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REAL - TIME ROBOT CAR CONTROL USING HAND SIGN RECOGNITION

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Abstract: ***This paper presents a novel algorithm to recognize a set of static hand gestures for the Human-Computer Interaction (HCI) and controlling a robotic car wirelessly after successful recognition using X-Bee module. Through this method, the user can control or navigate the robot by using gestures of his/her palm. The command signals are generated from these gestures using image processing. These signals are then passed to the robot to navigate it in the specified directions. In short we have implemented a system through which the user can give commands to a wireless robot using gestures. The application for gesture recognition has been created on MATLAB environment with operating system as windows 7. The system has been tested and verified under both incandescent and fluorescent lighting conditions. The experimental results are very encouraging as the system produces real-time responses and highly accurate recognition towards various gestures.***

Index Terms: Hand Gesture Recognition, Human Robot Interaction, Image Processing, MATLAB, Robot Control, Webcam, Wireless, X-Bee.

I. INTRODUCTION

Recently, the demand for the indoor robots has increased tremendously. Therefore, increased opportunities for many people to operate the robots have emerged. However, for many people, it is often difficult to operate a robot using the conventional methods like remote control ([15], [16], and [17]). The variety of physical shapes and functional commands that each remote control features also raises numerous problems: the difficulties in locating the required remote control, the confusion with the button layout, the replacement issue and so on. A simple definition of the term gesture is suggestive movement of bodily parts such as fingers, arms etc, which convey some information ([2], [8], [17]). Waving the hand is a gesture that suggests "good bye".

Even though gestures can originate from any bodily movement, generally it originates from movement of face or hand. Gesture is one of the most natural and expressive ways of communications between human and computer in a real system ([3], [10], [13], and [17]). We naturally use various gestures to express our own intentions in everyday life. Hand gesture is one of the important methods of non-verbal communication for human beings. Hand gesture has been one of the most common and natural communication media among human being. Hand gesture recognition research has gained a lot of attention because of its applications for interactive human-machine interface and virtual environments ([3], [10], and [19]). So, we propose a robot operation system using the hand gesture recognition. Based on one unified set of hand gestures, this system interprets the user hand gestures into pre-defined commands to control the robotic car wirelessly using X-Bee module. Unlike the conventional method for hand gesture recognition which makes use of markers, special gloves or any other devices, this method does not require any additional devices and makes the user comfortable as in the glove-based system user needs to wear burdensome accessories, which are generally connected to computer ([4],[7],[14],[18]). This barehanded proposed technique uses only 2D video input. Our hand gesture recognition system was carried out on a 2.33 GHz Intel (R) Core TM 2Duo CPU 2 GB RAM on Windows 7 platform using MATLAB R2010a.

II. PROPOSED WORK

The robot control system includes four parts as shown in Figure 1: A webcam connected with the laptop computer. A gesture recognition system running on a laptop computer. A robotic car and the robot controller. A pair of wireless communication modules connected with the gesture recognition system and the robot controller respectively. The webcam is used to obtain the image data of the human palm and fingers. The image or video acquired as input may be noisy or may reduce the performance by recognizing surrounding as hand region. The acquired data is subjected to enhancement and processed further to make it fit for approximation with the gestures (data) stored in the database. Then the data are processed to recognize the gesture. Each gesture is corresponding to a different robot control comma-

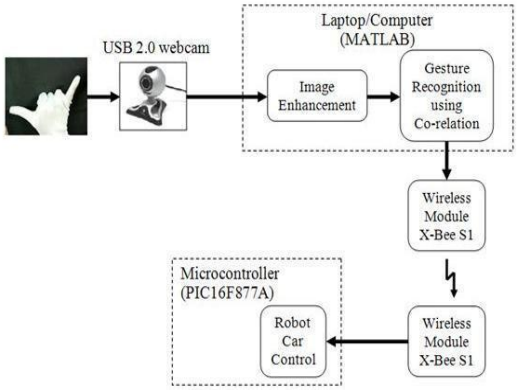

Fig. 1 Proposed System Framework

nd. Then the X-bee wireless module is used to send these different robot control commands to the robot controller. Accordingly, the robotic car will do actions according to different human hand gestures, thus human-robot interaction can be achieved. The gesture recognition system is developed with MATLAB.

III. SYSTEM COMPONENTS

The different System Components are Camera Unit, Gesture Recognition Unit, Wireless Communication Unit, and Robot Car Unit. We will take look at each unit sequentially

A. Camera Unit

A 6 megapixel USB 2.0 still webcam of INTEX Company is mounted on a stand having a perfectly black platform. The user has to perform different gestures wearing a white glove in his/her hand on this platform.

Fig. 2 Camera Unit

Skin tones and texture changes from person to person. This is the only reason user is supposed to wear white glove, so that same database can be used by different users. However, the user is free to create his/her database anytime and any number of times. Use of a white glove while performing a gesture also enhances the discrimination capability of the gesture recognition unit.

B. Gesture Recognition Unit

The Gesture recognition unit comprises of a MATLAB code running on a laptop/computer. A gesture recognition system is proposed and developed which can effectively recognize hand gestures with less computing but high accuracy ([1],[5],[11],[12],[14],[20],[25]). The proposed methodology for gesture recognition involves acquisition of live video from a camera for gesture identification. It acquires frames from live video stream whenever the user desires to capture a gesture. The overall proposed technique to acquire hand gestures, recognizing it accurately and sending appropriate commands wirelessly to the robot consists of four subparts:

- Image acquisition to get hand gestures.
- Enhancement of the acquired gesture image.
- Determining gesture by co-relation with the pre-stored database gestures.
- Generation of instructions corresponding to matched gesture, for specified robotic action & sending them on serial port.

The video obtained through webcam is in RGB color model & it is assumed that while capturing video, black background is used. Thus the hand region is represented using white color and the background region as black. From the corpus of gestures, specific gesture of interest can be identified, and on the basis of that, specific command for execution of action can be given to robotic system.

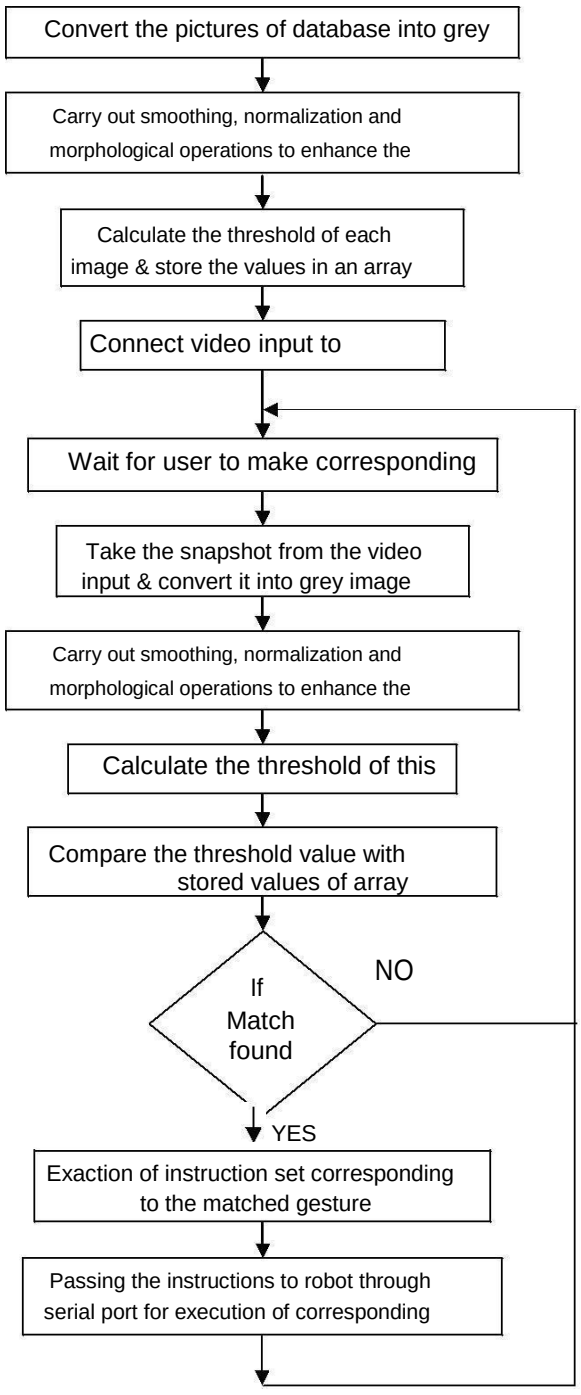

Fig. 3 Flow diagram for robot control using gesture

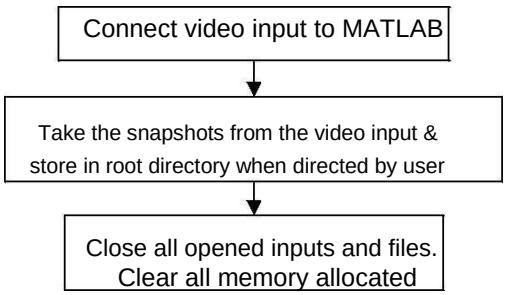

Fig. 4 Flow diagram for creating database

C. Wireless Communication Unit

After gesture recognition, each gesture is encoded and the coding is sent to the robot controller wirelessly using X-Bee S1 Module. ([22], [23])

X-BEE S1 Module

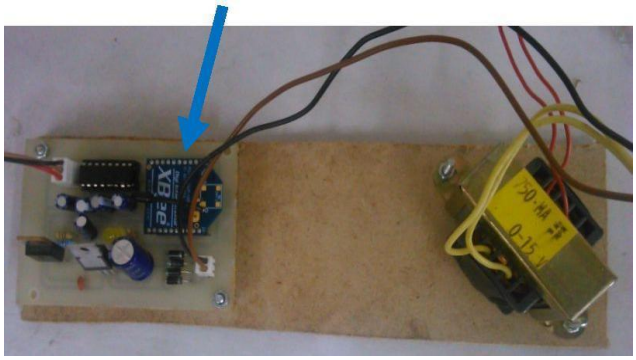

Fig. 5 Wireless Communication Unit

D. Robot Car Unit

The Robotic Car Unit comprises of a microcontroller (PIC16F877A) to take decisions depending on the received code ([22], [23],[24]). The different microcontroller interfaces implemented in the Robotic Car Unit are shown in figure 6. PIC16F877A works on 5V, while the X-Bee module works on 3.3V, so we have designed a regulated power supply for this purpose. DC motors are used to physically drive the application as per the received code. The dc motor works on 12 V. To drive a dc motor, we need a dc motor driver called L293D. This dc motor driver is capable of driving 2 dc motors at a time. In order to protect the dc motor

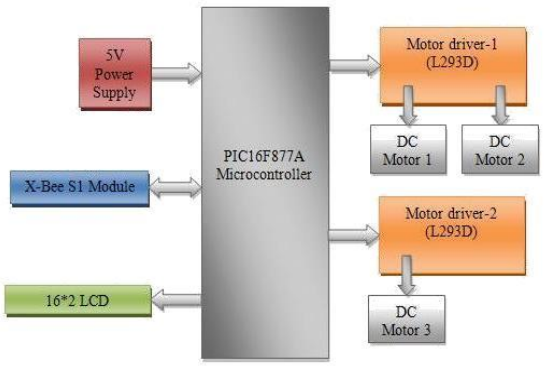

Fig. 6 Block Diagram for Robot Car Unit

from a back EMF generated by the dc motor while changing the direction of rotation, the dc motor driver have an internal protection suit. We have also provided the back EMF protection suit by connecting 4 diode configuration across each dc motor. LCD is used in a project to visualize the output of the application. We have used 16x2 LCD which indicates 16 columns and 2 rows. LCD can also used in a project to check the output of different modules interfaced with the microcontroller. Thus LCD plays a vital role in a project to see the output and to debug the system module wise in case of system failure in order to rectify the problem.

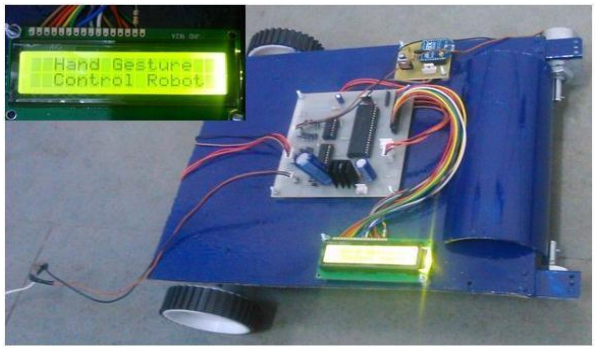

Fig. 7 Robot Car Unit

IV. ROBOT CONTROL WITH HAND GESTURE

Once a hand gesture is recognized, an appropriate command is sent to a robot. After the robot receives a command, it performs a pre-defined work and keeps doing until a new command arrives. Movement commands are written as a function in robot specific language.We define total seven gestures to direct the operation of the robot. The operations include the following motions “Straight”, “Reverse”, “Left”, “Right”, “Up”, “Down” and “Stop”. These gestures with the assigned code and their functions are listed in TABLE I

TABLE II
USED GESTURES AND THERE MEANINGS

Sr. No.	Hand Gesture	Code	Description
1.		#11	Forward
2.		#21	Reverse
3.		#31	Left

4.	#41	Right
5.	#51	Up
6.	#61	Down
7.	#71	Stop

V. GESTURE USES

Gesture recognition is useful for processing information from humans which is not conveyed through speech or type. As well, there are various types of gestures which can be identified by computers.

Sign language recognition: Just as speech recognition can transcribe speech to text, certain types of gesture recognition software can transcribe the symbols represented through sign language into text ([9], [24]).

For socially assistive robotic: By using proper sensors (accelerometers and gyros) worn on the body of a patient and by reading the values from those sensors, robots can assist in patient rehabilitation. The best example can be stroke rehabilitation.

Directional indication through pointing: Pointing has a very specific purpose in our society, to reference an object or location based on its position relative to ourselves. The use of gesture recognition to determine where a person is pointing is useful for identifying the context of statements or instructions. This application is of particular interest in the field of robotics.

Control through facial gestures: Controlling a computer through facial gestures is a useful application of gesture recognition for users who may not physically be able to use a mouse or keyboard. Eye track in particular may be of use for controlling cursor motion or focusing on elements of a display.

Alternative computer interfaces: Foregoing the traditional keyboard and mouse setup to interact with a computer, strong gesture recognition could allow users to accomplish frequent or common tasks using hand or face gestures to a camera.

Immersive game technology: Gestures can be used to control interactions within video games to try and make the game player's experience more interactive or immersive.

Virtual controllers: For systems where the act of finding or acquiring a physical controller could require too much time, gestures can be used as an alternative control mechanism. Controlling secondary devices in a car or controlling a television set are examples of such usage.

Affective computing: gesture recognition is used in the process of identifying emotional expression through computer systems.

Remote control: Through the use of gesture recognition, remote control with the wave of a hand" of various devices is possible. The signal must not only indicate the desired response, but also which device to be controlled.

VI. APPLICATIONS AND FUTURE WORK

Controlling a robot, in real time, through the hand gestures is a novel approach and its applications are myriad. The inflammation of service robot to domestic users and industries in the upcoming years would need such methods extensively. The approach has huge potential once it gets further optimized, as its time complexity is higher, with the help of hardware having better specifications. Use of more efficient wireless communication technique and a camera on the robot unit would improve the performance of system to a great exte nt and can be incorporated in future work.

VII. CONCLUSIONS

A low cost computer vision system that can be executed in a common PC equipped with low power USB web cam was one of the main objectives of our work, which has been implemented successfully. We have experimented with around 30 hand gesture images and achieved higher average precision. The best classification rate of 97% was obtained under different light conditions. But the drawback in this method is that the hand should be properly placed with respect to the webcam so that the entire hand region is captured. If the hand is not placed properly the gesture is not recognized appropriately. Gesture made in this method involves only one hand and this reduces the number of gestures that can be made using both hands.

VIII. ACKNOWLEDGMENT

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