Comparative Analysis of a Vision Based HGR System Used for Handicapped People

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***Abstract*—The object tracking is critical to visual / video surveillance, analysis of the activity and gesture recognition. The major difficulties to be occurred in the visual tracking are different environmental conditions, illumination changes, occlusion and appearance. In this paper, the comparative analysis of the different systems which are used to recognize the head gestures under different environmental conditions is discussed. The existing algorithm used to recognize the head gestures has some limitations. The existing algorithm cannot work under outdoor environmental conditions. The traditional camshift algorithm and unscented kalman filter are integrated and used to recognize the head gestures under outdoor environmental conditions. The unscented kalman filter is a tracking algorithm used to remove the limitations of the traditional camshift algorithm. The simulation result shows the better performance of the improved algorithm than the traditional camshift algorithm.**

***Index Terms*—Camshift, Face Detection, Face Tracking, Head Gesture Recognition.**

I. Introduction

The traditional wheelchair has been developed for the handicapped people, persons having disabilities, caused by the parkingson diseases and quadriplegics. Currently, the manually controlled wheelchairs are used by the persons having the parkingson diseases and quadriplegics. The electric powered wheelchairs become more intelligent known as electric powered intelligent wheelchairs. The various developments on intelligent wheelchairs have been carried out in the last decade such as Wheelesley, Smart Wheelchair, Nav Chair, Upenn Smart Wheelchair.

Y. Zhang, J. Zhang and Y. Luo presented an intelligent system which is the hand gestures [1]. Noriyuki Kawarazaki and Alejandro Israel Barragan Diaz proposed a system used depth sensors [2]. E. Ramirez, H. Hu and K. Maier proposed the system which uses the head movements [3]. Kawarazaki [4] presented a depth sensor based system. The wheelchair moves according to the position of the hand. A depth sensor is used to recognize the hand gestures quickly. The system offers a hands freedom sense to the user, simplifying their daily activities by using the hands movements as the direction control input. Klaus McDonald Maier et al. [5] proposed an intelligent wheelchair based on the head movements of the user in an indoor environment. The system contains two modes of operations. Mode 1 includes the generation of the controlling commands for the head movements to give the controlling actions to the wheelchair. The Mode 2 employs four head

movements such as left turn, right turn, up movements and down movements of the intelligent wheelchair. An Emotiv EPOC device is used for the head movements. Ralph Oyini Mbouna et al. [6] proposed a driver alertness monitoring system using eye state and head pose of the user. A support vector machine is used to classify a sequence of video segments into alert or non-alert driving events. In this paper, an improvement of head gesture recognition using improved camshift based face tracking algorithm is used. For real time face detection, adaboost face detection algorithm and for face tracking, camshift object tracking algorithm is used. The block rotation invariant uniform local binary pattern is used to recognize the head gestures under different outdoor conditions. According to the above problems, the camshift algorithm combined with block rotation invariant uniform local binary pattern method is proposed. The block rotation invariant uniform local binary pattern, explores space structure to improve the accuracy of recognizing the head gestures in different outdoor conditions.

II. Algorithm Principles

The gesture recognition system consists of three processes namely face detection of the user, face tracking with the gesture recognition. The Adaboost face detection algorithm extracts the features which contains the information. These set of features detect the faces under different environmental conditions. The haar like features more focus on the information within a certain area of the given image and not on each single pixel. Due to this property, the haar like feature based system gives better performance. The haar like features having the three kinds and four form of the characters. The three types are: two rectangular characters, three rectangular characters and four rectangular characters. The total pixel values present in the white rectangles are to be subtracted from the total pixel values presents in the gray rectangles. This process is known as haar like character method.

The camshift algorithm is basically used for the tracking of the user's face. It is the most powerful and mostly used for the tracking purpose. It correctly tracks the user's face. The camshift is based on the image hue. The hue, consisting of RGB colors and so on. The tracking is one of the most difficult tasks because of the various environmental conditions and the changes in the facial expressions. The basic camshift has some limitations. These limitations are; in varying illumination conditions, the camshift gives poor results. The speed is fast but it fails in the various outdoor

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environmental conditions. The system needs to improve the tracking performance by improving the basic camshift. The camshift based unscented kalman filter is proposed to overcome the limitations by the basic camshift.

III. UKF METHOD

UKF method is a tracking algorithm used to remove the disadvantage of old camshift algorithm. Also in some cases, it is used to remove the sheltered problem. It converts the input from RGB to HSV color space. The detection process is takes place first, after that for tracking the face this algorithm is applied on the detected face. In this algorithm the speed threshold and the turn threshold plays the important role for showing the position of the head i.e. weather the head is in left, right, up or down position. But in different environmental conditions like in darkness, sunshine also in cluttered background the UKF algorithm is not able to give the proper result. It is not able to track the face properly. The speed is not fast enough and it takes the more time for tracking the face.

IV. BLBP METHOD

Before going to the BLBP method, first we see the LBP operator. In local binary patterns, the pixels of an image is replaced by decimal numbers. Here we consider a 3 x 3 matrix.

Consider a 3 x 3 matrix of the pixels of an image.

5	9	1
4	4	6
7	2	3

1	1	0
1		1
1	0	0

The binary value: 11010011
The decimal value: 211

$$\mathrm{LBPP,R\ (xc,yc)} = \sum_{P=0}^{P-1} \mathrm{S(iP - iC)2^P}$$

$$\mathrm{SBLBPP,R} = \sum_{P=0}^{P-1} \mathrm{S(gps - gc)2^P}$$

$$\mathrm{gp,s} = (\sum_{r=0}^{R} \mathrm{gp,r})/(\mathrm{R}+1)$$

$$\mathrm{RBLBPP,R,N} = \sum_{i=0}^{N-1} \mathrm{S(gi - gc)2^i}$$

BLBP = {SBLBP, RBLBP}

V. COMPARATIVE ANALYSIS OF THE SYSTEM

The comparative analysis of the system is shown in the form of table. The comparison is based on the following parameters. They are: Environmental Parameters, Different Head Gestures, Minimum Face Size and Time Cost per Frame. The environmental parameters consist of the indoor as well as outdoor environmental parameters. In the comparative analysis, it shows that the improved algorithm gives the accurate user's head gesture recognition under the different environmental conditions. The comparative analysis of the different methods is done based on the different environmental conditions namely sunshine, shadow, cluttered background etc.

TABLE I: THE SPEED OF CAMSHIFT

Environmental Parameters	Different Head Gestures	Minimum Face Size	Time Cost Per Frame
Sunshine	Profile Front	123 x 123	0.0370 S
	Left Turning	123 x 123	0.0026 S
	Right Turning	123 x 123	0.0026 S
	Upward	123 x 123	0.0030 S
	Downward	123 x 123	0.0043 S
Cluttered	Profile Front	100 x 100	0.0333 S
	Left Turning	100 x 100	0.0047 S
	Right Turning	100 x 100	0.0039 S
	Upward	100 x 100	0.0026 S
	Downward	100 x 100	0.0043 S
Shadow	Profile Front	143 x 143	0.0406 S
	Left Turning	143 x 143	0.0003 S
	Right Turning	143 x 143	0.0040 S
	Upward	143 x 143	0.0007 S
	Downward	143 x 143	0.0032 S

TABLE II: THE SPEED OF CAMSHIFT WITH ADABOOST

Environmental Parameters	Different Head Gestures	Minimum Face Size	Time Cost Per Frame
Sunshine	Profile Front	123 x 123	0.0350 S
	Left Turning	123 x 123	0.0019 S
	Right Turning	123 x 123	0.0025 S
	Upward	123 x 123	0.0022 S
	Downward	123 x 123	0.0041 S
Cluttered	Profile Front	100 x 100	0.0339 S
	Left Turning	100 x 100	0.0041 S
	Right Turning	100 x 100	0.0027 S
	Upward	100 x 100	0.0003 S
	Downward	100 x 100	0.0008 S
Shadow	Profile Front	143 x 143	0.0361 S
	Left Turning	143 x 143	0.0040 S
	Right Turning	143 x 143	0.0028 S
	Upward	143 x 143	0.0022 S
	Downward	143 x 143	0.0041 S

TABLE III: THE SPEED OF CAMSHIFT WITH UKF

Environmental Parameters	Different Head Gestures	Minimum Face Size	Time Cost Per Frame
Sunshine	Profile Front	123 x 123	0.0345 Second
	Left Turning	123 x 123	0.0026 Second
	Right Turning	123 x 123	0.0046 Second
	Upward	123 x 123	0.0008 Second
	Downward	123 x 123	0.0043 Second

	Profile Front	100 x 100	0.0368 Second
	Left Turning	100 x 100	0.0022 Second
Cluttered	Right Turning	100 x 100	0.0041 Second
	Upward	100 x 100	0.0026 Second
	Downward	100 x 100	0.0043 Second
	Profile Front	143 x 143	0.0406 Second
	Left Turning	143 x 143	0.0020 Second
Shadow	Right Turning	143 x 143	0.0008 Second
	Upward	143 x 143	0.0008 Second
	Downward	143 x 143	0.0046 Second

TABLE IV: THE SPEED OF CAMSHIFT WITH BLBP

Environmental Parameters	Different Head Gestures	Minimum Face Size	Time Cost Per Frame
	Profile Front	123 x 123	0.0012 S
	Left Turning	123 x 123	0.0013 S
Sunshine	Right Turning	123 x 123	0.0014 S
	Upward	123 x 123	0.0012 S
	Downward	123 x 123	0.0020 S
	Profile Front	100 x 100	0.0011 S
	Left Turning	100 x 100	0.0016 S
Cluttered	Right Turning	100 x 100	0.0015 S
	Upward	100 x 100	0.0548 S
	Downward	100 x 100	0.0418 S
	Profile Front	143 x 143	0.0014 S
	Left Turning	143 x 143	0.0014 S
Shadow	Right Turning	143 x 143	0.0015 S
	Upward	143 x 143	0.0013 S
	Downward	143 x 143	0.0014 S

TABLE V: PERCENTAGE ACCURACY IN DIFFERENT METHODS

Sr. No.	Tracking Methods	Time Cost Per Frame	Percentage Accuracy
1	Camshift Method	0.0370 Second	48.57 %
2	Camshift with Adaboost	0.0041 Second	57.14 %
3	Camshift with UKF	0.0026 Second	63.33 %
4	Camshift with BLBP	0.0011 Second	86.00 %

VI. CONCLUSION

This paper describes the comparative analysis of the different HGI system. This system is mainly used in an intelligent wheelchair system for the handicapped people and the persons having disabilities, caused by the parkingson diseases and quadriplegics.

The different methods used for the head gesture recognition are presented in this paper. Based on the parameters, time cost per frame and percentage accuracy, the comparative analysis is done in different methods. The basic camshift method gives 48.57 % with speed of recognition 0.0370 second; second method camshift with adaboost gives 57.14 % with 0.0041 second; third method camshift with UKF gives 63.33 % with speed 0.0026 second; and the proposed method that is camshift with BLBP method gives 86.00 % with 0.0011 second.

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