

Implementation of an Intelligent Head Gesture Recognition System

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Abstract - As per the rapidly advancement in the changing technology, the numerous applications are required. For example, for face, hand and gesture recognition. The previous researchers have been developed various methods for head gesture recognition and they presented various limitations. Therefore the paper proposes an FPGA based gesture recognition system. The gesture detection and gesture recognition can achieve 30 frames per second using FPGA system. Accordingly that the system software can subsequently schedule all the tasks during the processing. The proposed system also introduces the obstacle detection technique. The system uses ultrasonic sensors for the obstacle detection. The proposed system is responsible for the detection of obstacles.

Index Terms - Wheelchair Interface, Ultrasonic Sensors, Face Detection, Gesture Recognition.

I. INTRODUCTION

The wheelchair is one of the most commonly method for enhancing the personal mobility of the users or peoples or the individuals with the certain disabilities. As per the world health organization, the total estimated count 1 % of the world's population or just over the 65 million people or user or individuals need a wheelchair. Over the 6.1 million people in India have movement related disability. The evolution of the User Interface (UI) witnessed the development from text based UI based on keyboard to GUI based on mice. In current virtual environments applications, keyboards, mice, and joysticks are still the most popular and dominant devices. However, they are inconvenient and unnatural. The use of human movements, especially head gestures, has become an important part of HCII (Human Computer Intelligent Interaction) in recent years, which serves as a motivating force for research in modelling, analysing and recognition of head gestures. Many techniques developed in HCII can be extended to other areas such as surveillance, robot control and teleconferencing. Recognizing Gestures is a complex task which involves many aspects such as motion modelling, motion analysis, pattern recognition and machine learning. The successful deployment of the intelligent system relies on their high performance as well as low cost.

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As compared to the other head gesture recognition system, the main performance of the intelligent system includes the autonomous navigation capability for good safety, flexibility, mobility, obstacle avoidance etc., an intelligent system including voice based control system, vision based control system, and sensor based control system. The new generation, an intelligent system of head gesture recognition should be able to deal with the uncertainties from the practical applications point of view. They are the user head either out of the image view or only the profile face is in the captured image, the face color of the user is user dependent, or may change dramatically in the varying illumination conditions, the different facial appearances conditions of the user, such as mustache and glasses, and the cluttered background. The proposed system is an intelligent system for the head gesture recognition, which is based on the combination of Adaboost and improved camshift algorithms.

II. HUMAN GESTURE REPRESENTATION

There have been many studies on human gestures in psycholinguistic research. K. Yuan [1] represents the Head Gesture Recognition for Hands Free Control of An Intelligent Wheelchair. In this paper, a novel integrated approach to Real - Time Face Detection, Tracking and Gesture Recognition is proposed, namely Head Gesture Based Interface (HGI). It is to be used as the Human Robot Interface for the Intelligent Wheelchair, namely Robo Chair. The system is used to solve the problems. They are - The user head may be out of the image view, or only the profile face is in the captured image, the face colour is user dependent, and may change dramatically in varying illumination conditions, the user may have different facial appearances, such as mustache and glasses, and the background may be cluttered when an Intelligent Wheelchair move in the real world. Hyunduk Kim, Sang Heon Lee, Myoung Kyu Sohn and Dong Ju Kim [2] present a novel approach for head pose estimation in gray level images. The two techniques were employed in this research project. The method of Random Forests was employed for dealing with the large set of training data. In the field of computer vision, this is known as a state of art classification. For the changing in the illumination conditions that is outdoor environmental conditions, a Binary Pattern Run Length matrix is very useful. This matrix is combination of Binary Pattern and a Run Length matrix. The binary pattern was calculated by randomly selected operator. M. Davy and R. Deepa [3] present Head Movement System using Accelerometer Sensor. For detecting the head movements of the users, the system includes the accelerometer sensors.

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The proposed system uses the accelerometer to find out the movement of the head is detected. Ericka Janet Rechy Ramirez, and Huosheng Hu [4] present a flexible bio signal based HMI system. In this HMI system, an Emotive EPOC sensor is used to detect facial expressions and head movements of the user, which are then recognized and converted to four uni modal control modes and two bi modal control modes to operate the system. Chanlit Noiruxsar and Pranchalee Samanpiboon [5] presents face orientation recognition system for head gesture recognition system. The USB camera was fixed in front of the user's face.

III. HAND GESTURE RECOGNITION SYSTEM

The Human Gestures typically constitutes a space of motion expressed by the body, face, and / or hands. Of these, the hand gestures are often the most expressive and the most frequently used. The hand gesture involves, a posture having static finger configuration without hand movement and a gesture having dynamic hand movement, with or without finger motion.

IV. SYSTEMS APPLICATIONS IN PROPOSED SYSTEM

There have been many implemented application systems in many domains such as virtual environments, Health Care Centre, Industries as Robot to carry goods, Smart Surveillance, Physically Handicapped Individuals, and Control of Mechanical Systems etc. Pei Fia and Huosheng H. Hu [6] present Head Gesture Recognition for Hands Free Control of an Intelligent Wheelchair. The system based on visual recognition of head gestures. The recognized gestures are used to generate motion control commands to the low level DSP motion controller so that it can control the motion of the Robo Chair according to the user's intention. To avoid unnecessary movements caused by the user looking around randomly, the HGI is focused on the central position of the wheelchair to identify useful head gestures. P. Saikia and K. Das [7] present an intelligent system in which Head Gesture is to be recognized by using the optical flow based Classification with the reinforcement of GMM based background subtraction. The proposed system can be implemented in various control system. In this paper, we present a gesture recognition system that takes input from a simple camera and necessary processing steps is done to recognize the gestures from a live video. At first, a frame (image) from the webcam is captured. The main information was collected from the image, so subtraction of the background for the entire process was done. For image subtraction, the Gaussian Mixture Model (GMM) system is used. After using Gaussian mixture model (GMM), to determine the movement of the given input, we applied the Horn Schunk optical flow algorithm to the foreground. Using optical flow algorithm we determined the movement between the frames of images of the video. Preeti Srivastava and Ritula Thakur [8] present a novel head gesture recognition based control for intelligent wheelchairs. In this paper, an intelligent system is designed for severely disabled i.e. multiple sclerosis, quadriplegic patients and old age people based on head gesture control. The system developed based on basically works on the principle of acceleration. According to the head

tilt movement of user, the accelerometer MMA7361 used in the system gives variation in the voltage across x-axis & y-axis as output. The accelerometer is connected to ATMEGA328 Microcontroller which sends commands according to the head gesture recognition of user. Further Microcontroller controls the direction of wheelchair by using H-Bridge Motor driver ICL293D. The Obstacle avoidance is also done in this paper. For obstacle detection, an ultrasonic sensor is used which is attached to the wheelchair in front provides safe navigation and LCD attached on top gives user friendly interface.

V. GESTURE RECOGNITION TOOLS

An ideal example of multidisciplinary research is the Gesture Recognition. For gesture recognition in different environmental conditions, there are different tools, based on the approaches ranging from statistical modelling, computer vision, image processing, pattern recognition etc. Computer vision and pattern recognition techniques involving feature extraction, object detection, and classification, has been successfully used for many gesture recognition systems. The image processing techniques such as detection of shape, texture, colour, motion, image enhancement, and segmentation, has to be found very effective. Yuan Luo Zhang Fang Hu, and Lin Li Yizhang [9] presents a system which includes head gesture recognition system using kalman filter as well as Adaboost Algorithm. In this paper, kalman filter forecast the lips position detected by ada boost algorithm which may be appeared in the next frames first, and then detect the lips in the next frame. To confirm the head gesture correspondingly, compare the lips window position with a fixed point. The kalman filter overcome detects all the possible lips position by using the ada boost algorithm in every frame, which greatly improve the lips detection precision and reduce the detection time. Chanlit Noiruxsar and Pranchalee Samanpiboon [10] present face orientation recognition system using adaboost learning algorithm as well as Flandmark detector. In this system, the USB camera was fixed in front of the user's face. The face area was detected based on adaboost learning algorithm. Then using flandmark detector, the facial landmarks were detected.

VI. SYSTEM HARDWARE STRUCTURE

The proposed intelligent system uses the following components. They are the ultrasonic sensor for the obstacle detection or avoidance, for the motion control of two differentially driven wheels we use the DSP TMS320LF2407 based controller, to connect to analog to digital conversion of the DSP based controller, a local joystick, for recognising the head gesture of the user, a webcam and to analyse the head gesture, laptop with windows XP installed. The DSP chip TMS320LF2407 is used as the core processor of the control module. The DSP Processor offers an excellent processing capability that is 30 MIPS and a compact peripheral integration. From this the whole intelligent system is able to obtain both the real time signal sampling and the high performance driving control. The intelligent system has two

control modes. The first control mode is the intelligent control mode. In this control mode, the intelligent system is controlled by the HGI with an obstacle avoidance module embedded in the DSP motion controller. To acquire the facial images of the user in different environmental conditions, the webcam is used. First the image data is to be sent to the laptop, the head gesture analysis and the decision making are implemented. Then the laptop sends the control decision to the DSP motion controller which actuates the final motor actions.

The second control mode is manual control mode. In this control mode, an intelligent system is controlled by the joystick which is connected to the DSP motion controller. The system is also connected with the obstacle avoidance module embedded.

VII. OBSTACLE DETECTION TECHNIQUE

The obstacle system is responsible for the detection of obstacles occurred in front of the wheelchair. The system consists of ultrasonic sensors. The ultrasonic sensors emit the sound waves whose frequency is well above the perceivable frequency range of the human ears. When these sounds waves strike an object, gets reflected and are received by the sensor. Thus, by calculating the total time for the waves to return back, distance can be derived.

Distance (in cm) = (Travel time * 10⁻⁶ * 34300) / 2

In our prototype a limit of 40 cm was set. If any obstacle comes closer than this limit, a buzzer activates and user is warned. However, if obstacle comes closer than 30 cm, chair's movement in that direction is stopped.

VIII. CONCLUSION

The importance of gesture recognition is to make the flexible interaction between the human machines in an efficient way. In this proposed system, we have provided a survey on gesture recognition with particular emphasis on head gesture and facial expression which is used for the face detection process. In this review paper, a system is considered called as robo chair used for the disabled person with the aim to make their life easier and simple. This chair recognizes the head gesture & detects the face using webcam fixed on the chair. By detecting the head gesture a motion control command are generated and is briefly discussed in this paper.

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