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Gesture-Based Wheelchair Control For The Physically Challenged

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Abstract

Traditional input systems for interaction with machines include keyboards, joystick or the mouse. Those suffering from physical handicaps such as Carpel Tunnel Syndrome, Rheumatoid Arthritis may be unable to use such forms of input. In this paper, a "Human Machine Interfacing Device" is proposed utilizing hand gestures to communicate with computers and other embedded systems acting as an intermediary to an appliance. Developments in field of communication have enabled computer commands being executed using hand gestures. Inertial navigation sensor like an accelerometer is utilized to get dynamic/static profile of movement to navigate the mouse on the computer or provide commands to appliances, thus accelerometer profiles are converted into wireless interactivity. The device involves non-tactile interaction with machines to manipulate or control them in accordance with hand gestures.

Keywords: MEMS, ADC, ultrasonic sensor, relay,

1. INTRODUCTION

In the current era, embedded systems are being integrated into every aspect of our lives (Eg. Microsoft Surface 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.

Human hand gestures are a means of nonverbal interaction among people. They range from simple actions of pointing at objects and moving them around to the more complex ones that express our feelings or allow us to communicate with others.

To exploit gestures in Human Machine Interfacing, it is necessary to provide the means by which they can be interpreted by computers or intermediate embedded systems enabling appliance control. Though various efforts are being made in this direction, they face issues of variable reliability, cost and convenience and often need to train the device. There was an effort in this direction which eventually leads to filling a patent. A careful study reveals that this device is adequate for 3D interactions.

This paper describes our work in this direction mainly with the wheel chair as the target device and highlights extending this system to an embedded platform as an intermediary to an appliance as a target device. The inertial sensor, the accelerometer along with a microcontroller, maps the orientation and position of the hand in 3-D space. This data is then transmitted to the end application where it can be interpreted and acted on, thereby simulating wireless interactivity.

Firstly, it aims at venturing into the field of physiological computing and permitting convenient interaction with the surrounding appliances through minimal hardware. Also, the use of hand gestures for interaction avoids the most prevalent injury due to continuous use of the joystick, the Carpal Tunnel Syndrome which occurs when the median nerve that runs from the forearm into the hand gets pressed at the wrist. For the users suffering from Rheumatoid Arthritis causing loss of function at the finger joints it would be easier to use simple hand gestures which don't require the use of fingers but only hand movements to move the wheelchair.

This technology is also of prime importance in dealing with 3-dimensional objects, effective teaching aid, and for providing an alternative to the traditional joysticks in the gaming industry. Such device was built, a hand glove and demonstrated successfully. This paper highlights the components used in the device and their interaction with the MEMS system as applied to a wheel chair.

2. LITERATURE SURVEY

The author discusses the directions of future research in gesture recognition, including its integration with other natural modes of human-computer interaction. -substantial research effort that connects advances in computer vision with the basic study of human-computer interaction will be needed in the future to develop an effective and natural hand gesture interface [1]. This paper describes a three-class taxonomy for the computer vision-based Technology and gives examples within each of the classes [2]. In this work, the author describes current applications work in the computer-rendered environments known as virtual reality (VR) is examined. Caterpillar Inc. , a manufacturer of earth-moving and construction equipment is using VR to assess interior visibility on new prototypes reports on the development of a hand to machine interface device that provides real-time gesture, position and orientation information. The key element is a glove and the device as a whole incorporates a collection of technologies [3]. In this paper, component technologies include its use in conjunction with a host computer which drives a real-time 3-dimensional model of the hand allowing the glove wearer to manipulate computer-generated objects as if they were real, interpretation of finger-spelling, evaluation of hand impairment in addition to

providing an interface to a visual programming language [4]. The author presents uWave, an efficient recognition algorithm for such interaction using a single three-axis Accelerometer. uWave in gesture-based user authentication and interaction with three-dimensional mobile user interfaces using user created gestures [5]. The author describes that it would be ideal for computer-human interaction if a computer could understand human gestures. Hand gestures are one means of interaction between computers and humans. A hand gesture interface device, the VPL Data Glove, provides real-time information on a user's hand movement [6]. In this work, interaction using gesture technology for effective communication empowering physically challenged to interact with machines and computing devices including 3-D graphic interactions and simulations [7]. The author describes that with a larger training set and context modeling, lower error rate are expected and generalized to a freer, user independent [8].

3. SCOPE

The person using the wheel chair holds the gesture controller. This gesture band is connected wirelessly to the motorized wheel chair that he uses. Hand gestures such as raising fingers. tilting palms are used to control the motion of the wheel chair. Raising fingers up takes the wheel chair ahead, lowering the fingers takes it back, tilting the palms to the right turns the wheelchair to the right while tilting the palms to the left turns it left. In order to avoid unintended motions, a safety switch is incorporated at the joint of the index finger. The acceleration of the wheel chair is determined by the angle of the tilt or how fast / slow one raise lowers the fingers. .

Traditionally we have had button controls for the motorized wheel chair. After talks with several wheel chair users we understood that a psychological feeling of machine overpowering the man arises since the buttons are visualized as a part of the machine. With an aim to use an alternative which would be received as a psychologically friendly device, we took up the challenge of integrating gesture technology with the technology. The gestures are captured with an accelerometer fitted in the band. The co-ordinate data is continuously sent to the Atmega8L microprocessor, care is taken to ensure zero interference with the signal. The data is first filtered for unintentional gestures and error corrections before being interfaced with the motor for control. The research for this product has led us to make a generic system for controlling household appliances (TV, refrigerator, ACs, ovens and even curtains, doors and windows) with the gesture band. This research has been reflected in the paper "Handicap Assistance Device for Appliance Control using User-Defined Gestures" which has been accepted at the International Conference on Machine Learning and Computing 2010.

4. BLOCK DIAGRAM

In this paper MEMS sensor takes major role. Here we are designing a module containing MEMS sensors. These sensors are used to detect the movements of hands. According to the movement the sensors gives signals. These signals detected by

MEMS detector it is interfaced with the microcontroller. Microcontroller drives the motor according to the input pulses from the MEMS detector. This motor will be moved in different directions like forward, reverse. Here we are using AT89s52 microcontroller.

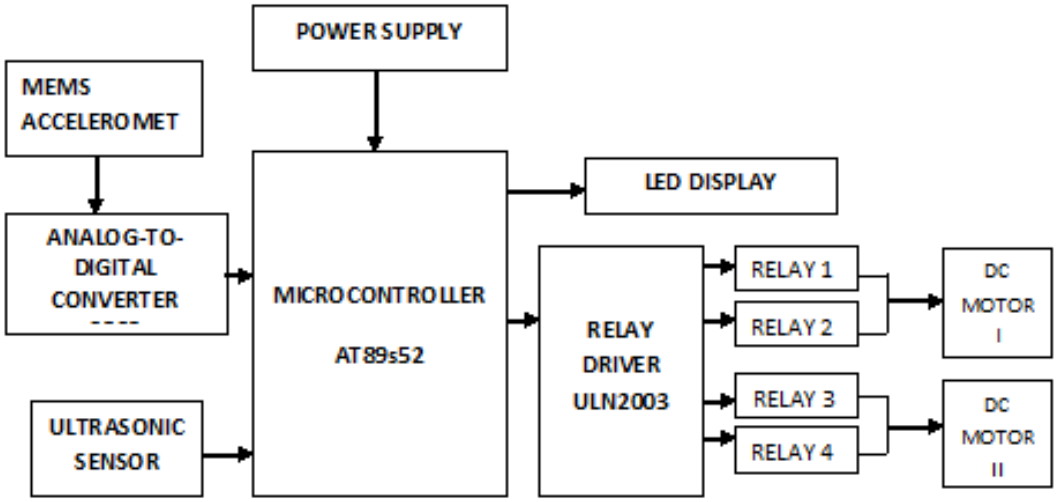

Fig. 1 Block Diagram

5. HARDWARE DESCRIPTION

5. 1 MEMS Accelerometer

MICRO-ELECTROMECHANICAL SYSTEMS is the technology of very small mechanical devices driven by electricity. They usually consist of a central unit that processes data, the microprocessor and several components that interact with the outside such as micro sensors.

A) 0g-Detect

The sensor offers a 0g-Detect feature that provides a logic high signal when all three axes are at 0g. This feature enables the application of Linear Freefall protection if the signal is connected to an interrupt pin or a poled I/O pins on a microcontroller.

B) Self Test

The sensor provides a self test feature that allows the verification of the mechanical and electrical integrity of the accelerometer at any time before or after installation. This feature is critical in applications such as hard disk drive protection where system integrity must be ensured over the life of the product. Customers can use self test to verify the solder ability to confirm that the part was mounted to the PCB correctly. To use this feature to verify the 0g-Detect function, the accelerometer should be held upside down so that the z-axis experiences -1g. When the self test function is initiated, an electrostatic force is applied to each axis to cause it to deflect. The x- and y-axis are deflected slightly while the z-axis is trimmed to deflect 1g. This procedure assures

that both the mechanical (g-cell) and electronic sections of the accelerometer are functioning.

C) ***g-Select***

The g-Select feature allows for the selection between two sensitivities. Depending on the logic input placed on pin 10, the device internal gain will be changed allowing it to function with a 1. 5g or 6g sensitivity. This feature is ideal when a product has applications requiring two different sensitivities for optimum performance. The sensitivity can be changed at anytime during the operation of the product. The g-Select pin can be left unconnected for applications requiring only a 1. 5g sensitivity as the device has an internal pull-down to keep it at that sensitivity (800mV/g)).

D) ***Sleep Mode***

The 3 axis accelerometer provides a Sleep Mode that is ideal for battery operated products. When Sleep Mode is active, the device outputs are turned off, providing significant reduction of operating current. A low input signal on pin 7 (Sleep Mode) will place the device in this mode and reduce the current to 3 μA typ. For lower power consumption, it is recommended to set g-Select to 1. 5g mode. By placing a high input signal on pin 7, the device will resume to normal mode of operation.

E) ***Filtering***

The 3 axis accelerometer contains an onboard single-pole switched capacitor filter. Because the filter is realized using switched capacitor techniques, there is no requirement for external passive components (resistors and capacitors) to set the cut-off frequency.

F) ***Ratiometricity***

Ratiometricity simply means the output offset voltage and sensitivity will scale linearly with applied supply voltage. That is, as supply voltage is increased, the sensitivity and offset increase linearly; as supply voltage decreases, offset and sensitivity decrease linearly. This is a key feature when interfacing to a microcontroller or an A/D converter because it provides system level cancellation of supply induced errors in the analog to digital conversion process.

5.2 ADC (Analog To Digital Converter)

The ADC0808, ADC0809 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register. The 8-channel multiplexer can directly access any of 8-single-ended analog signals. The device eliminates the need for external zero and full-scale adjustments.

Easy interfacing to microprocessors is provided by the latched and decoded multiplexer address inputs and latched TTL TRI-STATE outputs. The design of the

ADC0808, ADC0809 has been optimized by incorporating the most desirable aspects of several A/D conversion techniques.

The ADC0808, ADC0809 offers high speed, high accuracy, minimal temperature dependence, excellent long-term accuracy and repeatability, and consumes minimal power. These features make this device ideally suited to applications from process and machine control to consumer and automotive applications.

5.3 555 Timer

The 555 Timer is a monolithic timing circuit that can produce accurate and highly stable time delays or oscillations. The timer basically operates in one of the two modes—monostable (one-shot) multivibrator or as an astable (free-running) multivibrator. In the monostable mode, it can produce accurate time delays from microseconds to hours. In the astable mode, it can produce rectangular waves with a variable duty cycle. Frequently, the 555 is used in astable mode to generate a continuous series of pulses, but you can also use the 555 to make a one-shot or monostable circuit.

The 555 can source or sink 200 mA of output current, and is capable of driving wide range of output devices. The output can drive TTL (Transistor-Transistor Logic) and has a temperature stability of 50 parts per million (ppm) per degree Celsius change in temperature, or equivalently 0. 005 %/°C.

5.4 Microcontroller

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin out.

In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

5. 5 Ultrasonic Sensor

Ultrasonic sensors (also known as transceivers when they both send and receive) work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.

Since piezoelectric crystals generate a voltage when force is applied to them, the same crystal can be used as an ultrasonic detector. Some systems use separate transmitter and receiver components while others combine both in a single piezoelectric transceiver

5. 6 *Relay and Relay Driver*

A relay is an electro-magnetic switch which is useful if you want to use a low voltage circuit to switch on and off a light bulb (or anything else) connected to the 220v mains supply.

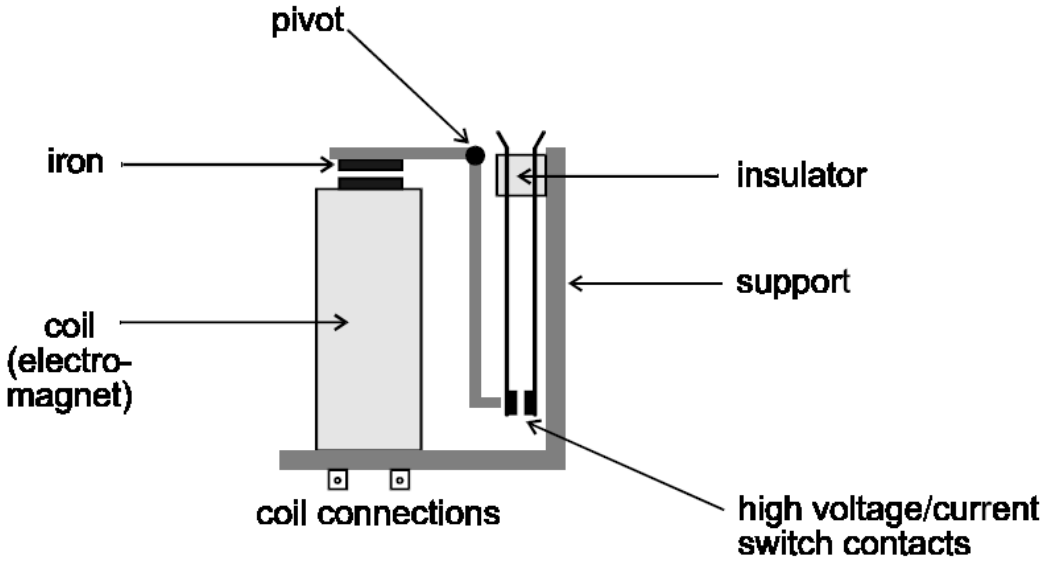

Fig. 2 Relay Diagram

The current needed to operate the relay coil is more than can be supplied by most chips (op. amps etc), so a transistor is usually needed. A resistor of about 4k7 will probably be alright. The diode is needed to short circuit the high voltage "back emf" induced.

5.7 Dc Motor

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

6. INTERFACING ISSUES AND SOLUTIONS

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

A) 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.

B) The major issues faced by us while interfacing included data communication between the Atmega8L and the wheelchair.

C) Selecting the right data type for carrying information was of utmost importance as it influences the entire data transfer process as well as transfer speeds. This was resolved by designating one data packet as four 8-bit frames. The frames contain button/click information, X Axis Voltage, Y Axis Voltage and Z Axis Voltage in that order.

D) Scaling the data received by the wheelchair to obtain the resulting motion on path required a lot of tuning of the received data to obtain optimum sensitivity. The issue could be resolved by either hardware filters or software. The latter option was selected by us as it provided greater tuning and customizing ability without addition of any external hardware to the device.

E) 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.

7. RESULT

Human hand gestures provide the means by which they can be interpreted by computers or intermediate embedded systems enabling appliance control. 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. For the users suffering from Rheumatoid Arthritis causing loss of function at the finger joints it would be easier to use simple hand gestures which don't require the use of fingers but only hand movements to perform tasks on a computer.

8. CONCLUSION

This is work is very useful for in the field of physiological computing and permitting convenient interaction with the surrounding appliances through minimal hardware. This technology is also of prime importance in dealing with 3-dimensional objects and provides an alternative to the traditional joysticks. This paper highlights the components used in the device and their interaction with the iMEMS system as applied to a wheel chair.

9. REFERENCES

[1] Vladimir I. Pavlovic, Rajeev Sharma, Thomas S. Huang, "Visual Interpretation of Hand Gestures for Human-Computer Interaction: A Review", IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 19, no. 7, pp. 677-695, July 1997, doi:10. 1109/34. 598226

[2] Thomas B. Moeslund and Lau Nørgaard, 2003, ”A Brief Overview of Hand Gestures used in Wearable Human Computer Interfaces”, Technical report: CVMT 03-02, ISSN: 1601-3646, Laboratory of Computer Vision and Media Technology, Aalborg University, Denmark.

[3] Adam, J. A. “Virtual reality is for real. ”, IEEE Spectrum, New York, NY, USA

[4] Thomas G. Zimmerman , Jaron Lanier , Chuck Blanchard , Steve Bryson , Young Harvill, “A hand gesture interface device”, Proceedings of the SIGCHI/GI conference on Human factors in computing systems and graphics interface, p. 189-192, April 05-09, 1987, Toronto, Ontario, Canada.

[5] Jiayang L. , Wang Z. , Zhong L. , Wickramasuriya J. , Vasudevan V. , “uWave: Accelerometer-based personalized gesture recognition and its applications”, Pervasive Computing and Communications, IEEE International Conference on, Vol. 0 (2009), pp. 1-9

[6] Tomoichi Takahashi , Fumio Kishino, “Hand gesture coding based on experiments using a hand gesture interface device”, ACM SIGCHI Bulletin, v. 23 n. 2, p. 67-74, April 1991 [doi:10. 1145/122488. 122499

[7] Sisil Mehta , Dhairya Dand , Shashank Sabesan , Ankit Daftery ; “Handicap Assistance Device for Appliance Control Using User-Defined Gestures”, Bangalore, India . February 09-February 11. ISBN: 978-0-7695-3977-5

[8] Mubarak Shah, Ramesh Jain, “Motion-Based Recognition”, a book page no 241

APPENDIX
SNAP SHOTS OF THE WHEEL CHAIR