starts the initialization of camera's fixed calibration parameters. So far all the things are the same as the testing based on the objectives. After that the camera starts to capture and detect whether there is a target creature feature in the scene, the extraction of characteristics is made if there is and the accurate characteristic is judged to screen the area met the standard and finally it calculates the registered points of virtual products and add it into a real scene.

DESIGN OF INTERACTION

All the time, the most commonly used and the most convenient human-computer interaction is to use mouse and keyboard. But in the augmented reality system (special the try-on of clothing and assembly system, etc.), a more natural interactive way in real scene is needed which makes it convey the intention of the people more accurately.

In this framework, gesture detection, action detection, voice detection and multiple markers detection, etc are included.

Gesture detection: The introduction of gesture detection in this framework is mainly aimed to let users to fully experience the feeling of augmented reality system. When using augmented reality System, the user only needs to set out right hand gestures, the system can react accordingly. This makes users infused into the world of augmented reality, making them feel that they are operating "real" objects in the real world.

Because visual gestures interaction has rich information: different positions, different gestures, different directions can be combined and express a lot of information and can cooperate with other interactions such as speech etc. This can make the more combination. At present, the gesture recognition is mainly based on data glove, single background and special materials (Malik and Laszlo, 2004) etc. This system brings gesture interaction based on visual, according to the specific interactive task to design detective system structure. The basic process of gesture detection can be parted as: modeling, orientation, matching and interacting. Modeling is mainly aimed to extract the position of hands from existing image data by some of the algorithm. This can make the following detection of the position of hands faster. The existing Haar characteristic class and Adaboost algorithm have quite good robustness. Positioning is determined according to the accurate results geometry algorithm of the area, such as finger's vertex coordinates and etc. Matching is the coordination of custom model based on the existing information such as target gestures, etc. If there is more than a certain threshold, it is determined success matching and moves on to the next step of the interaction. That is to say, the system executes associated command of the custom model.

Action detection: In the design of the current system there is a virtual menu, user can use body movements to touch the virtual menu and make the system act correspondingly. The only drawback of the interaction is the lack of feedbacks: when the user uses hand touch the virtual menu, he or she does not have a real movement feedback. Definitely, it is because all these are completed by machine vision and the user did not wear any equipment. Only the guiding color of the program can strengthen the feedbacks.

The designed motion detection for this system is based on gesture detection technology mentioned above. After gesture detection the user can make sure whether the hand is on the location with virtual menu. This system divides screen into a number of blocks and it is conducive to speed up the judgment of whether the two parts touch each other or not.

Voice detection: Voice detection is designed in this framework. The current computers which are equipped with WEB camera are always equipped with microphones, or the computer itself has the microphone. Therefore, adding voice detection, users can use the mouse and keyboard and even body movement as less as possible. Just move their mouths and they can achieve some basic functions, such as menu selection, as well as to change virtual products' color.

Speech recognition has a history of more than 60 years, for initially isolated words, small vocabulary or some specific speech recognition, to today's large vocabulary, no human sound limited. The current main stream's direction is continuous speech. The e-commerce system based on augmented reality does not need continuous speech, it only needs to identify isolated words because the words used in controlling the menu are limited for most users. So, it just needs to introduce speech identification based on small voice database.

Detection of multiple markers: Many of the interaction of the multiple markers are already realized. That is to say, FLARoolKit also can be used to realize the interaction of e-commerce system. This interaction can not only be used on the Augmented Reality module for M class but also for ML class.

REAL-TIME FACE DETECTION AND TRACKING ALGORITHM BASED ON AUGMENTED REALITY

This study uses Augmented Reality technology to the glasses online exhibition, so the face detection and tracking are involved. The key of this is the face detection and tracking algorithm. The face tracking algorithm this study used is based on Viola-Jones's face detection framework and Camshift's algorithm is improved according to the environment of practical application of glasses.

In order to improve the accuracy of the face detection, in an acceptable time range, this study puts forward a method to improve. For Camshift's algorithm, though it has very good performance in the real-time and robustness but as stated in the algorithm, initial target tracking area need to choose manually and the loss of the target tracking is another problem too. To improve tracking algorithm, this study puts forward the iterative detection method. This is applied with the combination of practice. When designing the display system, this study finds out from a survey that the best waiting time is 3 sec or less when inspection, 5 sec most. More than this long, consumer feels tired and that greatly reduce the user experience. Making full use of this limit waiting time can greatly improve the accuracy of detection, tracking and registration. For Camshift's algorithm, this study adds condition constraint to solve the problem of missing target. This study puts forward real-time face detection and tracking algorithm is based on the improvement mentioned above.

First of all, the improvement for Viola-Jones's face detection framework is to use iterative method. After using Viola-Jones's face detection algorithm to detect face and a pair of eyes correctly, save the data and then do the next detection, until reaching iteration times, namely the iteration threshold. Because of the camera is tracking movement data directly, the collected data is judged whether convergent or not, if convergent, then stop the detection. Through the experiment, this study determines the biggest iteration threshold with the limit waiting time.

For Camshift's algorithm, it needs to set the initial search target range, this study puts forward a way that uses the iterative collected data and the only returned face coordinate after average weighting. When losing the tracking of target, it adds constraint to judge whether do face detection again or not. In this system, it is set as:

$$A_i > A_{i-1} \times 1.6 \quad (1)$$

$$A_i < A_{i-1} \times 0.5 \quad (2)$$

where, A means the size of detection area, i means this detection. When it is more or less than the average, it restarts face detection. The specific process is shown in Fig. 6.

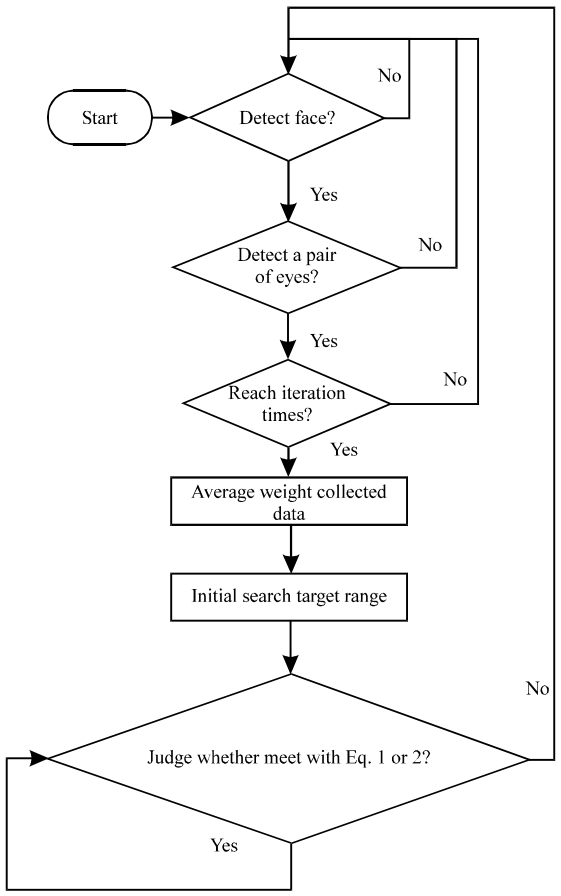

Fig. 6: Process of face detection and ctracking algorithm

REALIZATION OF PROTOTYPE SYSTEM

This prototype system is mainly aimed to realize the function of trying on the online glasses. The system has the purpose of selling one kind of products-glasses. The user can use this prototype system to build an online display system with the function of augmented reality which can be incorporated into e-commerce platform or other third party e-commerce platform.

The real-time face detection and tracking algorithm for augmented reality in this system is based on Viola-Jones's framework of object detection and Camshift tracking algorithm and after some improvement, this algorithm can get the position of eyes which needs wearing glasses.

Development platforms are Flash Builder 4.5 and Flex4.5 SDK. This study uses them to develop the SWF file embed to the web page. The Papervision3D (PV3D) library is used to implement flash rendering engine which can add the virtual glasses to the position of human eyes and can achieve certain interactive function.

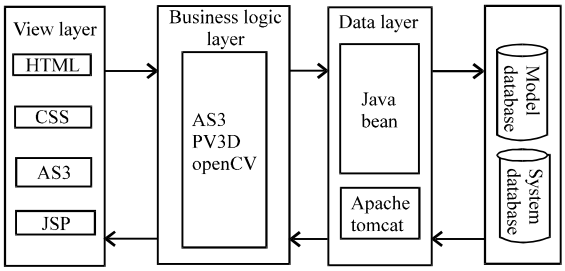

Fig. 7: Prototype system

Tomcat server is used as Web server which mainly realizes model management, upload for sellers and the system management for administrator. The data server of this system is SQLServer2005 which is mainly used to store the system data and 3D model data, etc.

Based on the design principles and system requirements mentioned above, the framework of this prototype system is shown in Fig. 7.

In order to show the effect of glasses' try on based on augmented reality, the following is the brief introduction of the system's main function interface. The user can choose appropriate glasses through the system interface and click "try on" button, the system jumps to the try on page and embed SWF file into web pages. As a result, the user can see the 3D glasses have been "worn" in user's face.

CONCLUSION

Based on the analysis of the present situation of the display of online products in e-commerce, this study aims at applying the technology of augmented reality to e-commerce and solves the insufficiency of current products display. It also provides a technology based on facial recognition and augmented reality to try on glasses. Through this function, users are able to see themselves wearing different glasses without leaving the house. The application of augmented reality in the e-commerce is not only in the glasses. In this study, online products display system framework based on augmented reality can be used in most of the products and has a broad practicability. In addition, with the development of the mobile network and the better function of mobile phones, this technology makes mobile e-commerce possible; users can enjoy shopping experience of augment reality by using mobile e-commerce.

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