Design and Implementation of a Gesture Recognition Control System for Medical Electronics Applications

T.M. Athul Anand[1] Keerthi S Nair[2] R. Dharmalingam[3] S. Sellam[4]
[1,3,4]Maharaja Institute of Technology Coimbatore [2]Rapid Techs Thrissur

I. INTRODUCTION

Now a day's electronic systems are extensively used in the medical field and many researches are being conducted in the Medical Electronics fields. The Medical Electronic equipments are usually mended for the assistance during the diagnosis of diseases, for monitoring the medical conditions, for the management of medical database and also for using as the life support equipments. We have diagnostic equipments such as ultrasound, MRI (Magnetic Resonance Imaging) machines, PET (Positron Emission Tomography) x-ray scanners, includes medical imaging machines, used to aid in diagnosis. Then another category of medical instruments is the Therapeutic equipments which includes infusion pumps, medical lasers and LASIK surgical machines. Life support equipment such as, medical ventilators, heart-lung machines, ECMO (Extra Corporeal Membrane Oxygenation), and dialysis machines, is used maintain a patient's bodily function. Medical monitors allow medical staff to measure a patient's medical state. Monitors may measure patient vital signs and other parameters including ECG (Electrocardiograph), EEG (Electroencephalogram), blood pressure, and dissolved gases in the blood. And finally we have medical laboratory equipments to analyze blood, urine and genes.

After the design and development of such a series of medical electronic equipments, that are making use of many physical parameters of the human body, now the technology is reaching at the gesture recognition system. A multipurpose gesture recognition control system (MGRCS) dedicated for the field of medical electronics is discussed here. The control system can be used for several applications by reprogramming the controlling element which is a microcontroller. The system is designed on the ARM platform. LPC2148 is used here.

The paper starts with the design details of the MGRCS, which is explained in section I & II, and continues with the implementation of the MGRCS in a medical electronics application which is given in the successive sections. Here we choose a wheel chair for the implementation purpose. The evaluation result of implemented model is also given

II. MULTIPURPOSE GESTURE RECOGNITION CONTROL SYSTEM

The MGRCS consist of an ARM processor, LPC2148 as its brain, a set of mems accelerometers as its sensory organs and small dc motors as its actuators. The accelerometers placed in a glove will take the hand gesture movements of a person wearing that glove. According to the software loaded in the ARM processor, the output operation of the MGRCS can be changed.

The accelerometers are interfaced to the ADC module of the ARM processor and the motors are interfaced to the I/O ports. The number of accelerometers can be increased up to the capacity of processor used. The number of motors is also programmable for MGRCS. The block diagram of the MGRCS is given in Figure I

The MGRCS is having a wide application area as the controlling element. We are focusing in the medical electronics field. Some of the applications in this field are explained later.

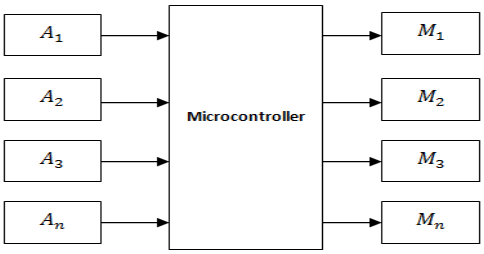

Fig. 1: Block diagram of the MGRCS

A. MEMS Accelerometer

The Micro Electro Mechanical Systems (MEMS) structures within a package respond to motion events through bending, flexing, or somehow altering their structures just as a cantilever beam or spring system behaves in the real world scale. This, in turn, changes the value within some electrical interface component of the design allowing for measurement to take place.

There are several different types of accelerometers that differ in their method of sensing movement. These include capacitive, piezoelectric, piezoresistive and thermal. The thermal type accelerometers use a gas producing material within an enclosed package. There are then at least four temperature sensors arranged in the four corners of the device and one directly over the gas producing material itself. These types function by comparing the values from the temperature sensors to determine the orientation of the device.

The more common types of accelerometers use capacitive techniques. The function is that a suspended proof mass acts as one plate of a parallel plate capacitor while the plate is stationary. The suspended proof mass deflects with motion, much like a spring, and changes the distance between the parallel plates. This then changes the value of the capacitor and allows interface circuitry to detect the difference and then calculate the force of the acceleration event. Many of these capacitive types are fabricated using Silicon on Insulator (SOI) techniques that provide a suitable platform for the silicon device, comprising the accelerometer, to be fabricated upon. It is important that the substrate the device is on is an insulator so that the capacitance values are not interfered with on the package itself.

B. Analysis

1) CASE STUDY

Here we are considering a medical electronics application for closely observing the operation of MGRCS.

A dynamic wheel chair is under consideration. The patient wears the glove containing MGRCS and he can

control the movement of the wheel chair using the glove. In order to examine the operation of MGRCS in a second field, a home automation system is also incorporated with the dynamic wheel chair. In this system the patient can control the house hold electrical and electronic devices by simply wearing the glove and making some hand gestures. For the home automation segment a relay circuit is also included in the MGRCS module.

The basic idea behind the project is wheel chair automation with tilt control and gesture control. The tilt control is used for controlling the movement of wheelchair. And gesture control is for room automation. All the electronic gadgets in patient's room can be controlled by certain gestures from the patient. The gesture control signals for room automation are communicated through zigbee modules. There is an emergency call alert system in the wheelchair which will be activated by a special gesture. For this purpose, GSM modules are used.

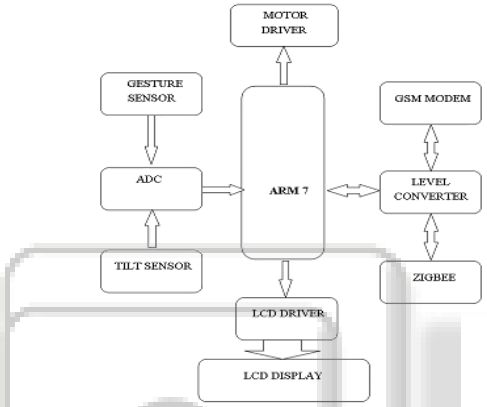

Fig. 1: wheelchair section

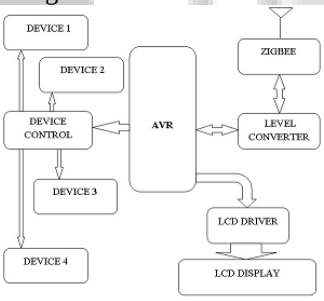

Fig. 2: room automation purposes

The system is having two sections, one on the wheel chair and other for the room automation purposes. The wheel chair section is done on the ARM processor and the other is done on AVR AT mega 32. Gesture recognition from accelerometer data is an emerging technique for gesture based interaction, with the rapid development of the MEMS technology; people can wear/carry one or more accelerometer-equipped device in daily life. The accelerometer used in our project is ADXL335. It is either attached to fingertips or back of the hand. It sends the information about the tilt of the accelerometer sensor in the form of X, Y, Z axis. The data from the accelerometer is given to the ADC controller. Using this information the direction of the motor can be controlled.

The data for room automation is outputted to MAX232. It is an interface IC which converts the TTL logic to RS232 standard and vice versa. RS232 standard defines the signal level requirement at transmitter and receiver. So MAX232 is required to make it compatible with TTL logic.

The fig 3.1 shows the wheelchair section. The basic idea behind the project is wheel chair automation with tilt control and gesture control. The tilt control is used for controlling the movement of wheelchair. And gesture control is for room automation. All the electronic gadgets in patient's room can be controlled by certain gestures from the patient. The fig 3.2 shows the automatic room control section. The gesture control signals for room automation are communicated through zigbee modules. There is an emergency call alert system in the wheelchair which will be activated by a special gesture. For this purpose, GSM modules are used.

III. RESULTS AND DISCUSSION

We get the gesture from the accelerometer. In addition to this, the system uses hand tilt control signals for controlling the movement of a wheel chair. The entire system becomes a helping aid to the patient who is using the wheel chair. The system is having two sections, one on the wheel chair and other for the room automation purposes. The wheel chair section is done on the ARM processor and the other is done on AVR ATMEGA 32.

X axis reading	X axis reading	Y axis reading	Z axis reading
Greater than 150	Less than 100	Greater than 150	Less than 50
Vehicle section turn right	Vehicle section turn left	Vehicle section forward	Send emergency message via GSM modem
X axis reading	X axis reading	Y axis reading	Z axis reading
Grater than 150	Less than 100	Grater than 150	Less than 50
Vehicle section turn right	Vehicle section turn left	Vehicle section forward	Send emergency message via GSM modem

Table. 1: Results and Discussion

IV. APPLICATIONS

MEMS accelerometers have also been used in discovering the loss of balance in older patients that lead to frequent falls and injuries. Other than patients older in age, motion detectors can aid in analyzing other medical related issues such as Parkinson's disease and many others . This has, in turn, created an emerging need of motion detection and signal processing so that the information from these MEMS devices can be properly interpreted and analyzed.

