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Real Time Data Acquisition and Actuation via Network for Different Hand gestures using Cyber glove

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Abstract—Real time data acquisition from a cyber glove based hand gesture recognition system and data transmission through internet is proposed in this paper. The joint angles of the fingers are recognized for different gestures using a Cyber glove. Data from cyber glove is obtained in real time by a Client module developed using Windows Application Program Interface (WINAPI), from Virtual Hand Suite (VHS). TCP protocol is used for transmission of extracted data to the Server. Microcontroller (AT89S52) is used to control the speed of the motor depending upon the real time data received at the server end. Real time working of the prototype is demonstrated with successful data tapping, transmission, reception and speed control.

Keywords—Cyber glove, Virtual Hand Suite (VHS), Windows Application Program Interface (WINAPI), Microcontroller, Transmission control protocol (TCP).

I. INTRODUCTION

On-line data acquisition, transmission and control play a vital role in the development of real time control systems and also in the field of measurement. The design of these systems involves integrated electrical and electronic devices, which creates a doubt on reliability of the system in terms of long distance data transmission. Data Acquisition systems with remote accessibility are of great demand. Its task is to acquire data and transfer it to the base station. The complexity involved in the design of online data transmission system can be reduced with the help Internet [1] & [2]. Nowadays, Sensor and Actuator networks have an important impact in several fields such as smart power grids, smart buildings and smart industrial process control for efficient use of resource. It is possible to realize a variety of applications in the area of feedback control systems by combining sensors and actuators that operate in the environment. Integrating actuators into sensor networks is often considered to be the next logical step in the evolution of wireless sensor networks. Actuation based on network improves the processing capability of a system and overcomes the problem of poor real time operation and reliability [1]. By combining gesture recognition with internet data transmission, actuation of any type of actuator from a remote location, in response to the gesture is possible. A cyber glove based hand gesture recognition system that senses joints and hand orientation can be used for gesture recognition [9]-[12]. Interface to computers through hand gestures is one of the efficient methods for communication between computers and humans [7].

The invention of glove input devices has led to increased research and development projects using hand inputs to a variety of applications [8]. Ongoing researches in this field give a solid foundation for extracting online data from a hand gesture recognition system and to control the speed of a motor using the extracted data. This paper deals with an approach of extracting the real time data from a cyber-glove using VHS. A lookup table is formed from joint angle data received from the VHS. Appropriate values that are defined as per the look up table are sent to the server for different postures of cyber glove via Internet using TCP protocol. Internet communication is done using a client and server module developed in Visual C++, which uses the WINAPI (Windows Application Programming Interface) available in Microsoft Windows Operating System. A client-server based data transmission used in this project makes the system less complicated and reliable [3]-[6].

The rest of the paper is organized as follows. In section II, a brief overview of Cyber glove is presented. Experimental Setup is discussed in Section III. The proposed methodology for real time data acquisition and actuation via network is discussed in detail in Section IV. In section V, the results of the proposed prototype model is discussed. Section VI concludes the paper and the future works are presented in section VII.

II. CYBER GLOVE

The Cyber glove system is a fully instrumented glove that provides up to 22 high-accuracy joint-angle measurements. It uses appropriate resistive bending-sensing technology to accurately transform hand and finger motions into real time digital joint-angle data. It has three flexion per finger, four abduction sensors along with a sensor measuring thumb cross over, palm arch, wrist flexion and wrist abduction. The Cyber glove II used in our research is a wireless glove which obtains real-time digital joint-angle data from hand and finger motions. The Virtual Hand SDK is an application which integrates the real-time 3D hand interaction into software applications called Virtual Hand suite (VHS) in a simpler manner, from which the joint angles data can be extracted. Individual sensors in Cyber glove can be calibrated to provide maximum response for specific applications as shown in Fig 1. Depending on the posture to track appropriate sensors in Cyber glove are selected. Calibration is done to increase the gain for the particular finger or joint in order to distinguish the data obtained from other fingers. The joint angles obtained through the VHS are utilized to control the speed of the actuator.

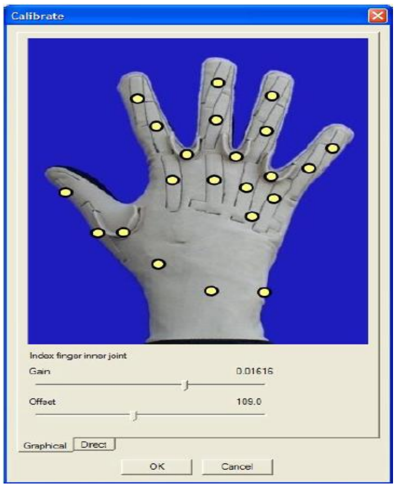


Fig.1 Advanced Calibration dialog in VHS

III. EXPERIMENTAL SETUP

The Experimental setup for real time data acquisition from Cyber glove using VHS at client end is shown in Fig.2.

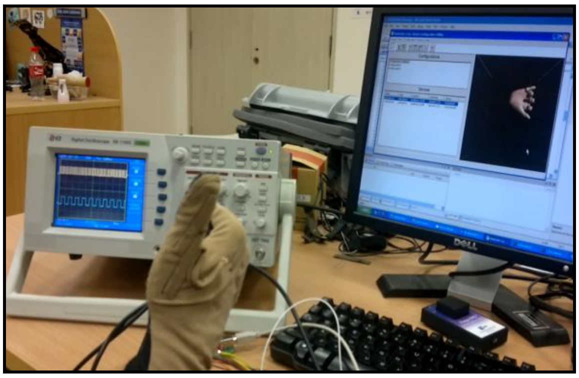


Fig.2 Cyber glove with VHS (Server end)

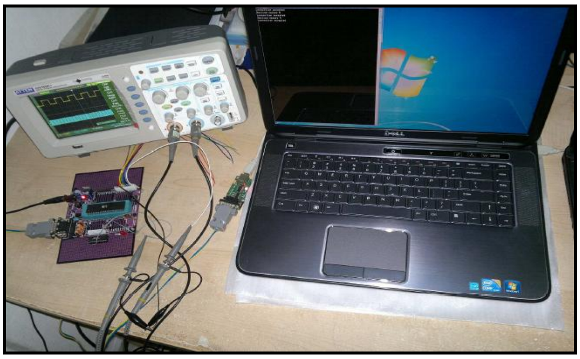


Fig.3 Microcontroller with serial port interface (Client end)

The setup involves a Cyber glove II with Bluetooth data transmission module. The data from Cyber glove is transmitted through a Bluetooth dongle to the client which interacts with VHS to simulate the virtual 3D hand. The server setup has a PC with a microcontroller connected to its serial port. The microcontroller responds to the data received from the server by sending corresponding pulse to the actuator (Motor) as shown in Fg.3.

IV. PROPOSED SYSTEM ARCHITECTURE

The architecture comprises of different simple modules working in a combined manner. The Flow diagram of the proposed algorithm is shown in Fig.4. The detailed working principle of each module in the algorithm is discussed in this section.

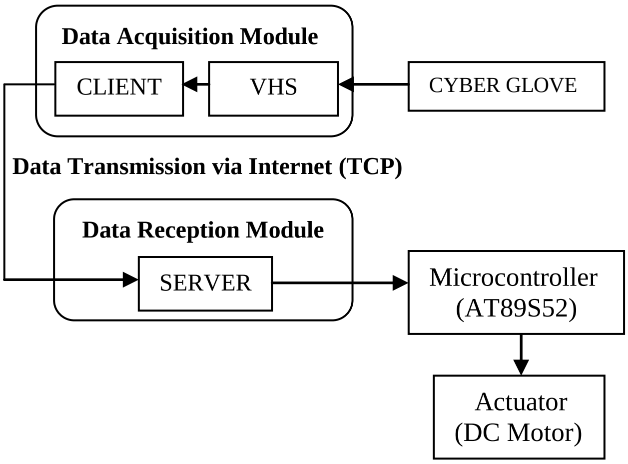
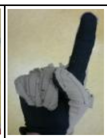


Fig.4 Flow diagram of proposed system

A. Data Acquisition Module

VHS application in the client end monitors the joint angle data of Cyber glove in real time. VHS application is to be programmed by building appropriate client module in Visual C++ using WINAPI, in order to extract the joint angle information for postures of interest. Client Module is developed to receive the data from the cyber glove and to transfer the received data to the server via network with a continuous polling mode using TCP in real time. The client module utilizes the libraries in VHT to communicate with VHS. A unique character is used to represent each hand gestures. Based on this data a lookup table is formed in Client module as shown in Table I.

Table I. HAND GESTURES AND ITS CORRESPONDING VALUES

Hand gestures				
Characters	5	6	7	8

The port address and dynamic IP address of server are the inputs to the client module. Once the client module is executed, the client code prompts for server Port and IP address and enters into polling after obtaining the values. It communicates with the VHS in real time and extracts the data for different postures. The extracted data is compared with the lookup table and an appropriate characters corresponding to the gesture is sent to the server, in real time. Calibration for the finger joints of interest is done by amplifying the gain of the sensor. Due to this the joint angle of interest can be easily identified.

B. Data Transmission

The data from the client module is sent to server via Internet. Communication between server and client is done using TCP, one of the core protocols of the Internet protocol suite. TCP provides communication service at an intermediate level between the application program (Visual C++) and the Internet protocol. The unassigned port in TCP ranges from 49152 to 65535. The port address used in our prototype module is 45000. A socket is declared, initialized and configured in both client and server module, for establishing network connection. The socket is to be checked by both modules in continuous polling mode.

C. Data Reception Module

The server module is developed in visual C++ using WINAPI similar to the client. The server module receives the data from client and sends it to the serial port. The server should be activated before executing the client module. If this condition fails, the client will automatically quit, prompting “connection error”. The server will be in continuous polling mode and will check for any data in the specified port. If the data appears in the declared socket it is retrieved and sent to the serial port. The server module is built with a separate module for serial port communication, in which the serial port is configured with 9600 bps, COM2, 8 bit data, with 1 start and stop bit. The baud rate can be increased for data transmission at high sampling rate. The data at the serial port should be present, until the incoming of next data from client. This is achieved by declaring serial port communication module as a thread, so that it executes independent of server module. The thread will be triggered by execution of server module which will be in continuous polling mode similar to client and server.

D. Microcontroller and Actuator

Microcontroller is a microprocessor designed specifically for control applications, and is equipped with ROM, RAM and facilities I / O on a single chip. AT89S52 is from MCS-51/52 family equipped with an internal 8 Kbyte Flash

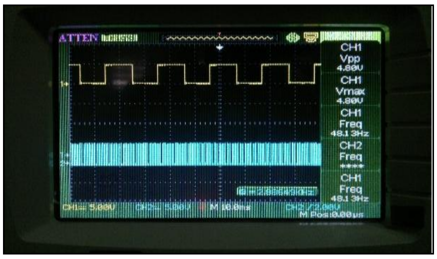
EPROM (Erasable and Programmable Read Only Memory), which allows its memory to be reprogrammed. There are four input and output ports 8 bits each. The microcontroller is clocked at 12 MHz. The program is done in assembly language and burnt using KEIL C. The data from the serial port is fed into a microcontroller (AT89S52) with serial interface (SCON). The microcontroller decodes the value and saves it in the accumulator. Depending on the accumulator value different frequency is generated. The generated pulse is fed via port 2, which is connected to a low power DC motor. Thus for different values received from the client the speed of the motor will vary. The actuator can be directly driven by a microcontroller, if the power rating is less else a driver circuit can be used to avoid loading.

V. RESULTS AND DISCUSSION

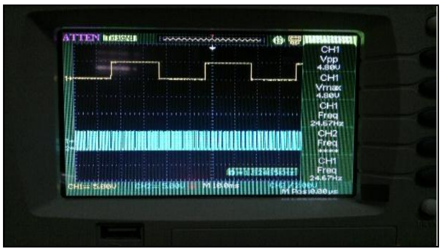
The data received by server is sent to the Serial port emulator which is used to convert the USB port into a serial port so that it can be used for present generation laptops and desktops which lacks serial port. The microcontroller is programmed such that it produces pulses of appropriate frequency as per the characters received from client as shown in Table II. A DSO is used to check the pulse pattern. It can be seen that the pulse pattern varies according to variation in the joint angles i.e. variation in data received from client as shown in Fig.5.

Table II. CHARACTERS AND ITS CORRESPONDNG FREQUENCY GENERATED

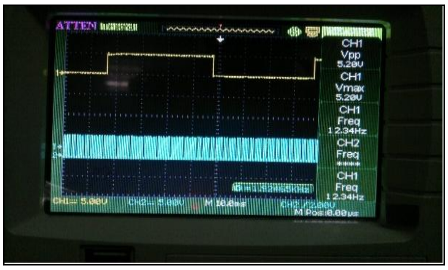
Characters	5	6	7	8
Frequency (Hz)	48	24	12	0



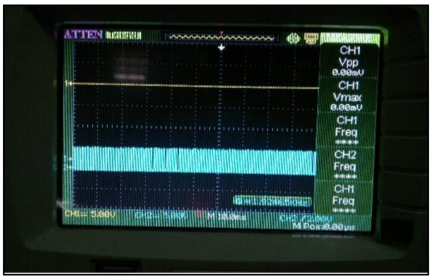
(a)



(b)



(c)



(d)

Fig.5 Pulse generated by Microcontroller for different received values
(a) 48 Hz (b) 24Hz (c) 12Hz (d) 0 Hz

VI. CONCLUSION

Real time data from the cyber glove is extracted with help of developed client module in developed VC++. The obtained real time data is successfully transmitted using TCP. The server module is able to receive the data and send it to Microcontroller (AT89S52). Threading technique of WINAPI is successful in transmitting the data from server to the Microcontroller. Pulse of appropriate frequencies is generated for unique character transmitted, which is used for actuation. The prototype built is able to track, transmit and receive the cyber glove data effectively with good response time.

VII. FUTURE WORK

The simplex communication method used in this paper can be done using Duplex communication through which real human-computer interaction can be visualized. To achieve more smoothing actuation and accuracy, the baud rate of microcontroller as well as the frequency count in the proposed topology can be increased. With some hardware modification, the proposed method can be used for home automation.

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