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Accelerometer Based Hand Motion Controlled Smart Wheelchair

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Abstract: **Wheelchairs are designed for disabled people, those are physically and mentally challenged Children's, youngsters and old people can use Wheelchairs. When a person is unable to walk or even when a person is disabled, malformed or paralyzed from the hips down or the legs, a wheelchair is generally used for their movement. This wheelchair was basically designed for walking especially for people with any of the above physical deformities. They can feel ease and more comfortable after using this wheelchair and it is indeed very helpful for them as they can move about freely. Recent developments are promises a wide scope of development in the field of smart wheelchairs. In this article presents a gesture based wheelchair which controls the wheelchair using hand movements. The system is divided into two main units, first one is MEMS Sensors unit and second one is wheelchair control unit.**

The MEMS sensors are connected to hand on wheel chair, which is 3-axis accelerometer can read the analog data of motion and ultrasonic sensor converts analog data into digital values and it gives in to the 8051 microcontroller.

Keyword- **Accelerometer, ADC, MUX, Microcontroller, LCD, GSM Modem, Mobile.**

I. INTRODUCTION

In today's time, an estimated there is 7,091,500,000 people [A.] in the world (as of January 13, 2013). Approximately 1,000,000,000 people live in the 34 'developed countries'. The remaining 6,091,500,000 live in the 156 'developing countries'. There are approximately 340,500 births each day in the world. Approximately 153,000 people die each day in the world. Therefore the world population increases by 187,500 every day.

In the 34 developed countries it is estimated that 1% or 10,000,000 people require a wheelchair. In the 156 developing countries it is estimated that at least 2% or 121,800,000 people require a wheelchair. Overall, of the 7,091,500,000 people in the world, approximately 131,800,000 or 1.85% require a wheelchair means at least 100 million children, teens and adults worldwide need a wheelchair but cannot afford one. Some international organizations believe that the number could be as high as 6% of the population of developing countries. The number in Angola is 20% of population of 12 million people. Other "landmine" countries such as Afghanistan, Vietnam, Cambodia, Bosnia, Eritrea, Ethiopia, Sierra Leone and Mozambique have extremely high physical disability rates.

Traditional wheelchairs have some limitations in context to flexibility, bulkiness and limited functions. Our approach allows the users to use human gestures of movement like hands and synchronize them with the movement of the wheelchair so that they can use it with comfort. Some existing wheelchairs are fitted with pc for the gesture recognition. But making use of the pc along with the chair makes it bulkier and increases complexity. This complexity is reduced by making use of the accelerometer, the size of which is very compact and can be placed on the fingertip of the patients.

Other existing systems, which make use of the similar kind of sensors are wired, which again increases the complexity of the system. They also limit the long range communication. This complexity is removed by using GSM module.

A. Block Diagram

The system comprises of different main parts:

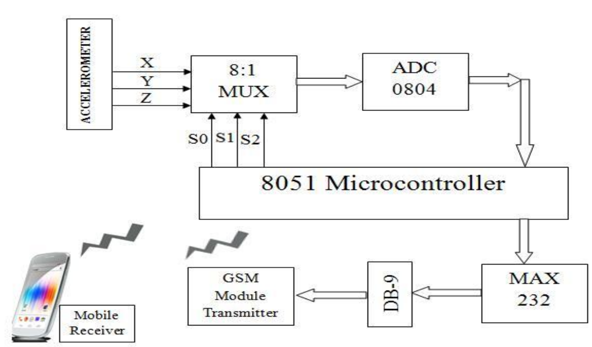

Figure 1: Block Diagramme of Tx & Rx Accelerometer

The different part of the wheelchair is Accelerometer, GSM Module and Mobile receiver. In Accelerometer reads the values of wheelchair motion and gives input to the ADC and ADC convert analog input into digital output is transmitted to the microcontroller and then transmitted by GSM Module to Mobile receiver. In Fig. 1 shows the block diagram of the Accelerometer. To control the movement of wheelchair by providing proper data to dc motor controller, this is connected to the wheelchair and it controlling the direction of dc motors.

II. GENERAL DESCRIPTION

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 *g*. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

The user can selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.

The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

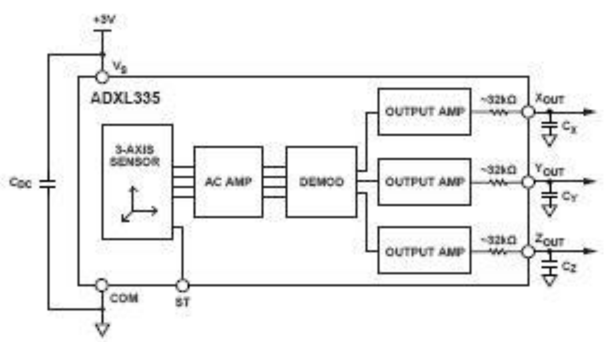

Figure 2: General Block Diagramme of Accelerometer

III. METHODOLOGY

The ADXL335 is a complete 3-axis acceleration measurement system. The ADXL335 has a measurement range of ±3 *g* minimum. It restrains a polysilicon surface-micro machined sensor and signal conditioning circuitry to implement open-loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration. The accelerometer can measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration.

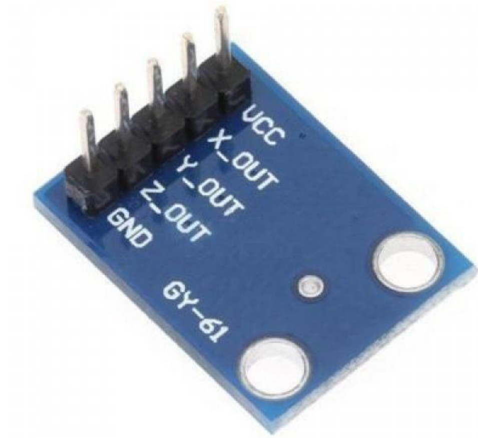

Figure 3: ADXL335 Accelerometer

The sensor is a polysilicon surface micro machined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass.

The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration.

The demodulator output is amplified and brought off-chip through a 32 kΩ resistor. The user then sets the signal bandwidth of the device by adding a capacitor. This filtering improves measurement resolution and helps prevent aliasing.

MECHANICAL SENSOR

The ADXL335 uses a single structure for sensing the X, Y, and Z axes. As a result, the three axes' sense directions are highly orthogonal and have little cross-axis sensitivity. Mechanical misalignment of the sensor die to the package is the chief source of cross-axis sensitivity. Mechanical misalignment can, of course, be calibrated out at the system level.

FEATURES

1. 3-axis sensing

2. Small, low profile package
3. 4 mm × 4 mm × 1.45 mm LFCSP
4. Low power : 350 µA (typical)
5. Single-supply operation: 1.8 V to 3.6 V
6. 10,000 *g* shock survival
7. Excellent temperature stability
8. BW adjustment with a single capacitor per axis
9. RoHS/WEEE lead-free compliant

APPLICATIONS

1. Cost sensitive, low power, motion- and tilt-sensing applications
2. Mobile devices
3. Gaming systems
4. Disk drive protection
5. Image stabilization
6. Sports and health devices

PERFORMANCE

Rather than using additional temperature compensation circuitry, innovative design techniques ensure that high performance is built in to the ADXL335. As a result, there is no quantization error or non monotonic behavior, and temperature hysteresis is very low (typically less than 3 m*g* over the −25°C to +70°C temperature range).

IV. WORKING

The proposed model is a wheelchair prototype built around eight bit microcontroller platforms. The microcontroller takes the input from acceleration sensor installed on the wheelchair covering all the directions and provides corresponding outputs that helps user to take decision and make judgments for the safe movement and control of the wheelchair. For movement control an analog joystick is to be installed on the wheelchair left arm-rest of wheelchair that will be responsible for the forward, backward and left-right movements of the wheelchair. The output of joystick is in nature of analog. So that signal will be converted to digital form by using an analog-to-digital converter before being feed as an input to the microcontroller for further processing. The microcontroller will get inputs continuously from the joystick and corresponding outputs will be controlling the wheelchair motors for movement of directions. The system will send alert signal to the concerned persons through SMS/call in case of an accident occur. The system will accept analog input from a 3-axis accelerometer; ADC will convert it into digital signal; microcontroller will process this digital signal to make decisions and finally the output values will be used to send alert through GSM modem accordingly. The whole electronic circuitry and the motors will be power assisted by a battery bank with a capacity of 4 ampere should be able to continuously supply a current of 1 ampere for exactly 1 hour.

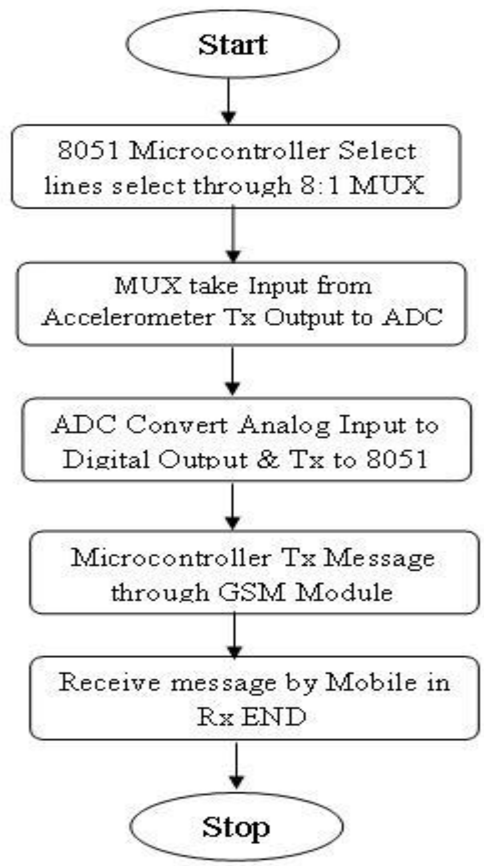

Figure: Flow Chart Accelerometer working

VI. CONCLUSION

In the race of man v/s machine, hand gesture controlled s/m comes as an example of companionship of man and machine. Taking the technology to the next level from speech recognitions and wired connections is the technology of wireless hand gesture controlled s/m,. Using a simple master I2C chip we can connect up to 128 chairs using a single remote. The applications of the same can be plenty. This s/m gives the user independence and a psychological advantage of being independent. To avoid physical deficiency to the user come the accelerometer to the rescue as with the slight twist of the finger the user gets the ability and freedom to turn the wheelchair into the desired direction. Of course some training is required to use the accelerometer wheelchair as its quite sensitive but in the end there could not be a better use of technology for an individual who is deprived of the same physical strength.

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