Concept of occlusion algorithm for registration technology in augmented reality

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Abstract: Augmented reality system is combination of real and virtual object which has lot of application in human life, such as in education, filmmaking, entertainment (video game), medical, engineering etc. I proposed in this paper occlusion algorithm for registration in augmented reality. Registration is a major problem in augmented reality. The main purpose of this paper is marker and markerless based registration in augmented reality which is mainly broadly applicable in filming industry and video game making. we proposed in these paper 4 steps, these are (1) marker identifying and projecting (2) adjustment of projecting model (3)trackering (4) real and virtual object occlusion.

Keywords: Augmented reality, Diminishing-reality, registration, occlusion.

1. Introduction

Main purpose of this paper is registration in augmented reality. Registration is a big problem in augmented reality. There are various kind of technology are available in augmented reality research area provided by researchers. We proposed here marker based registration technology in augmented reality using occlusion algorithm. There are Which part of computer vision-based technology

In this paper in section (II) we described augmented reality, in (III) registration, in (IV) Diminishing realty in (V) occlusion algorithm, in(VI) result ,in(VII) Conclusion and in section (VII) References

II Augmented realty

Augmented reality is a system which **combination of real object and virtual object means** *Real-world environments can interact with virtual objects* .and *Virtual objects will respond to real-world physical actions.* **Interactive in real time means** *real time processing, data can be generated in real time.* **Registered in three dimensions means** *Imagery in 3D, graphics and models are created by designers.* Current market AR has lot of application such as Medical, Manufacturing and repair, Annotation and visualization, Robot path planning, Entertainment, Military aircraft etc.

Figure1: augmented reality based surgery

III. Registration technology

The major problem in augmented reality is registration. Three kind of technology used in augmented reality for registractions purpose.

III.1tracker based registration technology

Tracking technologies may be grouped into three categories [11] These are:

Active-target: Active-targets systems incorporate powered signal emitters and sensors placed in a prepared and calibrated environment. Examples of such systems use magnetic, optical, radio, and acoustic signals.

Passive-target: Passive-target systems use ambient or naturally occurring signals. Examples include compasses sensing the Earth's field and vision systems sensing intentionally placed fiducially (*e.g.,* circles, squares) or natural features.

Inertial: Inertial systems are completely self-contained, sensing physical phenomena created by linear acceleration and angular motion.

Demerit

The signal-sensing range as well as man-made and natural sources of interference limit, signal degradation, Inertial sensors measure acceleration or motion rates

III.2.knowledge based technology:

Knowledge-based registration technology first proposed by Columbia Universesity through developing augmented reality project in graphics and interface lab of computer science department. It is mainly used in 3D game development purpose. Here trackers are fixed on the equipment with known structure to ensure the position and direction. Some 3D trackers are fixed on the key components to monitor the position and state of the system.

The problems of knowledge-based registration technology are that we must realize the structure of key components in advanced and there are time delay and errors among trackers.

III.3 Computer vision –based technology:

Computer vision-based registration technology is easy and high potential in application of AR system. It has very high registration precision which can reach pixel level. Computer based registration technology can be separated into registration based on affine transformation and registration based on camera model (camera calibration).

IV. Diminishing-realty

Figure-2,shows an AR environment based on markers.fig2(a) a visible marker is more distant from the camera then a real element. In fig2(b): a virtual object is created in front of the real element where no occlusion between real and virtual objects[2]. To create occlusion between virtual and real element we described the diminishing-reality also called DR-marker[8].

Figure2:(a) marker and real element

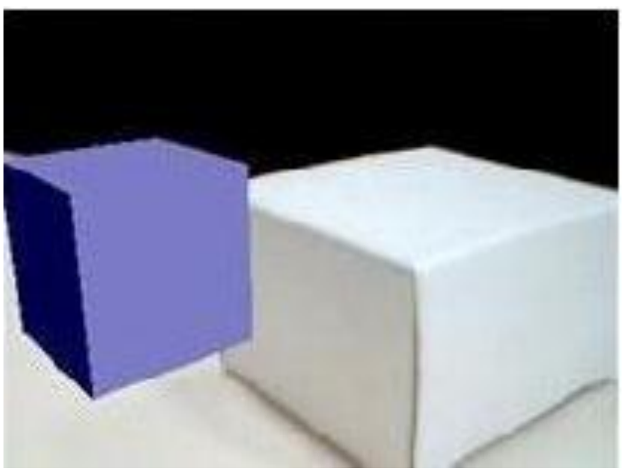

Figure2:(b) real and virtual object without occlusion.

Now a days marker-based and marker-less technology in augmented reality. marker-based best registration is not suit-able for in vocation of well visual feeling. Markerless registration also have geometric registration problem, such as position problem due to calculation error.

In augmented reality artificial content is not allow to real environment. DR-marker is used to removing the special marker from a live video stream of the user's real enviro-nment, It allows for removing real world content. DR- marker is a simple technic, it does not required 3D environment to remove on their background . In figure-3, a com - puter graphic character superimposed into real scene. The marker is under the CG (computer graphics) which is not visible. In DR-marker registration we proposed four steps[1] described in details in section V. these steps are (1) Detecting marker and projectting (2) adjustment of projecting model (3) trackering and (4) virtual to real occlusion.

V. Occlusion algorithm

Here we proposed 4 steps to occlusion bet-ween real and virtual object in real environment without using 3D environment. Bellow these three steps are described in details.

Figure3: disappeared character under virtual object.

V.1 detecting marker and projection model

here first detect the marker in real scene using computer (through ARToolkit)[3][4]. This is the famous method in augmented reality research area. After detecting the marker we use transformation matrix to build coordinate points of markers. Now the coordinate of the virtual object will translate into marker coordinate using transformation matrix [5].

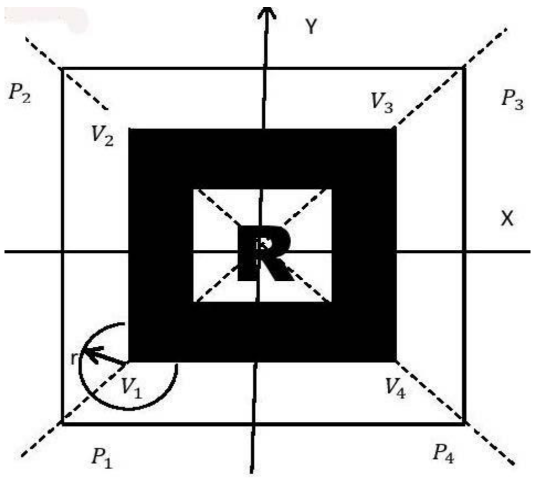

figure4: DR- special marker

Main important things here identify t ize and position (location) of the marker. We select the region of the interested (ROI)area. First we consider the real scene image without marker, then keep the marker in the image and gained the vertices, $V_i(i = 1,2,3,4)$ of the marker as shown figure-4. Here we consider the (ROI) by the points p_i (i=1,2,3,4)around the vertices[1]. The points around the vertices can be define as

$$\mathbf{p_i} = \mathbf{Size}(\mathbf{p_i})/\mathbf{Size}(\mathbf{V_i}).(\mathbf{V_i} - \mathbf{V_0}) + \mathbf{V_0} \qquad (1)$$

$$\mathbf{V_0} = 1/4.\textstyle\sum_{i=1}^{4} \mathbf{V_i} \qquad (2)$$

Where

$\boldsymbol{V_i}\rightarrow$ presents the side length of the marker.
$\mathbf{p_i}\rightarrow$ presents the side length of the ROI.
$\mathbf{V_0}\rightarrow$presents the centroid of the V_i

ROI is bigger than the marker, because ROI determined by the points around the vertices. Image in the ROI is saved as a texture of the projecting model, after ROI determined, as shown figure-5.in fig-5(c) a marker on a picture, in fig-5(c) ROI is computed and texture superimposed on the marker. In fig-5() special marker has been removed from the scene.

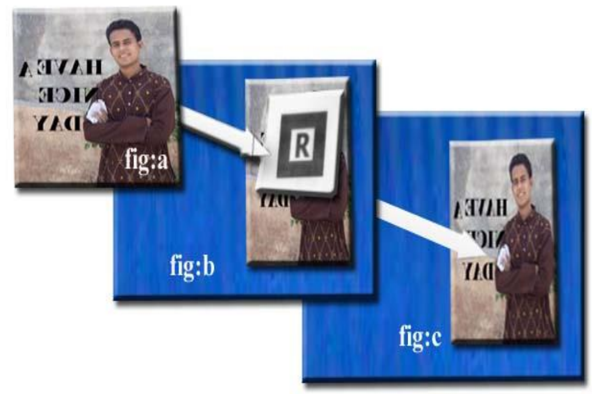

Figure5: projecting model (a) marker has been removed from scene.(b) original image (c) the texture of projecting model.

When AR marker is detected first time the ROI is picked up Then the affine transformation [6] matrix determined and ROI will be transformed and occupy place distortion. The image of the ROI is quadrate model which is called projecting model means region of interested area determined by points around the vertices is projected. When a live video stream comes, transformation matrix calculated, after marker detection and projecting model will change by it.

V. 2 Adjustment of projecting model.

The texture of the projecting model is not consistent due to light change[7]. So we have to adjust the projecting model in time. We adjust here **hue saturation value** (intensity) (HSV) of the texture to match the environment. We mentioned in previous section that the ROI is bigger than the marker, so we will see the part of the ROI, when the camera captured the images. Means there is an overlapping between the projecting model and real scene. Now we compare the same points HSV in the texture with real scene and adjust them. We can determine by the following equation [1].

$\lambda_{HSV}=\sum_{i=1}^{4} HSV(P_i)/HSV\,(V_i)$ (3)

Where

$HSV(V_i)$→HSV of the vertexes of the marker.

$HSV(P_i)$ →HSV of ROI vertexes.

λ_{HSV} → The coefficient of the projecting model and value of projecting model depend on this co efficient and its range 0 to λ_{max} .

The new texture can be determined by the following equation

$\mathrm{HSV}_{new}(tex_j) = [1 + \alpha_{HSV}.(\lambda_{HSV} - 1)].HSV(tex_j)$ (4)

Here $HSV(tex_j)$ denotes that HSV of the pixels of the projecting model and $\mathrm{HSV}_{new}(tex_j)$ is the new one. α_{HSV} is the wight for different function of hue, saturation, and intensity(value). Here α_V *is bigger than* α_H *and* α_S due to changing the intensity of the of the actual situation. If we consider α_V =1, α_H =0.20 and α_S=0.20 our result can be found as following figure-6.

Figure6:(a) A marker on the ground.

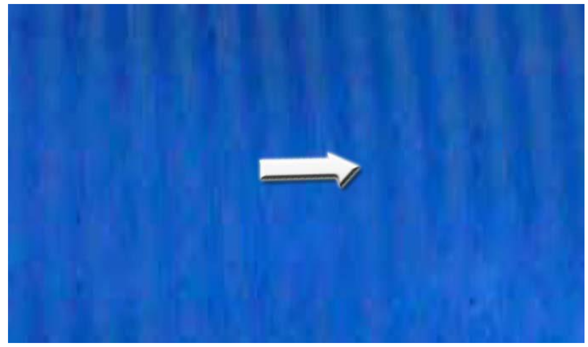

Figure6:(b) the marker is removed

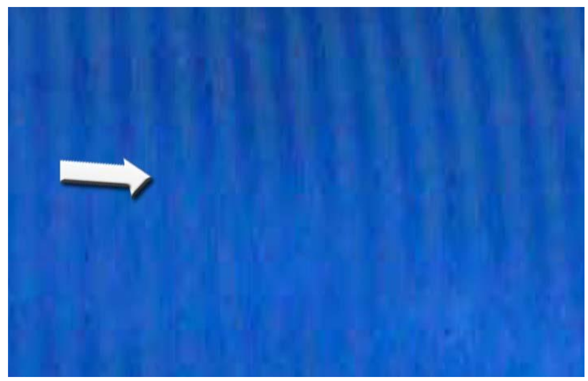

Figure6(c): the projecting model adjustment result

V.3 trackering

The AR marker will be detected, when live video stream comes and it processes very fist. But there is a little change in transformation matrix due influence by light and our visual feeling is not hopeful. So to swap this problem we used Euclidean distance equation [6][1] as shown below.

$$\begin{cases} \text{Not change T} & \left\| V_i^{last} - V_i^{current} \right\| < \text{r} \\ \text{Change T} & \text{others} \end{cases} \quad (5)$$

i= (1, 2, 3, 4)

where T is the transformation matrix

V_i^{last} are the vertexes of the marker in the last frame and $V_i^{current}$ are the vertexes of the marker in the current frame. *r* is the threshold of the allowed moving range, which is shown in the Fig.4. Equation (5) tells that if the all four vertexes move a little, the transformation matrix will hold on. The experimental result shows that the computer-generated models do not flutter after this method processes[5].

V.4 Occlusion of virtual to real object.

In an ordinary AR registration, graphic objects are added on marker. So real object occluded with computer generated (virtual) object. It is a simple approach and it cannot handle the occlusion between different types of objects in the real scene. Therefore here proposed a occlusion algorithm which can properly occluded between virtual and real object.

Here at first we consider the foreground of the real scene [9]. Now reference background is selected and saved. Then, once a frame comes, the reference background will compare with the current camera image as follows

1) If foreground color close to background it cannot be recognized.
2) If the intensity of the reference image and current image is large then weight of images also large, result color hard to recognize and image will pale.
3) If the intensity difference of two images is large then weight small.
4) So based on lightness (comparing) we can achieve projection model and occluded virtual object to real object.

To achieve above steps we use the the equation(6),(7) and(9)[1].

$$O(x, y) = \alpha(x, y).\Delta H(x,y)+(1-\alpha(x,y)).\Delta V(x,y) \quad (6)$$

Where

O(x, y) → pixel comparison.).ΔH(x , y) is a hue difference of pixel(x,y) in the reference background and current camera image. ΔV(x,y) is the intensity difference of two image.α(x,y) is a weight.

•ΔV(x,y) is inversely professional to α(x,y).

$$\alpha(x,y)= \Delta H(x,y)/ (\Delta H(x,y)+ \Delta V(x,y)).\ \beta.\min (V^{ref}(x,y), V^{current}(x, y)) \quad (7)$$

where$V^{ref}(x,y)$ is the intensity of reference pixels. $V^{current}(x, y)$ is the intensity of current image.

• $(V^{ref}(x,y), V^{current}(x, y)$ is directly professional to α(x,y).

$$\text{Occlusion}=\begin{cases} 1 & o(x,y)>\alpha(x,y).t_H+(1-\alpha(x,y)).t_V \\ 0 & \text{others} \end{cases} \quad (8)$$

Where t_H threshold of hue and t_V threshold of intensity. After equation(8) we decided which pixels should be drawn. Finally projection model is modified and image will be rendered as shown figure.7.

VI. result and discussion

In this paper we implement the proposed occlusion algorithm using laptop 2Ghz ,Intel core 2 Due processors and 3GB RAM and an ordinary camera. We used Microsoft visual studio 2010 to implement our proposed algorithm. We use ARToolkit, openGl, openCV toolkit

Figure7: Illustration of occlusion

At first we detect a marker in figure:6(b) projection model is applied a in figure:6(c) and there is no any marker after applied projection model in figure:6(a).now the artificial CG object can be superimposed on the projecting model as shown figure:1.
In this algorithm we used DR-marker[], which is stable and low-computation. It will rarely occur to flutter. DR-marker removes the marker from the image. It also achieved the result of the markerless method. We can show the final result as shown figure:8

Figure:8 in left fig (a) a marker is identified, in middle fig(b) remove marker and in right fig(c) a computer graphic object is added in marker removing place

VII. Conclusion

In this paper we proposed occlusion algorithm for AR registration. here we used DR-marker method, first we detect marker on real scene, then modified projection model and removed the marker.at last a computer graphic object is superimposed and occlusion relationship is created between real and virtual object, which look like a real scene as shown figure:8 this process mainly used in film making, video game etc. It has some problem still now. Our future plan to more improve this process.

VIII. References

[1] Chen ling Jing Zhao, Wenjun Zhang" DR-marker:a novel dimini-shing-a reality-based AR registration", 978-0-7695-5050-3/13 $26.00 © 2013 IEEE DOI 10.1109/ ICIG.2013.145

[2] Silvio R. R. Sanches, Daniel M.Tokun-aga, Valdinei F. Silva1,Antoni C. Seme ntille2, Romero Tori:" Mutual Occl-usion between Real and Virtual Elem-ents in Augmented Reality based on Fiducial Markers",Digital Object Identifier: 10.1109/ WACV.2012. 6163037, 2012 IEEE

[3] H. Kato, M. Billinghurst, "Marker Tracking and HMD Calibration for a Video-based Augmented Reality Conferencing System," IWAR'99, 1999, pp.85-94.

[4] JM. Liu, LX. An, Y. Chang, et al. , "Three-dimensional registration Met-hod based on triangular marker in aug mented reality," Journal of Shenyang University of Technology, vol. 35, no. 1, 2013, pp.79-84.

[5] G. Klein, D. Murray, "Parallel Track ing and Mapping for Small AR Work spaces," ISMAR 2007, 2007, pp. 225-234.

[6] I. Shahram, N.A. Richard, K. David, "KinectFusion: Real-time 3D Recons-truction and Interaction Using a Mov ing Depth Camera, SIGGRAPH '11, 2011.

[7] Y. Li, C. Sun, MM. Zhang et al. , "Parallel tracking and matching for natural feature based AR registration, Journal of Image and Graphics, vol 16, no 4, 2011, pp. 680-685

[8] J. Herling, W. Broll, "Advanced Self-contained Object Removal for Realizing Real-time Diminished Reality in Unconstrained Environments," ISMAR 2010, 2010, pp. 207-212.

[9] F. Jan, R. Holger, B. Gregory, "Detecting dynamic occlusion in Front of static backgrounds for AR scenes," EGVE '03, 2003, pp. 153-161.

[10] Li Yi-bo, Kang Shao-peng, Qiao Zhi-hua, Zhu Qiong "Development Actuality and Application of Registration technology in Augmented Reality" 978-0-7695-3311-7/08 $25.00©2008 IEEE DOI 10.1109/ ISCID .2008. 120

[11] Suya you, Ulrich Neumann, Ronald Azuma:" Hybrid Inertial and Vision Tracking for Augmented Reality Registration"