Visual Experience Enhancement based on Instant Calculation and Dynamic Tracking

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Abstract this project was designed according to the creative ideas in Daily Prophet (the newspaper in the science fiction Harry Potter), and it also realized a kind of software with similar science-fiction effect in the novel. The software can recognize the scene in camera, analyze the image in the camera according to certain algorithm, and achieve the dynamic information corresponding to the picture by interacting with the server. It can display in the client side, 'replacing' the static information with dynamic information, so that the dynamic information can 'blend into reality' and enhance the visual experience. Relying on all kinds of mobile terminals, this project can be widely applied in print media, museum, education, commerce, etc. aiming to improve the amount of information carried by the static pictures greatly, enrich the forms of expressions for images and strengthen the dynamic visual experience. This project analyzes the problems in image matching, approximate retrieval, image tracking and load bearing of the mobile platform. An assorted algorithm has been designed and developed independently for processing the images and videos, so that the algorithm can satisfy the demands of the algorithm to the greatest extent and achieve the expected effect.

Key Words: visual experience, enhancing, dynamic, mobile terminal, image processing

I. INTRODUCTION

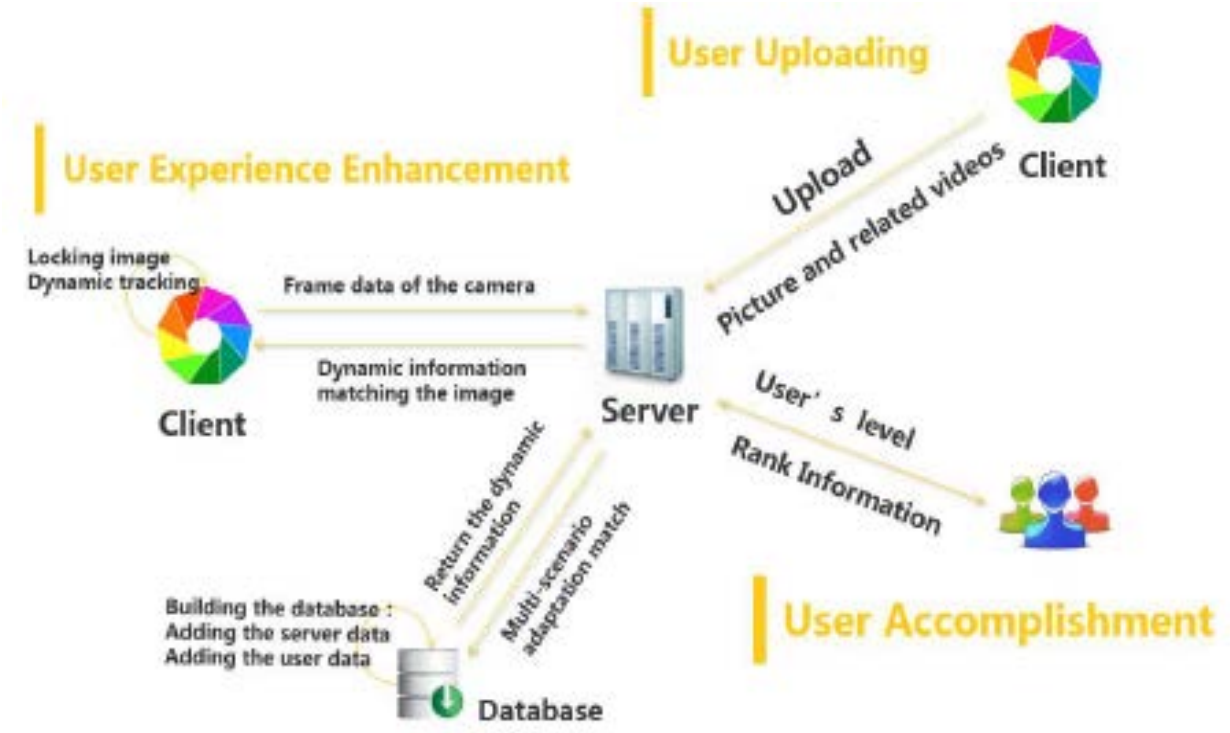
With the constant development of computer and information technology, there have been enormous changes in the application forms and scopes of computers. With the expansion in the computer function, the hardware upgrading of mobile terminal, as well as the popularity of the concept and technology of augmented reality, it can be expected that in the near future, the visual experience enhancement will be a popular research direction. However, owning to the hardware upgrading of portable mobile terminals over the past years, it can endure a huge calculated amount. As a result, it is quite appropriate to be deemed as the realization carrier for visual experience enhancement.

When we were young, we had contacted all kinds of science fictions and novels, as well as movies, in which various fancies left me a deep impression, and among them, I was impressed by the Daily Prophet in Harry Potter most. With the development of network, as well as the increasing knowledge about computer, an assumption has been put forward: if we could turn the reality as Daily Prophet? That is to say, can we make the static image on print media dynamic?

At present, the widespread approach for achieving information is still from the paper material. Although the generalization and networking of electronic material produce a great share of information, there are still many problems, such as the inconvenience in carrying, sharing and checking. Furthermore, sometimes we cannot achieve complete information from plenty of words, pictures, etc. This problem can be solved by the implementation of dynamic visual experience enhancement with image processing technology.

It has been discovered in our investigation that the most common similar product is the electronic newspaper. But owning to the inconvenience in retrieval and unclear retrieval target, it cannot realize the expected effect. Another kind of thought is to add cheap chip and playing screen to realize the dynamic effect in the paper content. However, it is not realistic at present, with high cost. Finally, it is focused on the mobile terminal, which can load the dynamic visual experience enhancement system to realize the dynamic effect by making full use of the portability of mobile terminal. This is the original intension of this project.

II. SYSTEM OVERVIEW



Structure chart of project implementation

The system based on such an idea: The current real scene is displayed on the device screen by the camera of the mobile device while the frame data is being uploaded to the server in the software backstage. Server will search the database by multi-scenario adaptability matching of image. Then server returns the dynamic information which matches the frame data to client. The client will lock the current static image within the camera range and display the dynamic information. In another words, It would send feedbacks about the corresponding dynamic information with the recognition of images, play in the mobile terminal, lock the image and track the location of the subject, so that the dynamic information can cover the image correctly, reaching the goal of replacing static information with dynamic information and realizing the dynamic visual experience.

The visual experience based on the instant calculation and dynamic tracking is quite different from the current Augmented Reality software, and it is mainly reflected in two aspects:

I. It is a kind of mobile terminal software, which can operate on the basis of today's intelligent mobile platform, without requiring other equipment.

II. Its core lies in the dynamic vision, which will replace the static information with dynamic information, and allow the integration of dynamic information in reality, rather than the enhancement of word information designed by the current mainstream.

III. KEY TECHNOLOGIES

In order to achieve the desired effect, we designed and implemented two core algorithm. The multi-scenario adaptability matching of image is an algorithm which can process fuzzy image matching with a good efficiency. The Universal subject tracking is an algorithm which can calculate the location and size of the subject in a specific frame instantly. The details of these two algorithms are shown as follows:

3.1 Multi-scenario adaptability matching of image

In the database, the pictures will be bound with the corresponding dynamic information to index the dynamic information with pictures for retrieving, and then it will search the corresponding dynamic information of the picture through image recognition. However, since the image retrieval technology that is available now is still quite shallow, and the common image retrieval of both Google and Baidu employs relatively simple algorithm, it can only realize the matching of similar pictures. But the algorithm that we need should be able to realize the multi-scenario adaptation matching. Therefore, approximate image matching algorithm that can satisfy our demands, realize the multi-scenario adaptation matching and have acceptable efficiency has been designed on the basis of OpenCV library. The major procedures for multi-scenario adaptation matching:

```
Outline outlines [] = extractingImageEdge(Image images[]);
Image scoped Images [] = outline Matching (Outline outlines [], Image frame Data);
double machingDegree = pattern Matching(Image scoped Images[], Image frame Data, Image result);
if(machingDegree < threshold){
SIFTData resultSIFT = siftDetect(result);
SIFTData frameSIFT = siftDetect(frameData);
double siftDegree = compareSIFT(SIFTData resultSIFT, SIFTData frameSIFT);
if(siftDegree < siftThreshold)
return null;
}
return result;
```

The specific method and details are shown as follows:

3.1.1 Image edge extraction

Since the goal is to realize the approximate matching, it is necessary to filter the irrelevant details in the picture. Therefore, it is necessary to extract the image edge, and eliminate the influence of light on the color of objects, as well as the influence of overall background on the approximate matching.

This step mainly adopts the canny operator, which realizes the edge extraction through denoising image, gradient detection of brightness and edge tracking.

At first, the optimal detection without additional response should be achieved, aiming to reduce the noise response. And then, correct location with the minimum distance between the border location and real edge should be detected, aiming to determine the correctness of edge detection. Finally, single response can be obtained after reducing the multi-response of the single edge, aiming to restrict the location of single peripheral point to the changes in brightness. It can realize the extraction of edge with this procedure.

3.1.2 Outline matching

Outline matching is the most fundamental matching, and it has a high efficiency. As a result, it can be used to screen the completely irrelevant pictures, reducing the searching scope greatly and improving the overall efficiency of the algorithm.

The major implementation method is to compare the HU invariant moment of different outlines. At first, the HU invariant moment of each image should be calculated, and then the similarity will be compared through checking the differences of different outlines' HU invariant moment.

The significant comparing equation is $I(A,B)=\sum_{i=1}^{7}\left|\frac{1}{m_i^A}-\frac{1}{M_i^B}\right|$, in which, A and B refer to the two images that will be compared respectively, $m^{A_i}=sign(h^{A_i})\cdot\log(h^{A_i})$, $m^{B_i}=sign(h^{B_i})\cdot\log(h^{B_i})$,

Refer to the two images' moment data, sign is a function which can returns the sign of the parameter. Through comparing one by one, we can get the images whose Hu invariant moment difference fall in certain threshold scope, which will determine the range for further search.

3.1.3Patternmatching

The pattern matching is the core of the algorithm, used for retrieving the final matching pictures. It mainly takes the searched pictures as module, and then matches with the module within the range produced by the outline matching. Finally, it will obtain the most similar results.

In this step, it mainly employs the discrete Fourier transform and Fourier multiplication, whose core is to make use of the allelism between the convolution and multiplication, with the help of Fourier transform.
The significant equation is $R(x, y) = \Sigma [(x',')-I(x+x',y+y')]2x',y'$, in which x and y stand for the pixel of the module and searched image respectively. R(x,y)stands for the matching degree of the pixel(x,y) and (x',y') stands for the pixel of the image which is used for matching.

Pattern matching is not sensitive to the noise and shielding, which can deal with the matching problems even with a high level of noise, and it is the core for realizing the approximate matching. Only appropriate noise capacity can satisfy the demands of approximate matching correctly.
Meanwhile, the search for module has been optimized, which greatly improves the efficiency of pattern matching, so that the process of approximate matching can be quicker, and it can also reduce the occupancy of computing resource in the server, and provide better response speed.

3.1.4 SIFT characteristics

SIFT characteristic refers to the in variant scale and feature conversion, it seek for the extreme point and extract the location, scale and rotation invariant in the spatial scale. This algorithm was published by David Lowe in 1999and perfected in 2004. SIFT characteristic has a huge amount of information, which is applicable for fast and accurate matching in the high-volume database.

It can reduce the low extraction probability caused by shielding, disorder and noise. At first, the differences of Gaussian operators should be applied into the images to determine some possible interest characteristics, aiming to guarantee that the selection of characteristics does not rely on the size (scale) or orientation. Secondly, these characteristics should be analyzed to determine the location and scale of the characteristics before determining the orientation with the local gradient direction. Finally, these characteristics will be transformed into an expression, which can process the illumination variation and local shape distortion. Essentially speaking, the information obtained by the standard operator is optimized with the local information.

At first, the SIFT characteristics of image should be detected and stored, and it should be compared when necessary to determine the final matching results. But it is not necessary. It can determine dynamically if SIFT characteristic detection and comparison should be conducted according to the previous matching of searching results and server efficiency.

3.2Universal subjecttracking

Since the goal is to realize the 'visual experience'enhancement, the 'experience'will be the key. The single play of related dynamic information about the pictures cannot reach the effect of augmented experiencewell. Therefore, the subjecttracking function should be added into the mobile terminal.
In this step, the man idea is to recognize and lock the subject in the current camera, track the motion of subject (the motion of subjecting the picture led by the small-scale changes in the location of mobile terminal), and achieve the size of the subject. Later the location and dimension of the dynamic information will be modified, so that the dynamic information can cover the subject completely, and it can also move with the subject, thus realizing the dynamic visual experience of 'moving pictures'. The basic procedures of the subject tracking algorithm:

```
Scope subject Scope = detect Subject (Image frame Data);
modify Scope(Scope subject Scope, Scope last Scope);
return subject Scope;
```

The specific implementation method is shown as follows:

3.2.1Image subject judgment and recognition

In order to realize the locking and tracking of objects, it is necessary to recognize it first. Related materials have been checkedatthis point,but ithas been discovered that at present most are about the face recognition, while there are quite few materials about the recognition of ordinary objects. Therefore, proper algorithm has been designed to solve this problem according to ourpractical demands.

According to the practical application scenarios of the software, the user should place the target object in the locationof subjectwhen applying. Thus it can reach the goal of recognizing the target object by relying on recognizing the subject. However, the greatest characteristic of the subjectis that it takes the greatest area in the image. Therefore, the subjectrecognition can be realized according to this characteristic.

Outline outlines = extractingImageEdge(Image frameData);
Laplace(Outline outlines[]);
int area[] = calculateArea(outlines[]);
int subject Area = findMaxArea(area[]);
Scope subjectScope = transformToScope(int subjectArea, int areas[], Outline outlines[]);
return subject Scope;

At first, the data of each frame of the camera should be achieved, the edge extraction should be conducted for the frame data (with the same method in 2.1.1), the disturbed outline should be filtered through the Laplace transformation for the extraction results, and the area circled by each outline should be calculated, the one with the greatest area will be the subject that has been looked for, Since it only needs to find the location of the subject and there is no need to care about other details, then it only needs to filter the edge obtained. Laplace transformation is a template of realizing the second-order differential. Thus horizontal second-order template should be worked out to combine with the vertical second-order differential, and then the whole template can be obtained. Such calculation is isotropous, but it has a strong response to noise. As a result, it is only employed in filtering Canny operator's results. On the other hand, since the computing efficiency of second-order differential operator is lower than the first-order differential operator, the output of first-order operator will be deemed as the input of the second-order operator. Thus it can optimize the computing efficiency to a maximum degree.

After obtaining the filtering results, the edge will be analyzed and chained to achieve the complete outline, and then the area of the outline should be calculated respectively to work out the bounding rectangle of the outline with the largest area, and the rectangle is the description for the location and size of the subject.

3.2.2Playing dynamic information

After achieving the location and size of the subjectof each frame, the real-time location for playing the dynamic information, as well as the coverage area of the dynamic information should be updated, so that the dynamic information can replace the original static information completely, and the dynamic information canintegrate into the reality, reaching the effect of dynamic displaying and realizing the goal of 'dynamicpictures', namely the dynamic visual experience enhancementmentioned previously.

For the specific implmentation, since the demois developed on the Androidplatform, the double bufferingSurfaceViewof Android will be employed to preview and play. With two SurfaceView, namely four buffering surfaces, it will reach the goal of previewing the camera scene and replacing the static information with dynamic information at the same time, thus to realize the real visual experience.

3.2.3 Modification of mobile dynamic information element's moving

Since vibration is unavoidable inholding the mobile terminal with hands, it will lead to the small change in the recognition results about the subject. Since such small changes should not be applied to move the dynamic information. Therefore, the recognition results should be modified every time to avoid the unnecessary move of dynamic information.

Its inevitable that there may be errors in the recognition result of some frame, for it cannot guarantee the accuracy of the algorithm for recognizing the subject. However, the recognition errors will certainly lead to the substantial changes in the recognition results. Therefore, the range ability of the recognition results should be detected and modified, avoiding the great deviations brought by the recognition error.

Mobile modification is mainly controlled with threshold, and it will only respond to the movement within certain threshold range, rather than the movement without the threshold range, thus to avoid the damage to the visual effect caused by the inaccurate movement.

IV. IMPLEMENTATION

4.1 Implementation of the sever

It is hoped that the visual enhancement effect can be experienced as long as there is a mobile terminal, and it can also constantly expand its own material library after being used by the users. The material library is placed on the server. The identity verification and data transmission can be realized through the interactions between the mobile terminal and server. The server is deployed with Axis2+Tomcat+Mysql, which will verify information, select information and realize the data interaction with Web Service. Multi-scenario adaptability matching will be carried out by calling the local algorithm of the server for reducing the consumption of computing resource of the mobile terminal. Meanwhile, the tracking algorithm is calculated and modified by the mobile terminal itself, which will avoid the stoppage brought by the network interaction of the server and provide smooth visual experience for the user.

4.2 Implementation of the client

We implement the client on the android platform. There is three main functions available to the user:

4.2.1 Visual experience enhancement

This is the main function among the three functions. User just need to holds their mobile device in the front of an image and he will see the static image has been 'replaced' with dynamic video. No matter how he moves the device, the dynamic video will always replace the image, it seems like the static image is moving up. This is the result we respected.

4.2.2 User upload module

In order to enrich the database rapidly, we allow users to upload their own videos and pictures.User just need to record a video, shoot a video-related picture and then upload them.We will use thesematerials to build up the database.

4.2.3 User accomplishment module

We build up the user accomplishment module in order to encourage users to upload more quality videos.

V. RELATED WORK

5.1 Advantages of the project

5.1.1 Nice visual experience enhancement

The visual experience enhancement of static picturescan provide a novel and convenient approach for people to achieve information, and it can alsodramaticallyincreasethe amount of information carried by the static pictures. Meanwhile, it also has betteruser experience, which allows people to achieve information whileenjoyingthe visual effect. The dynamic visual experienceenhancement can also be widely applied in many fields, with excellent expansibility.

5.1.2 Emphasis on user experience

From the very beginning, the project takes the optimization of users'feeling as the design goal, and it will bring better user experience with simple operation and seamless connections. It is quite
simple in application and it is applicable for people of all ages. Betterenhancement effectswill bring more acceptable information reception.

5.2 Comparison of core technology

The difficulty of this project lies in the algorithm.

New design and test have been conducted for the current related algorithm, so that it can be improved a lot in accuracy of approximate matching, matching efficiency, accuracy of subject recognition, recognition efficiency, etc. meanwhile, this algorithm is highly targeted.

5.2.1Comparison of image matching algorithm

It is a difficult problem to realize the approximate matching for images in the project. Owning to the limitations in materials, there is no existing matching algorithm for application directly. Therefore, the algorithm should be customized. Finally, through the study on OpenCVbase, various functions have been employed to realize the multi-scenarioadaptabilitymatching algorithm.

When comparing similar types, the current applications of image matching mainly include the following types:

1). Tineye: it is the search engine for similar pictures developed by Canadian IdéeCompany, and it is mainly used for 1. Find out the source of picture and related information; 2. Study and track the transmission of picture on the internet; 3. Find out the high-resolution edition of pictures; 4. Find out the website with your pictures; 5. Find out how many different editions of the picture.

The characteristicof Tineye is that it can only search for pictures with high similarity, but it cannot satisfy the demands of this project in the processing of approximatesearching.

2). Baidu figure identification: based on the similar picture identifying technology, it asks the user to upload the picture or input the URL of picture first, and then analyzes according to the characteristics of the image, and finally finds out the information that is similar to the picture through the Internet.

Baidu figure identificationnearly processes nothing in approximatesearching, soit cannot conduct approximatesearching.

3). GazoPa: though it has four types of figure identification, as for its effect and performance, it cannot be matched with Google, etc. and the official website of GazoPa has already been shut down temporarily.

4). Picitup: this search engineis mainly the keyword search, and its special point is the Celebrity-match-up. It can search pictures with pictures, and it can also carry out the filtering search.

The searching picture with picture part of Picitup mainly focuses on the figure search, which can be realized by identifying the face. However, what the project needs is the universalsearch. Therefore, the face characteristic cannot help the approximatematching.

5). Tiltomo: Tiltomo is a search tool developed by Flickr, which is mainly applied for maintain the picture database of Flickr, and its search algorithmis mainly based on the similartheme style or similar color tone and material.

Tiltomo is indeed a approximatesearch, but its ambiguityis too high, while the matchingresults provided by the similar theme style, color tone and material are too low in precision, which cannot satisfy the project demands.

6). Incogna: Incogna has a fast search speed, which is mainly based on the similarity in color and shape. As for the approximatesearch, it shares the same defect with Tiltomo, namely the ambiguity is too high, while theprecision cannot satisfy the demands.

7). Terragalleria: It is mainly based on the visual similarity, rather than the contents in pictures. However, what the project demand is to identify the content first, and as a result, it cannot satisfy the project demands.

8). By image search: it will search for similar pictures according to the pictures uploaded, and its algorithm is mainly based on colors, including the theme style. Its disadvantages are the same as Tiltomo and Inogna.

It can be seen that the multi-scenario adaptability matching algorithm balances the requirements of approximate search and search precision by aiming at the project demands, which is the main
difference from the existing similar algorithms.

5.2.2 Comparison of identifying and tracking algorithm

Another difficult point lies in how to achieve the location of a target in the picture, the practical application scenario of the project is considered, which mainly realizes the targetrecognition by equating the target object as the subjectof the image. Later, the objectwill be tracked to realize the enhancement of 'visual experience'according to the identification data of the subject.

The current tracking algorithmismainlycharacterizedby realizing tracking with complicated iteration, recursionand filtering. But for this project, itrequires computing in the mobile terminal in image tracking, butthe computing abilityof mobile terminal is relatively weak. Therefore,it cannot adopt the algorithm with too much computing, and instead, a relatively simple and efficient algorithm that can also track accurately is needed.

It can decrease the complexity of the algorithm greatly through the equivalencebetween target and subject, and it only needs to detect the location of the subjectwithout complicated computing.

Therefore, it can be seen that thistracking algorithm try to simplify the algorithm, optimize the algorithm efficiency and guarantee thesmoothoperation of mobile terminal with limited computing power to a maximum degree by aiming at the requirements of the project.

VI. APPLICATION EXAMPLE

In this part, the applicationand development of this project at present and in the future will be introduced.

6.1Application prospect

With the updating and upgrading of various mobile terminals, the hardware of mobile devices is equipped with higher and higher processing ability,and the Augmented Realityis also a new and hot technology. Therefore, the combination of the two can have a good application scenario. In recent years, the diversity of mobile terminals can promote the realization of this projecton more platforms, so that it can make ourlivesbetter.

The Augmented Realityonmobile terminal has a promising future. At present, it has alreadybeen applied a lot, such as the map navigation, landmark enhancement, product identification, brand identification, etc. The dynamic visual experience enhancement realized by this technology is a new way of thinking, and it is quite appropriatefor being regarded as the carrier of information transmission owning to the convenient application method and dynamic information displaying form. The VirtualReality will be the irresistibletrend, while this technology has a strong practicability and promotion ability, so that it has a promising future.

6.2Application direction

6.2.1Print media like newspaper, magazines, etc.

At the very beginning, this technology is designed for the print media reading.It can be applied for the information of each picture. After identifying the static picture of the print media with the camera of mobile terminal, it can achieve related dynamic information, lock the subjectand track for displaying. Afterthe pictureis dynamically enhanced, it can achieve more abundantinformation.

The publisher only needs to upload the dynamic informationrelated to the pictures into our database before the issuance of print media, and the readers can realize the visual experienceenhancement when reading, which will not only bring good reading experience for the readers, but also provide more related information for the readers.

6.2.2Public facilities like museums, libraries, etc.

This technology can also be applied for the extractionand displaying of information for publicfacilities. Since most of the public places have no servers, this software can serve everyone and help reach better browsing and appreciation effect. For instance, the museum can create some related dynamic information for the pictures collected, so that the visitors only need to employtheir various mobile terminals to recognize the pictures, and obtain the good visual experience of 'moving pictures', which will improvethe interest of visitors and attract more visitors. Meanwhile, it can also provide more information for illustrating the pictures for the visitors, and influence more people with arts.

6.2.3Education, social welfare, etc.

In education, it is often considered that the illustrations in the textbooks are tooplane, abstract and difficult to understand. As a result, the illustrations in the textbooks can be added with related dynamic information, so that the students can achieve the dynamic explanation for the illustration with the mobile terminals, and they can understand the abstract illustration better and learn about the knowledge deeper, thus it can improve the teaching quality.

In terms of social welfare, it can be applied in public places for guiding people, which willreduce human resourcesinvestment and serve the masses better.

6.2.4 Commerce

This system can be applied in the specifications for commercial products, especially for electronic product, since it can provide a more direct product description for the consumers and help the consumers use complicated electronic product. With this technology, it can expand the consumers, for theconsumers of all ages can usethe complicated electronic products conveniently. The expansion of consumers will directly improve the sales of the product and promote the commercial development.

CONCLUSION

With the development of computer, as well as itsincreasingly wide application scope, it can be expected that the development of Virtual Reality technology will be an irresistible trend. One of the themes of Virtual Reality is the Augmented Reality, but considering the hardware and other reasons, it is impossible to apply the technology in lives widely. In the current market and life, the rapid development of mobile terminal brings a new situation, namely it can consider carrying out Augmented Realityon the mobile terminals. Independent algorithm and implementationprocedure have been designed and studied with 'visual experience enhancement'as the center, and it realizes the dynamic visual experience enhancement. Wehopethat the current studies can promote the scholars in this field to conduct deeper studies, and meanwhile, it can be promoted and applied in our daily lives, whichwill bring more conveniences for our lives and make our lives much more colorful.

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