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Implementation of Human Tracking System with Depth Estimation for Defense Application

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***Abstract* — Identifying human presence in a visual surveillance system is crucial for variety of applications. Various tracking systems are also refined with a vision to detect human beings. However lesser resolution pictures make them a challenging one. So a stereo vision based human detection and tracking system is proposed for recognition of intruders in the human access controlled areas and can help in observing and inspecting illegal activities. In this depth range of the system is used in parameter estimation. The human presence is identified by skin detection where segmentation is done in HSV color space. Human tracking is a separate hardware system coupled through a serial port. For targeting servo motors are used, along a buzzer and a laser light for pointing the target. Here the presence of animals is also eliminated by a change in algorithm. The proposed implementation need only less protection and climate conditions are least influenced.**

***Index Terms* — 3D vision, Depth range, Human tracking, Servo motor, Animal detection.**

I. INTRODUCTION

For the several past decades skin detection is used in a wide variety of applications like feature detection, exposed people detection as skin color gives helpful and powerful data's and also the range of occurrence is more compared to other parts. It is one of the frequently used approaches for diagnosing humans as it has many attractive properties like high processing speed, search space of area is less. However skin diagnosing techniques are affected by lighting status, multiple background, and non identical ethnicity.

Even though there are many classisifiers used for skin detection like Neural networks [1], Bayesian classifiers [2], Gaussian filters [3], Self Organizing Maps [4], Random forest approaches [5] , regularly used technique is by defining a fixed boundary for contrasting components [6].Then threshold values are calculated. But it covers an abundant region in domain. It also needs a huge number of other images. So here HSV color space [7] is used for segmentation of skin pixels which can be used to recognize the presence of human.

For human tracking schemes also vast number of techniques are accessible like network tracking, wireless tracking. They are used in different applications like Medicinal field, child Abuse, screenplay editing, and rows monitoring, search and rescue operation, calamity prone areas. Since it is simple to evaluate the motion of the object, many algorithms are developed till now [8]. But the presence of wind and shadow make the images blurred one.

Here using multiple cameras human detection and tracking is done, which is flexible to different skin colors and can manage non identical ethnicity. Hair color can also be included in detecting human faces. Skin detection is the fastest method for identifying as the area of occurrence is more compared to other parts. Tracking is a separate section which can be used to target the detected portion which is done using a laser light. Animals are also differentiated with a view to improve the accuracy.

II. RELATED WORKS

Skin detection is the process of finding skin colored pixels in an image or video and representing them in a suitable color space. Since color and texture are useful in identifying an object many applications are provided like identifying nude pictures on internet for filtering purpose, identifying original images [7].Since color of skin results from a dark brown to pinkish white illuminations are deeply affected. LO color

space [3] was commonly used to find skin regions because color opponency is significant. It is mostly representation of color information by applying logarithms. There is also a luminance invariant space approach [9]. A better survey of different color spaces for skin color representation [7] is available. Other approaches are multilayer Perceptron [4], Bayesian classifiers [2], random forest [5].Neural networks was trained to study about the complex class distributions of skin pixels in multilayer Perceptron whereas in Bayesian network a decision rule was established.

Intruders are the activists that violate the policy of the system and the process of finding them is the intruder detection. They are also classified, based on anomaly detection, signature based misue, host based detection, and network based detection. All these had been very successful but a real time stereo vision based approach which has high accuracy is proposed here which have only least computational complexity when compared with others.

III. SYSTEM ARCHITECTURE

Smart human identification system is classified into

A) Human Detection Systems(HDS)

B) Human Tracking Systems(HTS)

The detection part (HDS) is done with the help of image processing. To recognize the presence of human HSV color space is used. Applying a stereo vision based approach images can be captured and at the same time videos can also be converted to frames using software which identifies the human location. If the intruder is moving angle of the object with its centriod is obtained. A control word has been organized for uncomplicated correspondence.

The tracking part (HTS) is separate microcontroller section connected through a serial port. Two servo motors are p provided. The control word message can be decoded with the help of microcontroller which simultaneously drives the motors. Thus parameters can be extracted.

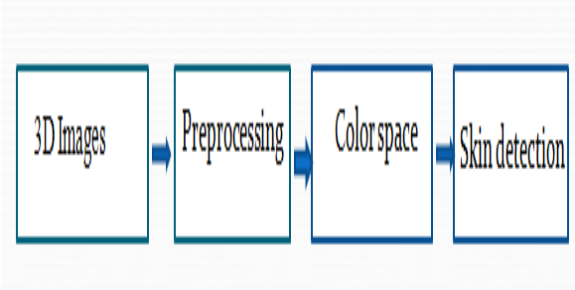

Figure 1: Block diagram of skin detection

HDS and HTS are separately coupled through a serial port. Once the message is created it reaches through the serial port .An LCD LM016L is utilized to display the received message, with the two servo motors controlling the angular positions. If there are several people present on the video or image then the centroid of all the regions are estimated and the midpoint of them gives the required result.

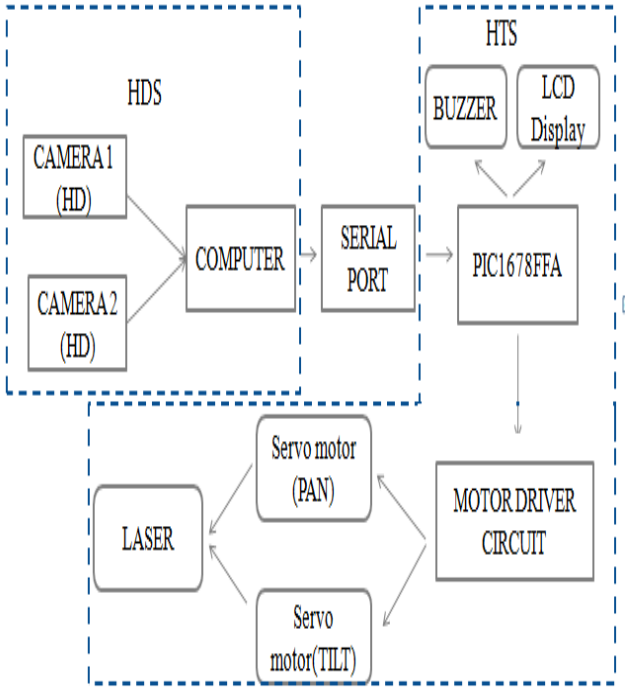

Figure 2: Block diagram

A. IMAGE ACQUISITION

Image acquisition is the first process to be done. The acquisition could be as simple as accruing a given image that is already in digital format. But here real time scenarios can be recorded. Higher resolution cameras are needed to capture the image. Since quality depends on size of the image different preprocessing steps like dilation, erosion has to be done.

B. SKIN DETECTION

The quickest channel for human tracking is by identifying the skin area as the region of appearance is larger. The hair color detection can also be used for face recognition so that accuracy can be improved [11].The color of human skin ranges from dark brown to pinkish white which is obtained from a combination of blood (red) and melanin

(yellow ,brown).Skin also has some texture which have high intensity values. It is similar more in brightness than in colors.So lightening conditions are affected. Since RGB model does not have a separate intensity and color component, HSV color space is used o segmenting skin pixels.

Hue (H) defines the dominant color of an area and is a measure of different color components which ranges from 0-360.Saturation gives the color of a region which contribute the clarity of an image with respect to its own brightness. RGB values obtained are equated in cylindrical coordinates, the radial position denotes this saturation value. Value or intensity represents the intensity of pixel, ranges from 0-1.

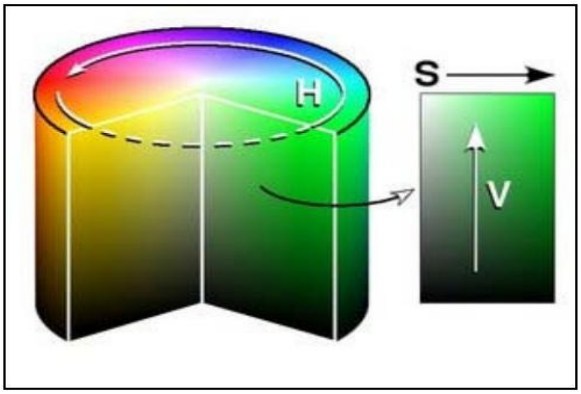

Fig 3: HSV color model

In RGB model since each color of pixel is a combination of brightness value, color component value is normalized with the brightness value I= R+G+B, where

$$r = R/I; \quad g = G/I; \quad b = B/I \tag{1}$$

$$\text{Where } r + g + b = 1; \tag{2}$$

Since r and g values signify the normalized color, it is represented by the 2D Gaussian distribution [3]. It is a advanced model that has the ability to describe complex shaped distributions. The Gaussian joint probability distribution function is

$$P(H|\lambda) = \Sigma W * g(c|\mu, \Sigma) \tag{3}$$

Where H is the color vector, $\lambda = \{W, \mu, \Sigma\}$, μ is the mean vector and Σ is the diagonal covariance matrix. Now the RGB values are converted to HSV by the following equations

$$h = \cos^{-1}(0.5\,(R-G)+(R-B) / \sqrt{(R-G)^2+(R-B)(G-B)}) \tag{4}$$

$$H=h \quad ; \quad B <= G \tag{5}$$

$$H= 360^0-h; \quad B>G$$

$$S= 1- \text{Min}(R,G,B)/\text{Max}(R,G,B) \tag{6}$$

$$V= \text{Max}(R, G, B) / 255 \tag{7}$$

Thus the condition for skin ranges between

$$0 <= H <= 48 \tag{8}$$

$$0.19 <= S <= 0.69 \tag{9}$$

Figure 4: (a) Group of people (b) Skin detection

Fig 5: (a) Single input (b) skin detection

C. ESTIMATION OF PARAMETERS

From the RGB image, segmentation is done. Skin pixels are taken out. Obtained skin regions are represented using a bounding box .Now the centroid is computed using the coordinates . Using this pan angle and the tilt angle can be calculated. If there are several region obtained then centriod of all regions are estimated [11] and the midpoint of them gives the centroid.

If A , B ,C are the coordinates then centroid of the X and Y axis are given by

$$I = A_X+B_X+C_X/3 \quad (10)$$

$$J = A_Y+B_Y+C_Y/3 \quad (11)$$

Here centroid of the detected region is (I,J).Thus angles can be obtained by

$$Pan\_angle = \tan^{-1}(J/I) \quad (12)$$

$$Tilt\_angle = \tan^{-1}(J/d) \quad (13)$$

where d is the distance from the centroid.

$$d_k^2 = (X- \mu_k)^T \Sigma^{-1}(X-\mu_2) \quad (14)$$

D. MESSAGE ENCODING AND DECODING

Message is a control word which couples HDS and HTS. It provides information about the Pan angle and the Tilt angle. It gives an efficient and effortless communication [11]. Single character # is used as starting word. At decoding time if # is received it identifies that a new message has been started. Title is a four word letter word by which it describes the system name. P and T represents that the next 3 characters are Pan angle and the Tilt angle. Termination message is given by END. After receiving the end message it waits for new message.

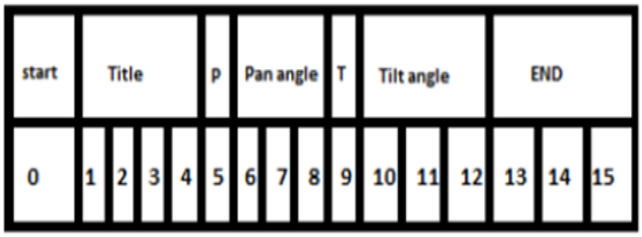

Figure 5: Control word structure

IV) **IMPLEMENTATION OF THE SYSTEM**

Using Stereo vision based image capturing; images are converted to a 3D matrix. Thus the program identifies the skin pixels and gives the information to the HTS through a serial port. The message is a 16 length character word which has both the parameter information. The HTS is a hardware system based on PIC16F877A.It has a buzzer to warn the presence of intruders, For pointing the target a laser light is also provided. Two servo motors are used for the parameter estimation with an LCD LM016L to display the received message from HDS.

The 40 pin 8 bit PIC16F877A has 368*8 bit RAM , 8K*14 flash memory and 256*8 bit data memory.[12] It has RISC architecture with a baud rate of 9600 bps used for serial communication.MAX232 IC consists of two transmitter receiver arrangement .Here we use a 16 pin IC.[13]

Human detection and targeting systems are separately arranged through a serial port. The output of the camera is displayed on the monitor screen through MATLAB.

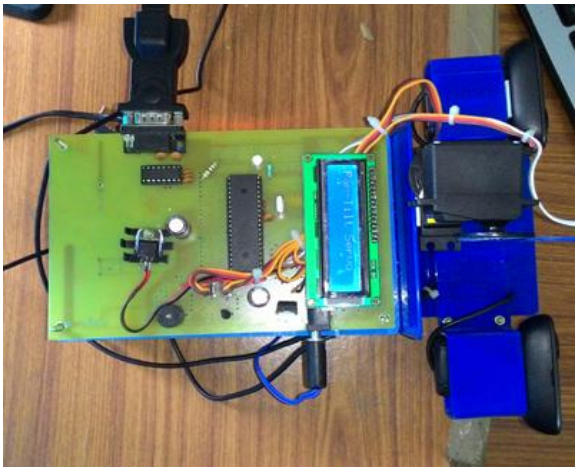

Fig 7: Hardware of targeting system

Once the message is reached, the laser starts its pointing device. The parameters are displayed on the monitor screen. According to that, servo motors get activated. Since stereo vision based approach is proposed here, real time scenarios can be captured and even video frames can be saved. A buzzer is also provided for targeting intruders.

Figure 8: Real time output of single person

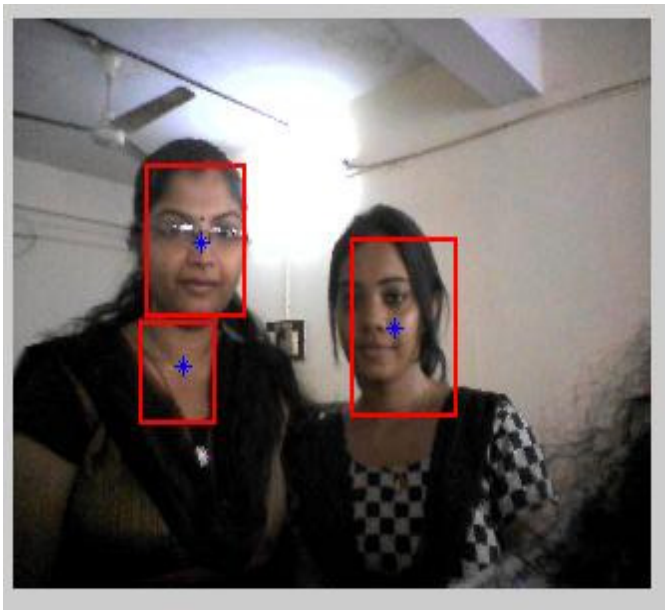

Fig 9 : Real time output of multiple people

Fig 10: Output for animal differentiation

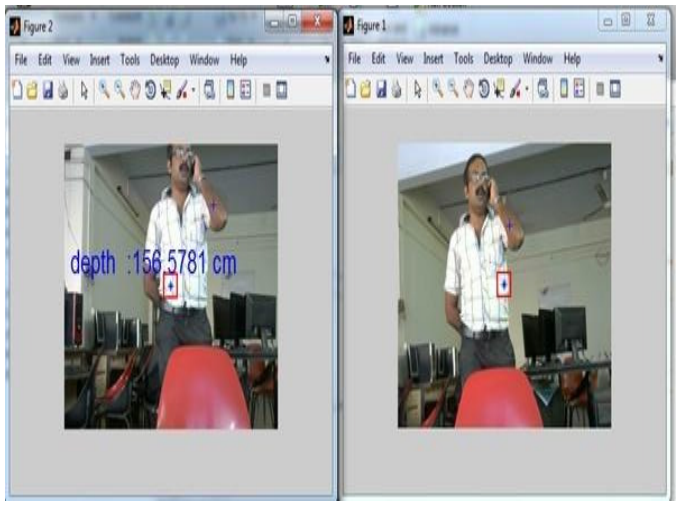

Fig 11 : Distance Estimation

V CONCLUSION

In this paper a stereo vision based approach is proposed by which depth range of the system can be obtained. Weather conditions are least affected which gives an effortless communication. Here HSV conversion is used for segmentation as it can differentiate the skin portions from complex backgrounds. It can also be converted to YC_bC_r color space. As future scope for human tracking system we can implement by using FPGA. To improve the robustness eye detector algorithms can also be used. Animals are also detected by changing the algorithm.

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