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AUGMENTED REALITY LEARNING SYSTEM WITH CONTOUR ANALYSIS

Mrs. Namrata S. Mandvikar[1], Mrs.Snita Jadhav[2]

ME student of EXTC, SCOE, Mumbai University, Maharashtra, India[1]
Assistant Professor, Department of EXTC, SCOE, Mumbai University, Maharashtra, India[2]
[1]kinuss_2005@rediffmail.com
[2]smj311972@gmail.com

ABSTRACT

Augmented reality (AR) has been increasingly applied in various fields. It is a new technique of the computer vision application used to facilitate interaction in the digital arts. Augmented Reality (AR) employs computer vision, image processing and computer graphics techniques to merge digital content into the real world. It enables real time interaction between the user, real objects and virtual objects. We have discussed here different analysis methods for processing an image with more emphasis given on contour analysis. As Contour Analysis allows to describe, store, compare and find the object presented in the form of exterior outlines, solve the main problems of a pattern recognition - transposition, turn and a rescaling of the image of object. CA methods are invariant to these transformations. It provides more realistic interaction. It is an advance method and could be a promising technology for motivating users to engage in learning systems.

Keywords*:* Augmented reality, Pattern recognition, Image processing, Contour analysis.

I. Introduction

Augmented reality (AR) is a field of computer science research that combines real world and digital data. It is on the edge of becoming a well-known and common place feature in consumer applications. As a technology, augmented reality is now on the top of the "technology hype curve".

II. Augmented Reality

A*ugmented reality* is a type of virtual reality that aims to duplicate the world's environment in a computer. An augmented reality system generates a composite view for the user that is the combination of the real scene viewed by the user and a virtual scene generated by the computer that augments the scene with additional information. The virtual scene generated by the computer is designed to enhance the user's sensory perception of the virtual world they are seeing or interacting with .Augmented reality (AR) combines real world and digital data. At present, most AR research uses live video images, which the system processes digitally to add computer-generated graphics. In other words, the system augments the image with digital data. Encyclopaedia Britannica [1] gives the following definition for AR: "Augmented reality, in computer programming, a process of combining or 'augmenting' video or photographic displays by overlaying the images with useful computer-generated data."

Simple augmented reality system as shown in figure 1 consists of a camera, a computational unit and a display. The camera captures an image, and then the system augments virtual objects on top of the image and displays the result. The capturing module captures the image from the camera. The tracking module calculates the correct location and orientation for virtual overlay. The rendering module combines the original image and the virtual components using the calculated pose and then renders the augmented image on the display.

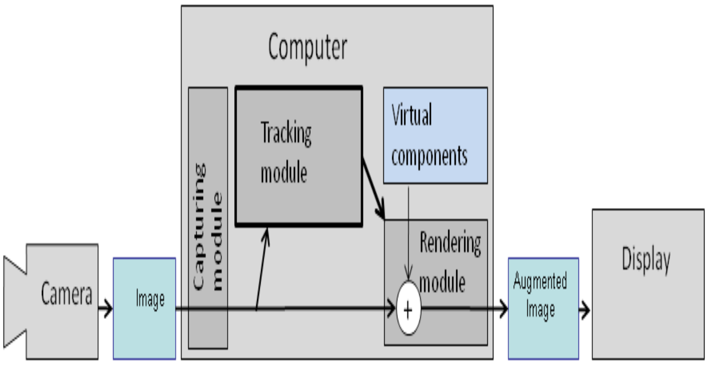


Figure 1. A flowchart for a simple augmented reality system

III. Different tracking methods

A. Marker-based tracking

Augmented reality presents information in a correct real world context. Thus in practice, the system needs to determine the location and orientation of the camera. The term tracking means calculating the relative pose (location and orientation) of a camera in real time. It is one of the fundamental components of augmented reality. As in most augmented reality setups the camera is already part of the system, visual tracking methods are used in AR. In visual tracking, easily detectable predefined sign is added in the environment and computer vision techniques are use to detect it. A marker is such a sign or image that a computer system can detect from a video image using image processing, pattern recognition and computer vision techniques. Once detected, it then defines both the correct scale and pose of the camera. This approach is called marker-based tracking, and it is widely used in AR.

B.Feature-based tracking

Feature detection and tracking algorithms are widely used for motion detection, image matching, tracking, panorama stitching, 3D modelling and object recognition well. We can divide localised features into three categories: feature points (e.g. corners), feature descriptors (e.g. SIFT) and edges. A feature point (also called an interest point or key point) is a small area in an image, which has a clear definition and a well-defined position. Term feature descriptor or image descriptor refers to the characteristics of an image region or a feature.

C. Hybrid tracking

Hybrid tracking means that the system combines two or more tracking methods. We discuss here model-based tracking and sensor tracking methods.

IV. Visual tracking method

A visual tracking method deduces the camera's pose from what it sees; therefore, visual tracking is often called camera(-based) tracking or optical tracking. Visual tracking can be based on detecting salient features in the images, this approach is called *feature-based tracking*. The system may also have a model of the scene or part of the scene and then tries to detect this model from the image and thus deduce the pose of the camera; this approach is *model-based tracking*.

Feature detection and tracking algorithms are widely used for different purposes in computer vision applications.

Two approaches are commonly used to find feature points and their correspondences:

- Tracking only, Selecting features that can be locally tracked.

Selecting features that can be locally tracked.
Detection + matching, detecting all features first and then matching them based on their local appearance.
A third approach is to combine these two:
Detection + local matching / detection + tracking, detected features are matched only to locations near their previously detected location. In other words, detected features are tracked.

A. Feature detection methods

We may classify them based on what kind features they detect: edge detectors (e.g. Canny), corner detectors (e.g.Shi&Thomasi), blob detectors (e.g. MSER) and patch detectors (e.g. [135]).

B. Feature points and image patches

Corner points and blobs are special types of feature points. A corner point is literally some kind of visual corner; it is an image area where two edges intersect. A blob or blob feature is an image area that is brighter or darker than its surroundings.
The basic difference between a corner and blob feature is the scale. If we shrink a blob feature, it becomes sharper and similar to a corner feature. Blob features have the advantage that they are rotation invariant and thus of special interest.
SUSAN (Smallest Univalue Segment Assimilating Nucleus) [146, 147] is a corner detection method. This algorithm generates a circular mask around a given pixel (nucleus of the mask) in an image. Then it compares the intensity of neighbouring pixels with it. The area with a similar intensity to the nucleus is called the USAN area. The procedure is repeated for each pixel in the image. This way it associates each point within an image with a local area of comparable brightness. The USAN area falls as an edge is approached, and near corners it falls further, giving local minima in the USAN area at the exact positions of the image corners. The SUSAN algorithm uses no image derivatives, hence gives good performance even when there is noise .
Features from Accelerated Segment Test (FAST) is another often used corner detection method. The FAST detector produces very stable features. The FAST detector is available for several platforms including Windows, Linux, MacOS and iPhone, and it is widely applied in different applications. It is used for parallel tracking and mapping.

V. Feature matching

After detecting the features, the system needs to *match* them, i.e. it needs to find corresponding features in different images. For feature matching, tracking systems use commonly two different approaches: they compare the small image areas around the features and find similar areas (template matching), or they calculate image characteristics around the features and compare them (descriptor matching).

A. Scale-invariant feature transform (SIFT)

It is a widely used feature detection and tracking algorithm [158] and [159]. SIFT is based on feature descriptors. The SIFT algorithm computes a histogram of local oriented gradients around the interest point and stores the bins in a 128-dimensional vector (eight orientation bins for each of the 4 × 4 location bins).

B. PCA-SIFT

It is a variation of a SIFT algorithm which is also based on the salient aspects of the image gradient in the feature point's neighbourhood. PCASIFT applies *principal components analysis* (PCA) to the normalised gradient patch image instead of using SIFT's smoothed weighted histogram. PCA-SIFT yields a 36-dimensional descriptor which is faster for matching, but has proved to be less distinctive than SIFT in the performance evaluation test [161].

C. Gradient Location and Orientation Histogram (GLOH)

It is also a SIFT-like descriptor that considers more spatial regions for the histograms. GLOH uses principal components analysis like PCA-SIFT, but yields to a 64-dimensional descriptor [161].

D. Speeded Up Robust Features (SURF)

It is a scale and rotation-invariant feature point detector and descriptor for image matching and object recognition [2]. SURF is based on sums of 2D Haar wavelet responses and makes efficient use of integral images. As basic image features, it uses a Haar wavelet approximation of the determinant of Hessian blob detector. The standard version of SURF is faster than SIFT and more robust against different image transformations than SIFT [3].

E. Local Energy-based Shape Histogram (LESH)

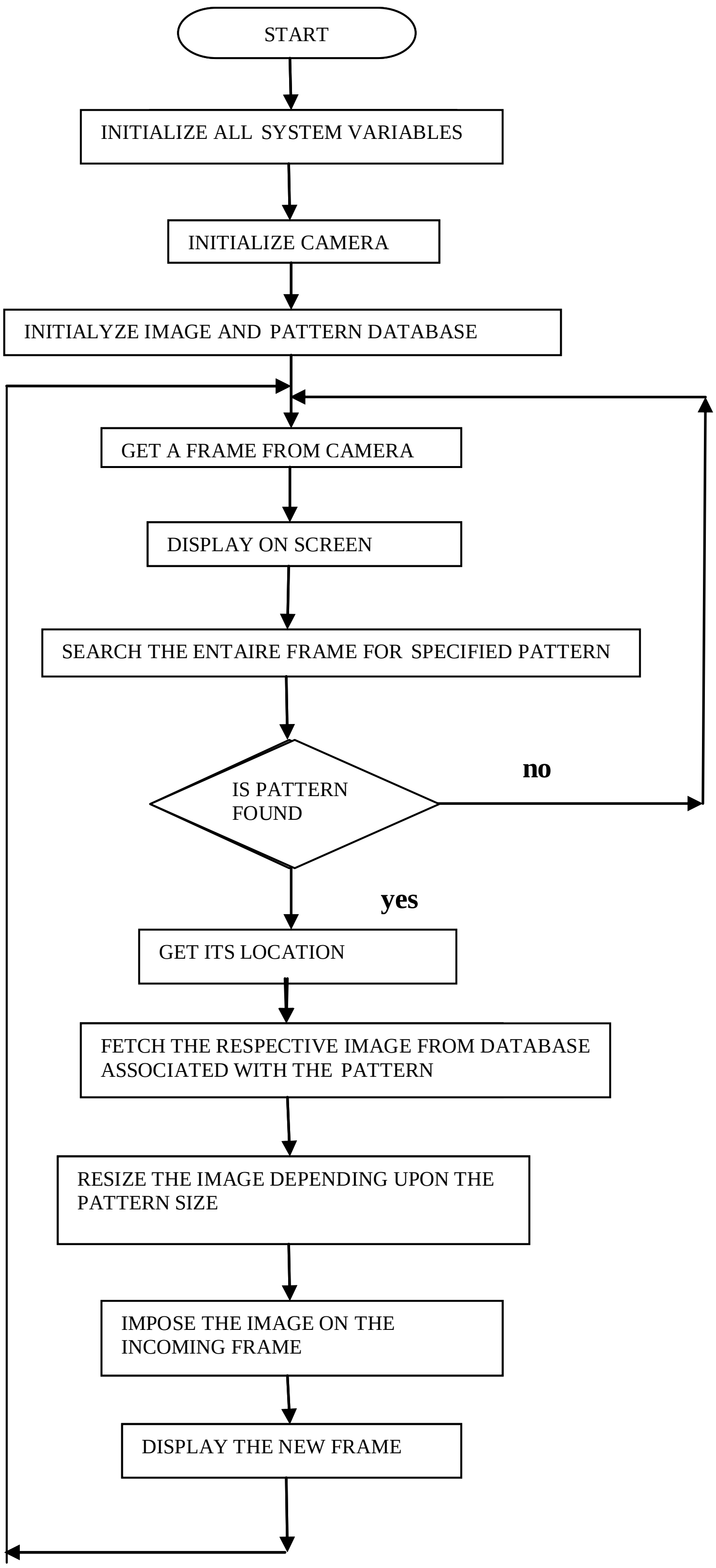
***It* is** a robust front-end pose classification and estimation procedure originally developed for face recognition [163, 164]. It is a scale-invariant image descriptor, which can be used to get a description of the underlying shape. LESH features suit a variety of applications such as shape-based image retrieval, object detection, pose estimation, etc. LESH. is based on a local energy model of feature perception. LESH accumulates the local energy of the underlying signal along several filter orientations, and several local histograms from different parts of the image patch are generated and concatenated together into a 128-dimensional compact spatial histogram.

F. Contour analysis(CA)

if the necessary information is in the object shape,we can go for CA. In a CA the contour is encoded by the sequence consisting of complex numbers. It allows to effectively solve the main problems of a pattern recognition - transposition, turn and a rescaling of the image of object. CA methods are invariant to these transformations.

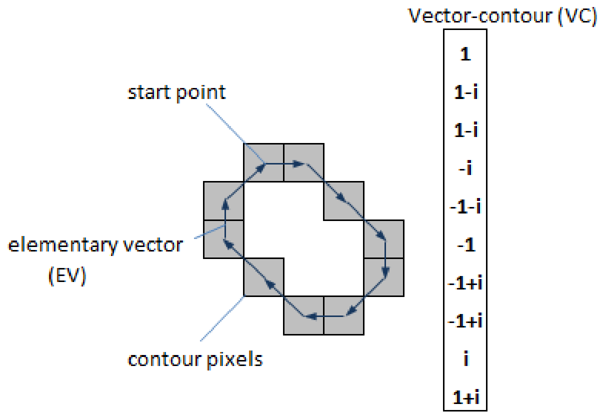
VI. Learning system

We propose a system where camera take the pattern image and display it on the screen.
Image processing is computer imaging where image are to be examined and acted upon by people. it include image restoration ,image enhancement, image compression. When matching one object to another, the objective is to have a precise and concise description of the object so that incorrect matches can be quickly rejected and the proper matches can be made without ambiguity. The nature of the description will depend on the application, in particular the shapes of the objects and the number of objects to be matched against. For instance if the objective is to recognize text and graphics, where all the graphics consist of long lines, then discriminating descriptors would be region size or contour length. Here Contour analysis is used for pattern recognisation.
This pattern is searched in entire available frame.If pattern is found then image associated with frame is fetch form the database.This image is augmented on the given frame and display.



VII. Contour Analysis

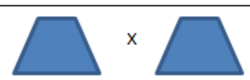
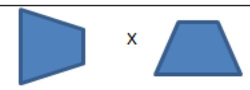
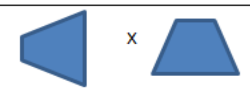
The contour is the boundary of object.It is the population of points or pixels,separating object from a background. In a CA the contour is encoded by the sequence consisting of complex numbers. On a contour, the starting point is fixed. Then, the contour is scanned and each vector of offset is noted by a complex number a+ib. Where a - point offset on x axis, and b - offset on y axis. Offset is noted concerning the previous point.



Owing to the physical nature of three-dimensional objects, their contours are always closed and cannot have self-intersection. Hence we can define unambiguously a way of bypass of a contour. The last vector of a contour always leads to the starting point. Each vector of a contour name *elementary vector* (EV). And sequence of complex-valued numbers - *vector-contour* (VC).Normalised scalar product (NSP) of a contour can be defined as

$$\eta = \frac{(\Gamma, N)}{|\Gamma||N|}$$

Properties of the normalized scalar product of contours

	NSP	Re(NSP)=cos(a)	|NSP|
	1	1	1
	i	0	1
	-1	-1	1
	-i	0	1

The norm of the normalized scalar product of contours gives unity only in the event that these two contours are equal to within turn and a scale. Otherwise, the norm of NSP it will be less unity. Actually, the norm a NSP is an invariant on transposition, rotation and scaling of contours. If there are two identical contours their NSP always gives a unity, is not dependent on where contours are, what their angle of rotation and a scale. Similarly, if contours are various, their NSP will be strict less 1, and also independent of a place, rotation and a scale.

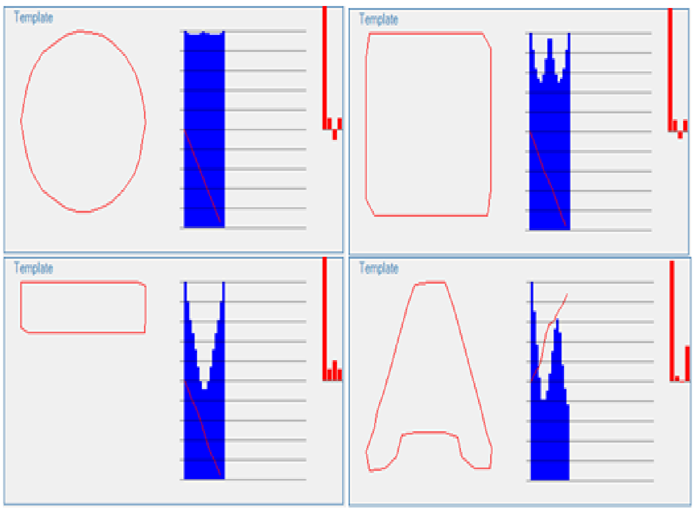
If contours are identical, but the EV reference begins with other starting point the norm the NSP of such contours will not be equal to a unity.

VIII. Practical application of contour analysis

Contour analysis is used for pattern recognition task on the image. Let us take the image a size n*n pixels. Then breed its uniform grid with a step s. The total length of all grid lines is: $L = 2n^2/s$ As the image in the form of contours already has natural segmentation - is divided into contours it is possible to carry out a filtration of parts of the image to simple indications.

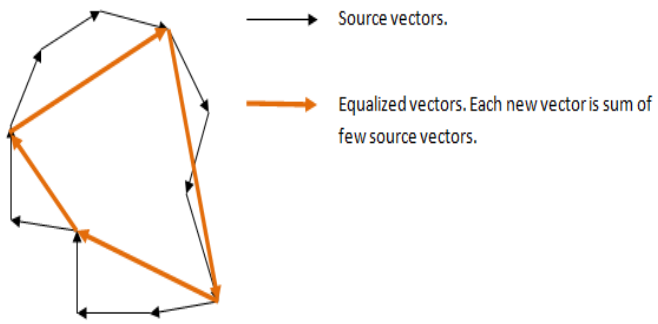
Among them - contour square, perimeter, the ratio of quadrate of perimeter to squares. Thus, there is enough simple and effective mechanism of a preliminary filtration of parts of the image. The CA allows to process the image in a progressive mode. It means that we can sort contours on any to an indication (for example, by square or on a gradient of boundaries, or on brightness, etc.). And then to treat the first contour, and to produce outcome. Remaining contours to process in a background mode. It means that the first outcome (and in many application-oriented tasks it and it is necessary) can be received for O(n) that is an excellent estimation for algorithms of pattern recognition. As contours are independent from each other algorithms of a recognition it is easy to parallelize. Besides, algorithms are very simple and can be executed on graphic processors.

For fast searching of templates, it is necessary to introduce the certain descriptor characterizing the shape of a contour. Thus, close among themselves contours should have the close descriptors. It would save us the procedure of an evaluation an ICF of a contour with each template. Would be to compare only descriptors and if they are close - only in that case enough - to calculate an ICF. Comparing of descriptors should be fast. Ideally, one number should be a descriptor. An ACF invariantly to transposition, rotation, scaling and a starting point choice. And besides, the ACF is a function of one contour, instead of two, as an ICF.Hence the ACF can be selected as the descriptor of shape of a contour. The close contours will always have the close values an ACF. In pictures, the norm the ACF is represented by dark blue color (an ACF it is represented only for an interval from 0 to k/2).



IX. Equalization of contour

In the real image contours have arbitrary length. Therefore, for searching and comparing of contours, all of them should be led to uniform length. This process is called *equalization*.At first, we fix length of a VC which we will use in our system of a recognition. We designate it k.Then, for each initial contour A we create vector-contour N in length k. Further probably two variants - or the initial contour has greater number of an EV than k, or smaller number than k. The picture shows the meaning of equalization:



X. CA limitation

the CA makes sense, only in that case when the object contour is defined unambiguously correctly in all points.CA methods assume that the contour describes all object bodily, and does not suppose any intersections with other objects or incomplete visibility of object.

XI. Software

Some software's for image processing are – matlab which is very slow in response, AForge.net which don't have more libraries for human computer interaction (HCI) and OpenCV. OpenCV is an open source computer vision library written in C and C++ and runs under Linux, Windows and Mac OS X. Image going to be processed is capture through web camera using open CV software.

As C#.net is based on C++ and is compatible with OpenCV library. For implementing base function of CA we propose C#.

Contour Analysis Processing uses library OpenCV (EmguCV .NET wrapper) for operation with the image.

C# is easy to use and is graphical user interface (G.U.I.) based. Emgu.CV is used as a wrapper for the C#.net and OpenCV environment.

XII. Advantages

- It helps students to understand and the concepts clearly.
- The chance of false imagination while learning is reduced.
- Less time to learn.

- Recall of concepts is enhanced.
- Self learning is possible or it is easy for lecturers to teach.
- It can be used in understanding geometrical puzzles, Structure of electron, atom...etc, g)
- It leads to innovative thinking
- It improves the standard of education.

XIII. Conclusion

CA methods are attractive for the simplicity and high-speed performance. high-speed performance of a CA allows to process video.

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BIOGRAPHY

Mrs. Namrata Mandvikar is working as a lecturer in B.L.Patil Polytechnic Khopoli, Raigar. She is pursuing M.E. in Electronics & Telecommunication from Saraswati College of Engineering, Mumbai University. She has seven years of teaching experience. Her research interest is in Image processing and Microwave.

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Mrs. Sunita Jadhav is working as an Assistant Professor in Saraswati College of Engineering Kharghar, Navi mumbai, Mumbai University, India. She obtained M.E. (Electronics/Computer Application) in 2006. She received MBA (Production & Marketing) in 1995 and currently pursuing Ph.D. at JJTU, Jhunjhunu, Rajasthan, India. She has eleven years of teaching experience. Her research interest is in Image processing, Microprocessors & Microcontrollers. She has published number of papers in National and International Journals.