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RESEARCH ARTICLE

ASSISTIVE DEVICES FOR SERVICE MEMBERS WITH DISABILITIE

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Abstract

Handicap assistance devise provides very easy handling system, which is very useful for the people how are physically disabled. In this project, we propose a Human Machine Interfacing Device utilizing hand gestures to communicate with computers and other embedded systems acting as an intermediary to an appliance. Inertial navigation sensor like an accelerometer is utilized to get dynamic/static profile of movement to navigate the wheelchair or provide commands to appliances, thus accelerometer profiles are converted into wireless interactivity. In order to provide users with an easy and convenient way of controlling various consumer electronics, it is necessary to use a universal way to control various devices.

Introduction

In the current era, embedded systems are being integrated into every aspect of our lives (eg. Microsoft Surface[1] and Automated Smart Homes) making it essential to move away from the conventional keyboard/mouse or keypad interface and delve into intuitive methods of interacting with the computers and other appliances around us. Also, the use of hand gestures for interaction avoids the most prevalent injury due to continuous use of the keyboard and the mouse, the Carpal Tunnel Syndrome which occurs when the median nerve that runs from the forearm into the hand gets pressed at the wrist . computer screen with 100% success rate:

- Navigate through various Microsoft Windows menus
- Drag a window to a different location on the screen
- Move the cursor on screen
- Interact with on-screen elements. • Maximize and minimize windows • Perform Video editing
- Interact with 3-D objects/images on screen • Gaming
- Control of external hardware such as robots.

BASE DESIGN

A simple cotton glove is fitted with an accelerometer. This glove is then worn by the user and the desired actions are performed .The accelerometer senses the orientation of the hand in space through an inbuilt capacitive system and feeds out electrical signals as unique voltages for each unique orientation. These voltages are converted to digital values by the microcontroller.

Figure : Right Glove, Main Circuit

COMPONENT SELECTION

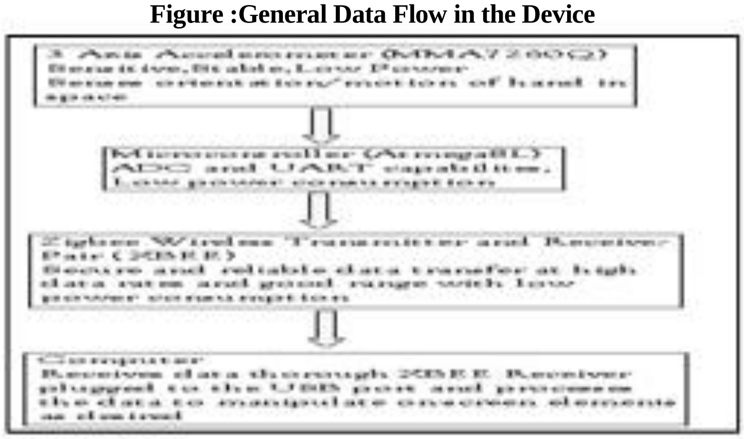
A. The Human-End

The human dons the gloves that are fitted with the accelerometer module and the micro switches in the right as well as on the left hand. This means that mere movements of hand (which need to be predefined) will translate into corresponding interaction with on-screen elements.

B. Accelerometer

The accelerometer is the device which will generate corresponding electrical signals to control the on-screen elements. The accelerometer used here is the 3-Axis Accelerometer[12] (MMA7260Q) with an easy analog interface and running at a supply voltage of 3.3V, which makes it ideal for handheld battery powered electronics. The accelerometer will experience acceleration in the range of +1g to -1g as the device is tilted from -90 degrees to +90 degrees. In order to determine the angle of tilt, θ, the A/D values from the accelerometer are sampled by the ADC channel on the microcontroller. The acceleration is compared to the zero-g offset to determine if it is a positive or negative acceleration. This value is then passed to the tilt algorithm[13]. When applied to all three axis, we are able to calculate the orientation of hand in three dimensional space.

Figure :General Data Flow in the Device



C. Microcontroller

The function of the microcontroller in this application is to act as an interpreter between the hand gestures and the end application. The ADC Port converts analog signals coming in from the accelerometer into corresponding 8-bit digital values. It then shifts out the result through the UART line to the device to be controlled. The ATmega8L[14] along with having all these features achieves throughputs approaching 1 MIPS per MHz by executing powerful instructions in a single clock cycle, allowing the system designed to optimize power consumption versus processing speed.

D. XBEE and UART Data Flow

The digital data is sent in the following order via the XBEE being operated in the transparent mode.

- Micro switches
- X axis data
- Y axis data
- Z axis data

The XBEE[15] and XBEE -PRO OEM RF Modules operating in the ISM 2.4 GHz band were engineered to meet IEEE 802.15.4 standards and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between devices. The XBee receiver module connects into the USB hub of the computer or can be serially connected to other hardware. The advantage of USB over other data transfer standards is that USB is a widely spread and well accepted standard and it also provides plug and play thereby not requiring either the computer or the appliance to boot-up every time the device is connected to it. The complete system, along with the data flow and interconnections.

INTERFACING ISSUES AND SOLUTIONS

Various problems arose during the development phase while interfacing. Some of them, along with their solutions are listed below.

- Selection of components had to be made keeping in mind the balance between the application requirements and the need for minimizing power consumption as well as weight, as the device was to be equipped on the user‘s hand.
- The major issues faced by us while interfacing included data communication between the Atmega8L and the computer and calibration of the on screen actions to the input received via the

Zigbee.

- Selecting the correct sampling rate of data to attain optimum sensitivity and accuracy as well as to avoid picking up stray natural motions/vibrations of the hand is important. This issue was resolved by selecting an appropriate data transfer rate as well as putting in software checks to resolve the problem of stray natural motion.

V. ALGORITHM FOR DATA

INTERPRETATION AND EXECUTION.

The serial data sent by the microcontroller via the UART is read by the software written in Visual Basic using the MSCOMM32.OCX module which interacts with the System Kernel [16] However one may use any system programming language that can provide access to the core kernel libraries to interact with the mouse

parameters.The following settings are required for

Initialization -

1. Defining the Port no.

2. Setting up the baud rate (9600 bps is the default), setting up parity bits and other error correction parameters The following are the essential functions that would be needed to be reused as modules.

1. Constructor for the Mouse Pointer Initialization.

2. State functions for defining the mouse clicks and the associated events.

3. Function for sending real time processed of the X, Y positional parameters to the kernel libraries.

The overall code function can be summarized in the following -

A. Getting data from the Serial port

The data is sent in packets, each packet representing one single positional state. Each packet is 32 bits in size - consisting of 8 bits each of X, Y, Z and Button State information. The values of X,Y and Z range from 0 to 255 which are mapped from the voltage from the accelerometer.

B. Calibrating

Since the values of acceleration may vary with altitude as well as with various people using it. The displacement of the positional parameters due to unintentional motions is to be neutralized. For this, we take the first 50 set of packets as sampling packets - to these packets we separate out the individual values and take an average, the person wearing the glove is expected to rest his hands in the rest position. The normal value hence obtained is used for subsequent mapping of co-ordinates into proportionate displacement.

C. Error Detection

The sources of errors can be -

- Signal noise
- Intermittent connection at the hardware
- Packet loss

In order to detect errors in the data, we compare each individual packet data with the previous data and measure if the difference is within limits of the normal deviation expected (The estimate of the standard deviation is done at the Calibration stage) In case we have an abnormal deviation, we neglect the packet and compare the next packet with the last error-free packet. Since we have 300 packets arriving every second we can afford a packet loss up to 10 %

D. Mapping Dynamic Data onto Positional Parameters

In order to map the error free packet data onto the screen, we use the following formulae to come up with the proportionate placement of co-ordinates -

$$Xonscreen=(-1)*X * 0.4 * ((X * X) / Xpix) \tag{1}$$

$$Yonscreen=Y * 0.4 * ((Y * Y) / Ypix) \tag{2}$$

where X and Y are the co-ordinates from the error free packets, the Xpix and the Ypix are the respective resolutions along the X and Y axis and Xonscreen and Yonscreen are the resulting positions on the screen. The 0.4 constant is estimated and adjusted according to the aspect ratio of the screen. The co-ordinates (Xonscreen and Yonscreen) hence obtained are passed onto the MouseMove() function which position the mouse co-ordinates to the respective position.

E. Processing Gestures

The raw coordinates obtained after the error correction are used in identifying gestures which are pre-defined. A button press on the glove puts it into the Gesture Mode; when in this mode, the co-ordinates are passed onto the Gesture Functions which constantly monitor and store previous co-ordinate data to recognize a pattern. These patterns can be customized and are to be pre-defined as required. During the testing phase of the device some of the hand gesture patterns that we successfully used:

- Hand lift and drop motion to copy and paste.

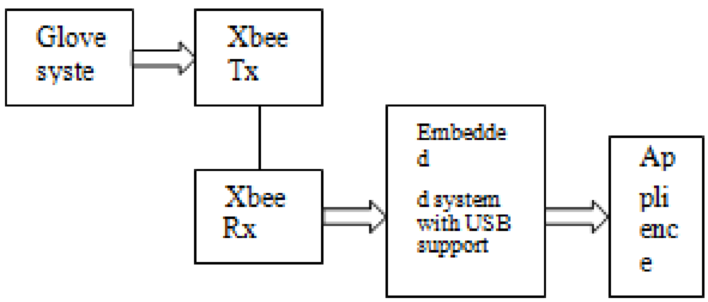
  Left Hand vertical sweep motion to scroll

  Dual hand motion to turn a 3D object.

  Right hand tilt motion to control the mouse.
  Left hand directional motion to control the arrow keys.
  Use of right directional motion and left hand tilt motion motion to play a video game (Call of Duty).
  Action button presses along with Palm lift and drop motion to minimize and maximize windows respectively.
  Use of Right hand horizontal sweep to fast forward, reverse or pause a video.
  Action button press along with left hand lift and drop to change volume.

VI. EXTENDING THE SYSTEM TO EMBEDDED PLATFORM

Figure General Data Flow for Appliance as End Target



VII. CONCLUSIONS AND APPLICATIONS

This proposed multi-functional portable device for better human - machine interaction using hand gestures can be applied in the following applications:
- Replace the mouse as a more convenient and natural interaction peripheral.
- Interacting with 3D objects on computer screen
- Easy control of Robots, Robotic Arms and Human Controlled Automation.
- Easy Home Automation
- Effective Teaching / Animation / Design Aid
- Easy accessibility tool for people with disabilities
- When used with other inertial sensors (eg. gyros) The glove can be used to manipulate objects in 3 Dimensions.
- It can be used extensively in the gaming industry for remote location manipulation.

VIII. FUTURE WORK.

We look forward to facilitate rich interactive features which would enable the users to interact and take portability to the next level. Use of smaller packages of the integrated circuits will scale down the size of the device to that of a watch, thereby improving the portability.

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