Museum Guide Through Annotations Using Augmented Reality

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ABSTRACT

The identification of objects displayed in existing Archaeological Museums, requires the observer to recognize the object or the associated concepts in the thematic environment. Usually, the visitor has a written guide or an expert that accompanies him on his visit. This paper presents an automated guide through annotations in Augmented Reality (AR) unmarked fiducial or free marker, by the recognition of objects shown in the showcase of the museum, showing 2D annotations on the objects. For that purpose, using Head Mounted Displays (HMD) or mobile PDA, the observer can see these annotations. The recognition is based specifically on mathematical relationships that gives us the principal component analysis (PCA), which evolves to create vectors that show more clearly the relationships in the image, which are known as principal component vectors (PCV). These concepts are used to identify archaeological objects and to create a symbolic image database for 3D archaeological objects existing in museum's showcases, which allows to conform the museum's guide system in appropriate time.

The work helps in shaping an appropriate proposal of recognition to create the symbolic image database of objects, the proper record of annotations on objects, when the mouse click selects it. This record is achieved by robust calculation, and monitoring based on homographies to ensure the insertion of the adequate annotation.

Keywords
Principal Component Vector (PCV), Wrapping, Homography, Augmented Reality.

1. INTRODUCTION
Augmented Reality (AR) is seen as a variation on the concept of Virtual Environment (VE), which allows the user to see the real world around him combined with superimposed virtual objects or compounded with it.

AR is a specific example of what Brooks, F. [Bro96] called Intelligence Amplification, using the computer to make easier tasks performed by humans. Hence the diversity of application fields, among which is, for example, Maintenance and Repair by Billinghurst, J. [Bil06], where AR applications simplify training and understanding for assembly, maintenance of complex industrial machinery, where annotation are shown, which can be used to associate them to real objects with information about themselves. Els Vilars [Vil06] in Arbeca, describes an Augmented Reality System developed at Universidad de Lleida, Spain, which using patterns marks placed on the environment, allow visits to the archaeological ruins.

Technological advances and tracking techniques experienced in recent years allow us to explore outdoor environments with mobile systems. These systems open new possibilities in navigation and the use of geographic information.

Simon, G. et al. [Sim00], performs tracking by planar homography, using the calculation of successive homographies with RANSAC (robust computing homography). The robust estimate of the homography is also used in the work in Malik, S. et al. [Mal02], tracking with passive mark a familiar pattern.

Yuan, M. et al. [Yua06] presents a scheme free of marks to achieve tracking through projection matrices, knowing the 3D points of the reference images. This is based on the work of Hartley, R. and Zisserman, A. [Har00] about factorization process of the fundamental matrix, which encapsulates the epipolar geometry and the essential matrix ($E = R \times T$), in this case, by decomposition, is projection or transformation matrices that relates the images and the coordinate system of the world always relative to the right image or second image. A more practical work is presented in Ma,Y. et al. [Ma06], which works directly with calibrated points and achieve compliance by the homographies and projection matrices that has reasonable mistakes, which are optimized for use later.

The purposes of this work focus on developing a methodology and propose an automatic architecture allowing insert annotations and virtual objects, without fiducial marker or intervention of the environment, near to the object in the showcase exhibited in the Archaeological Museum San Miguel de Azapa.

2. SYSTEM ARCHITECTURE

The system input consists of a sequence of images from the camera mounted on the video-based HMD or mobile device (PDA or Cellular). The system is make up of four main modules, where the former is responsible for selecting the object and its recognition by the method reported in [Her06]. If the object exit at the database the process continues with the initialization of the tracking. The next image of the sequence is considered second in order to initialize the tracking cycle, determining the correspondence matching using Scale Invariant Feature Transforms (SIFT) [Low04], where the points of interest of the recognized object is fit to the points identified in the second image, the third module calculates the homography with the corresponding points resulting from the matching and is optimized by robust calculation; and then selected points of entry are projected. Tracking to the next image consists of detecting image points in next image, then performing the matching with the points of the previous image. If the resulting number of matching points is greater than four points, then tracking process continues. The fourth module is responsible for positioning and inserting the virtual object so that it does not obstruct the object of interest (see Figure 1).
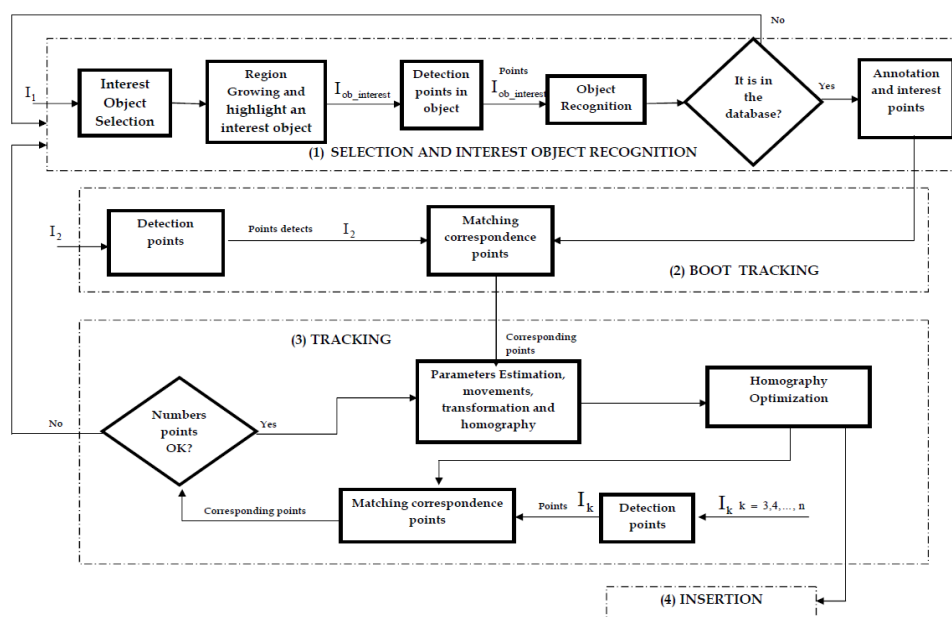

Figure 1. Proposed Architecture of the Augmented Reality System.

3. RESULTS

The test platform used to carry out the proposed method was a laptop with the following features: Intel Centrino Core 2 Duo T5550 processor, 1.8 GHz (2 MB cache, 3 GB of RAM DDR-2) with Windows XP operating system. The algorithm implementation was made using Visual Studio 2005 y Matlab Compiler, due to its ease of use and data management.

Following, the results step by step obtained during the development of the application is presented.

Selection and identification of the object of interest

In Figure 2a, is shown the first image, in which you select the object of interest (Textile loom) and is enhanced using the region growing algorithm (see Figure 2.b). From this new image (Figure 2.b), proceeds the detection of characteristic points to recognize the object of interest and thereby seek the associated annotation on the database, then proceed to add the annotation (see figure 2.c).

Initialization of Tracking

Once recognized the object of interest, initialization of tracking is performed, in order to detect characteristic points of the second image and perform correspondence between the selected points of interest from the object and those detected on the second image.

Tracking

After the correspondence of points, we can see there are points that are not relevant to the object of

interest, for this reason we proceeded to remove these spurious points by robust estimates and proximity.

Figure 2a. Image where the object of interest is selected.

Figure 2b. Object of interest.

Figure 2c. Annotation associated to the object of interest.

From these points we have the conditions to insert the annotation associated to the object of interest, using the process described in the system's architecture.

To verify the proposed method of tracking one object of interest is representing in showcase 6 of Archaeological Museum San Miguel de Azapa, which in this case is "Ceremony Helmet". The result of these tracking is found in Figure 3.

Effectiveness of the System

To analyze the results, we will consider only a showcase of the Archaeological Museum San Miguel de Azapa, in this case, we use the showcase 6 (see Table 1). This case includes the following items.

To perform the tests objects that are more representative here used. These objects are 1, 2, 14 and 16.

Figure 3. Test: tracking objects "Ceremony Helmet", courtesy of Archaeological Museum San Miguel de Azapa, Arica Chile.

Nº	Objects	Nº	Objects	Nº	Objects	Nº	Objects
1	Ceremony Helmet	5	Tray of Cociba	9	Points of Harpoons and fishing tools	13	Ceramic Pitcher
2	Textile Loom	6	Ceremony Plate	10	Cave painting	14	Ceramic Vase
3	Fishermen Pocillo	7	Kitchen Tools	11	Mummified skull	15	Mini pitcher
4	Fishing string	8	Fishing Harpoons	12	Rudimentary fishing harpoon	16	Typical Dress

Table 1. Objects in showcase 6 of the Archaeological Museum San Miguel de Azapa.

An important aspect to consider is the time it takes to make the insertion process of the annotation associated with the object of interest, as this process should be performed in real time.

In table 2 then assesses the time (in milliseconds) it takes to make the insertion process. This will take 5 iterations of the process.

As can be seen in Table 2, the average time it takes the system to perform the insertion of entries is 27 milliseconds, which is below the time required to make it in real time.

In the test, the results are valid for real-time or appropriate time en mobiles applications [Wag05], according to the time it takes to make integration meet the requirements.

		Time (milliseconds)					
	Object Showcase 6	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5	Average
1	Ceremony Helmet	28,74	31,63	22,94	24,10	28,32	27,14
2	Textile Loom	19,64	19,93	27,38	20,05	24,61	22,32
14	Ceramic Vase	10,18	6,51	9,48	6,45	6,11	7,75
16	Typical Dress	20,89	26,51	27,70	16,25	28,36	23,94

Table 2. Time (in milliseconds) to delay the insertion of annotations for objects 1, 2, 14 and 16.

4. CONCLUSIONS

The exploration of this area of image recognition and application of augmented reality in a space where the viewer is limited in connection with the object appears as a viable alternative and a contribution to multiple works on the use of PCV in computer vision.

According to the results, we conclude that the objects in the showcase number six are recognized without any problem, regardless of the size the region understands; this is due to the SIFT point detection and its use in establishing the automatic therefore it was used in earlier work of Harris and matching detection Pilu, see [Her06].

From the standpoint of characteristics points detector, it can be concluded that it must not only recognize a lot of points, but also that these are the most representative objects of interest, so that when carrying out the correspondence between images the object of interest and the second image successively obtained their positions. It is therefore very essential to optimize the points corresponding to eliminate those that do not belong to the object in question, and so, determine a best homography. The problem that arises is that for small objects, making this optimization eliminates points, which in some cases, prevents the determination of homography.

From the viewpoint of the insertion of objects, their accuracy depends heavily on the preliminary processes and taking advantage of existing natural brands in the showcase for the determination of the position. From the results obtained, we can conclude that for objects of considerable size, the insertion of annotations with a proper position perform a hundred percent, this was not so for small objects because of the number of points detected.

Regarding the time that it takes to perform the insertion of the annotation, we can conclude that the times obtained in the tests, are below those required to be used in real time, so the proposed method is valid to be used in real-time or appropriate time in mobiles applications.

5. FUTURE WORK

Performing the evaluation from the point of view of usability of the final system integration and insertion of alluding audio to the object on display will be considered. From the standpoint of computer vision operational comparisons with predictive and adaptive filters will be considered.

6. ACKNOWLEDGMENTS

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