

Augmented Reality based on Image Processing

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Abstract: Augmented Reality is hot trend in mobile industry, allowing addition of external data on top of camera input. Augmented Reality is used in areas such as gaming, navigation, tourism, and education in full interest. Using Digital image processing algorithms and computer vision different iPhone and android applications are created. Our concept is much like what we see and what our brain understand. We propose here to implement a real world object by capturing and follow several image processing technique to get an effective augmented image.

INTRODUCTION

Augmented Reality is research area which is in progressive stage and focuses on wearable technology like goggles, contact lenses which will be commonly used in future.

The three characteristics of Augmented reality system are[1]:

- Combine real and virtual environment
- Real time interaction
- Registered in 3D

The basic goal of Augmented reality system is to enhance the user perception of and interaction with real world through supplementing the real world with 3D virtual objects that appear to coexist in some space as real world. Registration of an image refers to accurate alignment of real and virtual object, without registration the illusion that virtual object exist in real environment is severely compromised[2].

There is drastic growth of data over the internet day by day due to which the searching of

required information has become difficult. Now, if we have to search about any topic then we have to enter a desired keyword for that searching else an unnecessary information are obtained.

Similarly, in case of augmented reality, it should be clear that which object should be augmented with virtual environment. So that desired

result is obtained. Just like in animation, gaming, navigation, medical, tourism, etc.

Our idea of using Digital Image Processing technique satisfy the above mentioned need using camera and augmented reality. Camera is used as a frame through which a user can see the object in that frame and that by using the feature detection technique, object to augment is obtained and then it is augmented with virtual environment by mapping technique.

Augmented reality allows the user to get the superimposition of real world with virtual object. So Augmented reality supplements or add

feature to the reality in place of removing it. There are some differences between virtual reality and an augmented reality which will be cleared by a reality-virtuality-continuum (RV-continuum) is used[3].

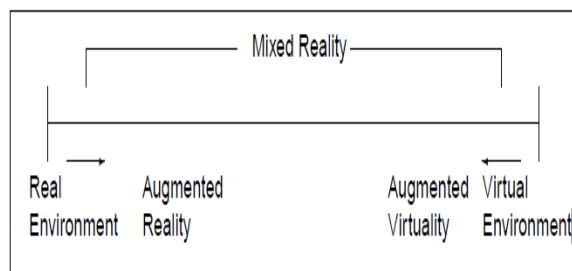


Figure 1: RV-continuum

An artificial environment developed by computer in which ones action partially defines that what would happened in a real environment via computer generated stimuli is known as virtual reality, whereas Augmented virtuality is virtual reality with some real world objects .For example: In whatsapp chatroom we send a voice messages to our friends in this virtual environment is augmented with real voice generated by chatters, augmented reality is same as augmented virtuality, only there is difference in ratio between real/virtual environment

METHOD

There are two stages in detecting an interest point, fiduciary marker, or optical flow and augmenting it with a virtual environment:

Stage 1: Feature Detection

Stage 2: Real World Coordinate + Data from Stage 1. Method used in this stage are: Projective Geometry, Geometric algebra, rotation representation with exponential map, Kalman and particle filter, Non-linear optimization, and robust stats.

The layout of the Augmented Reality is as shown in figure2. In this firstly we input a camera image as an input image then feature detection

technique is used to find out the interest point in an image and then extracted part is mapped as a viewing coordinate of a user with addition of a virtual environment features .Now the output as an augmented image is found a output frame.

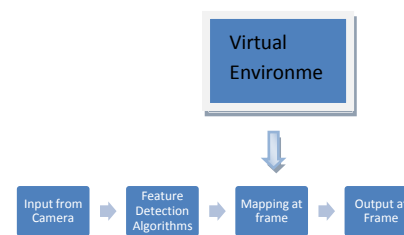


Figure 2:

Augmented Reality Layout

FEATURE DETECTION TECHNIQUES

A. EDGE DETECTION

It is a set of mathematical methods which aims at identifying points in digital image at which image brightness changes sharply or more formally, has discontinuity.

Problem of Discontinuity:

- 1) Step Detection : Problem of finding discontinuity in 1D.
- 2) Change Detection: Problem of finding signal discontinuity over time.

There are several edge detection techniques :

- 1) Sobel Operator: It consist a pair of 3*3 convolution kernels as shown in figure 3. One kernel is simply the other rotated by 90 degree.



Figure 3: Sobel operator kernels

It is designed to respond maximally to edges running vertically and horizontally relative to pixel grid[4].

$$|G| = \sqrt{G_x^2 + G_y^2}$$

Angle of orientation of edge:

$$\theta = \arctan(G_y/G_x)$$

2) Robert Cross Operator:

- a) Simple, Quick to compute, 2-D spatial gradient measurement on image[5].
- b) Operator contains pair of 2*2 convolution kernels as shown in figure 4.

+1	0
0	-1

Gx

0	+1
-1	0

Gy

Figure 4: Mask used for Robert Operator

$$|G| = \sqrt{G_x^2 + G_y^2}$$

Angle of orientation of edge:

$$\theta = \arctan(G_y/G_x) - 3\pi/4$$

3) Prewitt Operator: It is similar to sobel Operator and is used for detecting vertical and horizontal edges in images[6]. Operator contains pair of 3*3 convolution kernel as shown in figure 5.

-1	0	+1
-1	0	+1
-1	0	+1

Gx

+1	+1	+1
0	0	0
-1	-1	-1

Gy

Figure 5: Mask for prewitt gradient edge detector

4) Canny Edge detection Algorithm: It is preferred because

- a) Low Error Rate
- b) Distance between edge pixel detected and real edge pixels have to be minimized.
- c) Minimal response: Only one detector response per edge.

Steps in Canny edge detection:

- i) Use Gaussian Filter to filter out any noise.
- ii) Find Intensity gradient of an image.

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

$$|G| = |G_x| + |G_y|$$

- iii) Remove the pixel that are not considered to be a part of edge by using suppression . Hence only thin line remains.
- iv) Let there be two thresholds Tu and Tl (i.e upper threshold and lower threshold)

if(Gpixel>Tu)

then accepted

if(Gpixel<Tl)

then rejected

if(Tl<Gpixel<Tu)

then accepted if

connected to pixel above upper threshold

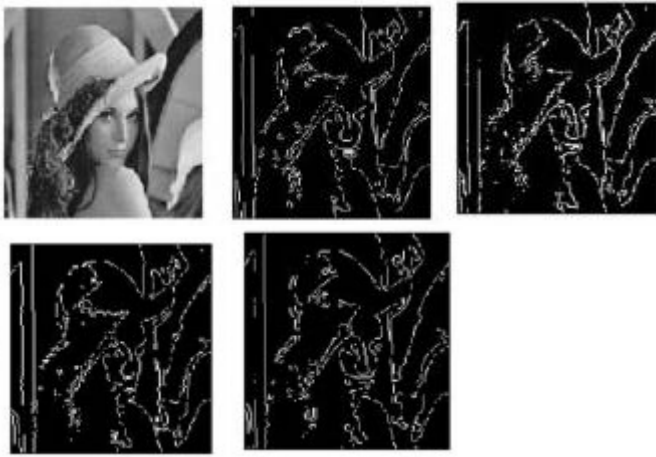
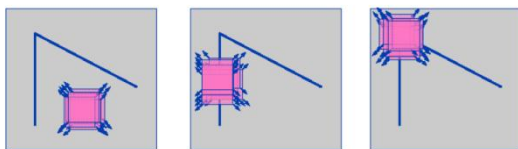


Figure 6: Comparison of edge detection technique on an (a) original image (b) Canny method (c) Robert edge (d) Sobel (e) Prewitt's.

B. CORNER DETECTION

Now, when the edges are detected so our next job is to determine the corners using those edges. Corners may be defined as the intersection point of horizontal and vertical edges. In extraction of image of an object it is necessary to obtain left top and right bottom corners to define coordinate of image.



(a) Flat region (b) edge found (c) Corner Found

Figure 7

In figure 7(a) there is a flat region there is no change in all direction, figure 7(b) there is an edge i.e no change about edge direction, figure 7(c) there is corner i.e. significant change in all direction.[8]

C. BLOB DETECTION

Now, after the detection of edges and corner another feature i.e. blobs are detected in an image.

Blob is a region of a digital image in which some properties are constant as vary within prescribed range of values. It can be done by two techniques:

- 1) Differential method
- 2) Method based On local extrema

D. OBJECT ORIENTATION AND TRACKING

It is a technique in which an object is oriented at a virtual plane . In this a object with corners ABCDELMN is projected on a virtual environment according to user view plane as shown in figure 8.

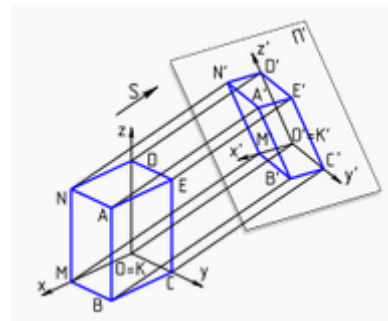


Figure8: Projection of an object in virtual environment[10]

E. AUGMENTING THE RESULT

Augmented Image = Data from feature extraction + Real World coordinate + Virtual Environment

Algorithm:

- 1) Input: RGB Image, Threshold T
Output: Augmented Image
- 2) Apply RGB to HSV Conversion(): Color vision can be processed using RGB color space or HSV color space. RGB color space describes colors in terms of the

amount of red, green, and blue present. HSV color space describes colors in terms of the Hue, Saturation, and Value. In situations where color description plays an integral role, the HSV color model is often preferred over the RGB model. The HSV model describes colors similarly to how the human eye tends to perceive color. RGB defines color in terms of a combination of primary colors, where as, HSV describes color using more familiar comparisons such as color, vibrancy and brightness.

The R, G, B values are divided by 255 to change the range from 0..255 to 0..1:

$$\begin{aligned} R' &= R/255 \\ G' &= G/255 \\ B' &= B/255 \\ C_{max} &= \max(R', G', B') \\ C_{min} &= \min(R', G', B') \\ \Delta &= C_{max} - C_{min} \end{aligned}$$

Hue calculation:

$$H = \begin{cases} 60^\circ \times \left(\frac{G' - B'}{\Delta} \text{ mod } 6 \right) & , C_{max} = R' \\ 60^\circ \times \left(\frac{B' - R'}{\Delta} + 2 \right) & , C_{max} = G' \\ 60^\circ \times \left(\frac{R' - G'}{\Delta} + 4 \right) & , C_{max} = B' \end{cases}$$

Saturation calculation:

$$S = \begin{cases} 0 & , \Delta = 0 \\ \frac{\Delta}{C_{max}} & , \Delta <> 0 \end{cases}$$

Value calculation:

$$V = C_{max}$$

- 3) Calculate change in image when motion accomplished i.e. I to I'

$$\text{Abs}(D) = |I(x, y, t) - I(x, y, t-1)|$$

- 4) If $(\text{abs}(D) > T)$

Binary motion map=0;

Else 1;

- 5) If(Binary motion map=0)
Probability Image=0;
Else $D(x, y, t) \quad \backslash \backslash$ Calculated in step 3
- 6) Is Image clear i.e Noiseless??

If no apply the filter to clear noise

To remove salt and pepper noise from the corrupted image the below described algorithm is used.

Step 1: A two dimensional window (denoted by 3×3 W) of size 3×3 is selected and centered around the processed pixel $p(x, y)$ in the corrupted image.

Step 2: Sort the pixels in the selected window according to the ascending order and find the median pixel value denoted by P_{med} , maximum pixel value (P_{max}) and minimum pixel value (P_{min}) of the sorted vector V_0 . Now the first and last elements of the vector V_0 is the P_{min} and P_{max} respectively and the middle element of the vector is the P_{med} .

Step 3: If the processed pixel is within the range $P_{min} < P(x, y) < P_{max}$, $P_{min} > 0$ and $P_{max} < 255$, it is classified as uncorrupted pixel and it is left unchanged. Otherwise $p(x, y)$ is classified as corrupted pixel.

Step 4: If $p(x, y)$ is corrupted pixel, then we have the following two cases:

Case 1: If $P_{min} < P_{med} < P_{max}$ and $0 < P_{med} < 255$, replace the corrupted pixel $p(x, y)$ with P_{med}

Case 2: If the condition in case 1 is not satisfied then P_{med} is a noisy pixel. In this case compute the difference between each pair of adjacent pixel across the sorted vector V_0 and obtain the difference vector VD . Then find the maximum difference in the VD and mark its

corresponding pixel in the V0 to the processed pixel.

Step 5: Step 1 to step 4 are repeated until the processing is completed for the entire image [9].

- 7) Final Probability Image = 0 if Binary motion map = 0
Else $\alpha * \text{Probability_Image} + (1 - \alpha) * \text{Color_Probability_Image}$

CONCLUSION

We foresee that Augmented Reality is an area of research that aims to enhance real world image by overlaying virtual object over it via superimposition technique. In this paper we proposed here to implement a real world object by capturing and follow several image processing technique to get an effective augmented image by superimposing it with a virtual environment using an algorithm, we also discussed about different feature extraction techniques to obtain an efficient augmented image.

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