3D Gesture Recognition Based Wireless control System

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Abstract: ***Gesture-based interfaces, in which the user specifies commands by simple freehand drawings, offer an alternative to traditional keyboard, menu, and direct manipulation interfaces. The ability to specify objects, an operation, and additional parameters with a single intuitive gesture makes gesture-based systems appealing to both novice and experienced users. Unfortunately, the difficulty in building gesture-based systems have prevented such systems from being adequately explored. Gesture-based systems require classifiers to distinguish between the possible gestures a user may enter. In the past, classifiers have often been hand-coded for each new application, making them difficult to build, change, and maintain. A wireless data glove was developed to control a robot. Sensors mounted on the glove send signals to a processing unit, worn on the user's forearm that translates hand postures into data. An RF transceiver, also mounted on the user, transmits the encoded signals representing the hand postures and dynamic gestures to the robot via RF link***

Keywords: Microcontroller, Zigbee, MEMS accelerometer.

1. Introduction

People naturally use hand motions to communicate with other people. This dissertation explores the use of human gestures to communicate with computers. Random House defines "gesture" as "the movement of the head, body, hands, arms, or face that is expressive of an emotion, idea, opinion, etc." This is a general definition, which characterizes well what is generally thought of as a gesture. The term "gesture" usually has a restricted connotation when used in the context of human-computer interaction. There, Gesture refers to hand markings, entered with a stylus or mouse, which function to indicate the scope and commands. In this dissertation, such gestures are referred to as single-path gestures. Recently, input devices able to track the paths of multiple fingers have come into use. The Sensor Frame and the Data Glove are two examples. The human-computer interaction, community has naturally extended the use of the term "gesture" to refer to hand motions used to indicate commands and scope, entered via such multiple finger input devices. These are referred to here as multi-path gestures. Robots are becoming increasingly useful on the battlefield because they can be armed and sent into dangerous areas to perform critical missions. Controlling robots using traditional methods may not be possible during covert or hazardous missions. A wireless data glove was developed for communications in these extreme environments where typing on a keyboard is either impractical or impossible. This paper reports an adaptation of this communications glove for transmitting gestures to a robot to control its functions. Novel remote control of robots has been an active area of research and technology, especially over the past decade. Remotely controlled robots have been used in environments where conditions are hazardous to humans.

2. Related Work

Research has been limited to small scale systems able of recognizing a minimal subset of a full sign language. Christopher Lee and Yangsheng Xu [1] developed a glove-based gesture recognition system that was able to recognize 14 of the letters from the hand alphabet, learn new gestures and able to update the model of each gesture in the system in online mode, with a rate of 10Hz. Over the years advanced glove devices have been designed such as the Sayre Glove, Dexterous Hand Master and Power Glove. The most successful commercially available glove is by far the VPL Data Glove as shown in figure 1. Zimmerman [2] developed based upon patented optical fiber sensors along the back of the fingers. Star-ner and Pent land(1995) developed a glove-environment system capable of recognizing 40 signs from the American Sign Language (ASL) with a rate of 5Hz. Hyeon-Kyu Lee and Jin H. Kim(1999) presented work on real-time hand-gesture recognition using HMM (Hidden Markov Model) . Kjeldsen and Kendersi (1996) devised a technique for doing skin-tone segmentation in HSV space, based on the premise that skin tone in images occupies a connected volume in HSV space.

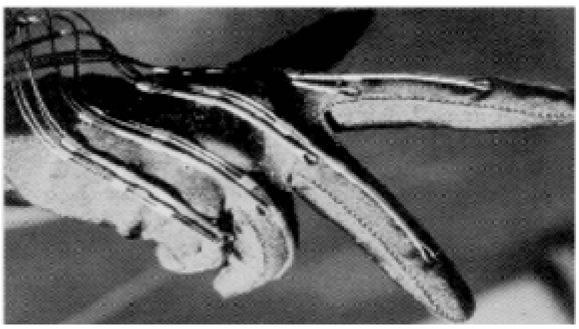

Figure 1: VPL data glove

They further developed a system which used a back propagation neural network to recognize gestures from the segmented hand images. Etsuko Ueda and Yoshio Matsumoto(2003) presented a novel technique a hand-pose estimation that can be used for vision-based human interfaces, in this method, the hand regions are extracted from multiple images obtained by a multiviewpoint camera system, and constructing the "voxel Model." Hand pose is estimated.

Chan Wah Ng and Surendra Ranganath[3] presented a hand gesture recognition system, they used image Fourier descriptor as their prime feature. Their system's overall performance was 90.9%. Claudia Nölker and Helge Ritter [4] presented a hand gesture recognition model based on recognition of finger tips, in their approach they find full identification of all finger joint angles and based on that a 3D modal of hand is prepared and using neural network.

Jeen-Shing Wang and Fang-Chen Chuang [5] present an accelerometer-based digital pen for handwritten digit and gesture trajectory recognition applications. The digital pen consists of a triaxial accelerometer, a microcontroller, and an RF wireless transmission module for sensing and collecting accelerations of handwriting and gesture trajectories. The proposed trajectory recognition algorithm composes of the procedures of acceleration acquisition, signal preprocessing, feature generation, feature selection, and feature extraction. The algorithm is capable of translating time-series acceleration signals into important feature vectors. Users can use the pen to write digits or make hand gestures, and the accelerations of hand motions measured by the accelerometer are wirelessly transmitted to a computer for online trajectory recognition.

Bojan Mrazovac[6] et al published about Human interaction with wearable computers. Natural and unobtrusive interaction with various devices should be simple and at the same time intuitive to any user. This paper represents the design and implementation of a novel interactive hardware which recognizes certain hand gestures and responds in a way of controlling a remote light source. The hardware is made as a "sensing glove" which provides 3-dimensional light control for switching the light on/off or dimming to a desired level. Control parameters are calculated by an accelerometer mounted on the glove, which detects positions of a user's palm in a 3D space. Slow palm rotation is translated into commands for the light dimming, whereas specific hand movements control the light switching. RF transmitter connected to the accelerometer sends the current palm and hand coordinates to the remote luminary. The luminary is managed by an RF receiver and a module for the light control which translates the received data into lighting commands.

A.Alice linsie and J.Mangaiyarkarasi [7] disclosed about a wearable prototype model for Hand gesture recognition system using MEMS which is capable of recognizing eight hand gesture, based on the signal from 3-axes MEMS accelerometer. This system is targeted mainly to help people with speech and hearing disabilities. The accelerations of a hand motion in three perpendicular directions are detected by accelerometers and acceleration values were transmitted to microcontroller. An automatic gesture recognition algorithm is developed to identify individual gestures in a sequence. Finally, the gesture is recognized by comparing the acceleration values with the stored templates. According to recognized gestures, respective commands are displayed on the LCD and same is played through speaker using voice chip.

Ruize Xu [8] et al presented about three different gesture recognition models which are capable of recognizing seven hand gestures, i.e., up, down, left, right, tick, circle, and cross, based on the input signals from MEMS 3-axes accelerometers. The accelerations of a hand in motion in three perpendicular directions are detected by three accelerometers respectively and transmitted to a PC via Bluetooth wireless protocol. An automatic gesture segmentation algorithm is developed to identify individual gestures in a sequence. To compress data and to minimize the influence of variations resulted from gestures made by different users, a basic feature based on sign sequence of gesture acceleration is extracted. This method reduces hundreds of data values of a single gesture to a gesture code of 8 numbers. Finally, the gesture is recognized by comparing the gesture code with the stored templates. Results based on 72 experiments, each containing a sequence of hand gestures (totaling 628 gestures), show that the best of the three models discussed in this paper achieves an overall recognition accuracy of 95.6%,with the correct recognition accuracy of each gesture ranging from 91% to 100%. We conclude that a recognition algorithm based on sign sequence and template matching as presented in this paper can be used for nonspecific-users hand-esture recognition without the time consuming user-training process prior to gesture recognition.

Jenay M. Beer [9] et al Describe a Design to meet older adults' needs for assistance and the older users must be amenable to robot assistance for those needs.

3. System Analysis

The main aim of this project is to control the robot by using MEMS accelerometer. The MEMS accelerometer tilts are processed by micro controller and transmitted to the ZigBee module. MEMS is a Micro Electro Mechanical Sensor which is a highly sensitive sensor and capable of detecting the tilt. The project consists of two micro controller based motherboards. One motherboard consists of a controller interfaced with MEMS Accelerometer sensor technology to control the direction of the robot, a ZigBee to send commands to robot and it will provide a channel for wireless communication, a LED indicator. This entire board acts as a remote to control the movement of the robot as well as receive the information from the robot. The microcontroller will act as the mediator between the input module and output module. And it is programmed using Embedded C language. This project finds its major applications while we are monitoring larger areas like political canvassing, cricket stadiums, international conferences, worship places, banking etc. This project assures us with more reliable and highly secured system.

A. Comparison study

Disadvantages/Limitations in the existing system

- Requires very finely tuned DC power supply.

- Unexpected noise.
- Some people find it more difficult to control using joystick.
- Joystick is delicate equipment. So it must be handled carefully, which is difficult for a new user.
- Prolonged use, the joystick and the buttons can become stuck.
- Joystick could accidentally break off in-between the complex operations.
- Extensive use of joysticks can cause repetitive stress injuries such as Carpal Tunnel Syndrome.

Table 1: Comparison study

Parameters	Joystick based with IR/ Wireless	Gyroscope Based	MEMS Acclerometer Based
Distance between human & controlling equipment	Less for IR	Depends for RF chip	Depends for RF chip
Background Noise	More If the power supply is polluted	Depends on wear and tear on it	Very less
Dynamic Response	Sudden	Moderate	Good
Data to be collected	Less	Moderate	very less
Image Processing	Not required	Not required	Not required
Accuracy	Good	Medium	Good
Interference	No	No	No
Visible Light	Not required	Not required	Not required
Implementation Cost	Low Cost	Very high for 3D sensors	Low Cost

4. Proposed System

Gesture-based interfaces, in which the user specifies commands by simple freehand drawings, offer an alternative to traditional keyboard, menu, and direct manipulation interfaces. The ability to specify objects, an operation, and additional parameters with a single intuitive gesture makes gesture-based systems appealing to both novice and experienced users. Unfortunately, the difficulty in building gesture-based systems has prevented such systems from being adequately explored. Gesture-based systems require classifiers to distinguish between the possible gestures a user may enter. In the past, classifiers have often been hand-coded for each new application, making them difficult to build, change, and maintain. A wireless data glove was developed to control a robot. Sensors mounted on the glove send signals to a processing unit, worn on the user's forearm that translates hand postures into data. An RF transceiver, also mounted on the user, transmits the encoded signals representing the hand postures and dynamic gestures to the robot via RF link.

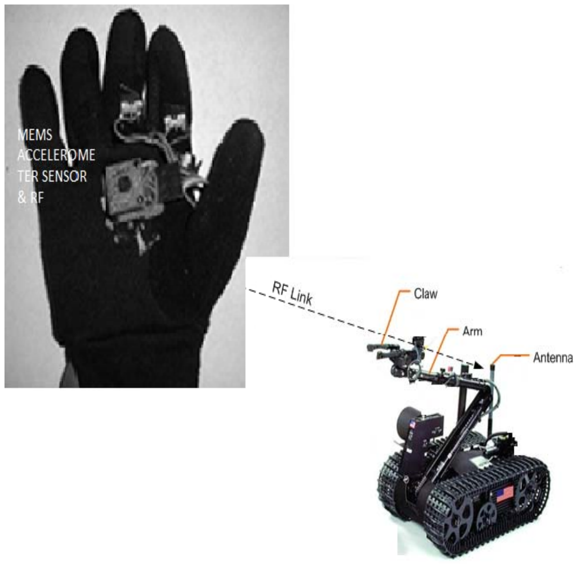

Figure 2: Proposed System

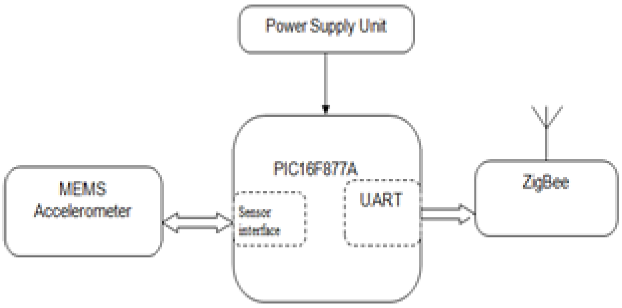

Figure 3: Remote Unit

Remote unit is that which is worn on the controller's hand. It may consist of;

- A fine DC power supply, which is normally provided by small DC battery.
- MEMS accelerometer sensor which provides the information on the hand gesture.
- A micro controller unit.
- An RF transmitter operating in ISM band which relays the gesture information to the crane unit. MEMS accelerometer is interface with microcontroller. Radio chip is connected to the port pins of microcontroller. Information from MEMS accelerometer is processed by microcontroller and appropriate gesture code transmitted via radio o crane unit.

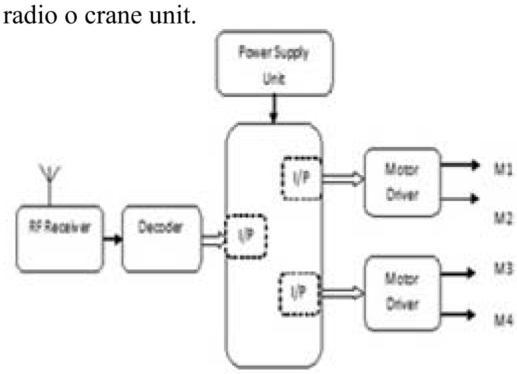

Figure 4: Crane Unit

Crane unit is controlled by the gesture from remote unit. The link between two units is via radio.

Crane unit may consist of;

- A fine DC power supply, which is normally provided by small DC battery.
- Motor drives along with motors for the operation of crane.
- A micro controller unit.
- An RF receiver operating in ISM band which receives the gesture information for the crane unit.

Radio and motor drives are connected to the I/O port of microcontroller. Control signals transmitted from the remote unit is received by radio in the crane unit. The signal is processed by microcontroller and appropriate motor drives are activated

5. Flow Chart

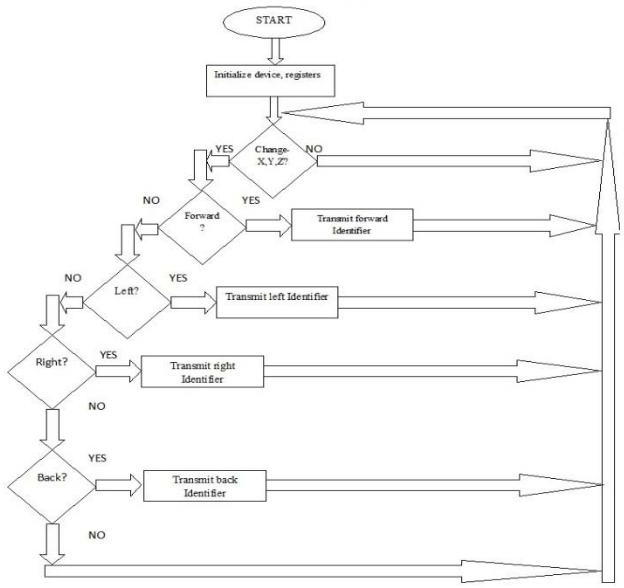

Figure 5: Remote Unit

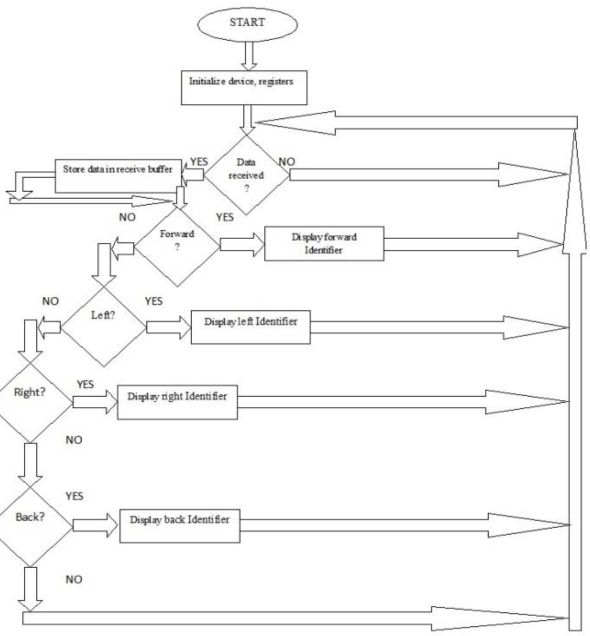

Figure 6: Robo Unit

6. Experimental Demonstration

Change in direction of hand is picked up by G-cell in accelerometer sensor. The capacitance change in g-cell is converted to voltage, which is filtered after adequate amplification. The filtered signal is in accordance to the movement of the sensor in XYZ directions. The data is fed to PIC 16F877A, where it is processed into information. The information is passes via Zigbee to the Robot unit. At the robot unit four DC-Motors will control the movement of wheel chassis as per the information from the received RF-Signal. Another set of DC-Motors control the movement of robotic arm unit in synchronization with the hand gesture.

7. Conclusion

What happens in future in gesture reorganization is beyond our prediction. Several researches' is done throughout the world on this topic. What happens tomorrow, it will be beyond our predictions, may be like fantasy Hollywood movies

8. Future Enhancement

Based on the above results, the authors recommend some techniques for the future development. Artificial intelligent Gesture recognition system;

- Extract the gesture form the video or moving scene
- It can also be very helpful for the physically impaired persons.
- This system can be used to operate any electronic devices by just keeping a sensor which recognizes the hand gestures.

Another application is that this can be used for security and authorization by keeping any particular hand gesture as the password

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