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MSP430 based Wireless Motion Detection using LabVIEW

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Abstract: The main aim of the paper is to develop a low power, low cost, compact embedded system which detects the motion using MSP430, 3 axis accelerometer sensor as a motion sensor and Wireless module.

Keywords – MSP430, LabVIEW, Motion Detection.

1. INTRODUCTION:

Motion detection is widely used in various fields of engineering. The detected motion can be vibrations (1). It can be the vibration of the motor used in space application (2). It also can be the motion of the ground like a earth's crusts vibrating due to seismic activity (3). Motion detection is also useful for human gait pattern recognition.The signal obtained from the detection can be processed to study the various parameters of the object.

The paper aims at operating the system at very low power, at a low cost, small size. Since msp430 is widely known for its ultra-low power feature, it becomes the core of the system. 3 axis MEMS accelerometer MMA7361 which has a range and sensitivity both can be selected.

2. Project Description.

For the motion detection system, we need the motion sensor MMA7361 which is a 3 axis accelerometer sensor.

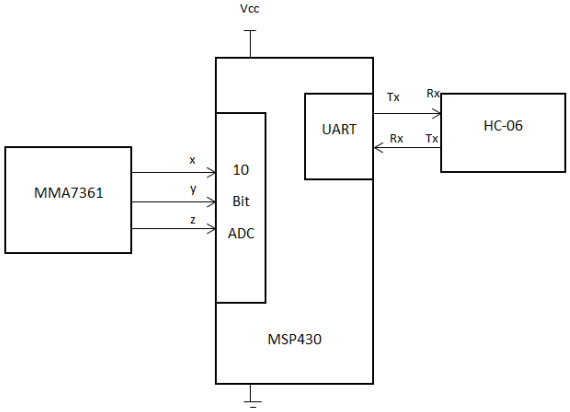

Fig. 1: Connection Diagram of the system

It is connected to the 10 bit inbuilt ADC of the MSP430 microcontroller. Fig. 1 shows the connection diagram of the system. X, Y and Z axis are connected to the P1.3, P1.4, and P1.5 respectively. These pins are the ADC channels. ADC converts the input to the digital values which are then transmitted using TX pin of the UART to the HC-06 which is a Bluetooth module. UART has been configured to 9600 baud rate.

The transmitted data is been received on the computer. LabVIEW is software, where the GUI is made for data acquisition and data processing.

3. Hardware Components:

The main hardware components used are: MMA7361, MSP430 and HC-06.

3.1 MSP430

The Texas Instruments MSP430 family of ultra-low-power microcontrollers consists of several devices featuring different sets of peripherals targeted for various applications. The architecture, combined with five low-power modes, is optimized to achieve extended battery life in portable measurement applications. Fig.4.2 shows the functional block diagram of msp430g2553 series. The device features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator (DCO) allows wake-up from low-power modes to active mode in less than 1 µs. The MSP430G2x13 and MSP430G2x53 series are ultra-low-power mixed signal microcontrollers with built-in 16- bit timers, up to 24 I/O capacitive-touch enabled pins, a versatileanalog comparator, and built-in communication capability using the universal serial

communication interface. In addition the MSP430G2x53 family members have a 10-bit analog-to-digital (A/D) converter. Fig.4.3 shows the pin diagram of 20 pin DIP package msp430g2553. Typical applications include low-cost sensor systems that capture analog signals, convert them to digital values, and then process the data for display or for transmission to a host system.

3.2 MMA7361:

This sensor can measure static (earth gravity) or dynamic acceleration in all three axis. Application of the sensor is in various fields and many applications can be developed using it. The accelerometer measures level of acceleration where it is mounted, enables us to measure acceleration/deceleration of an object, or tilt of a platform with respected to earth axis.

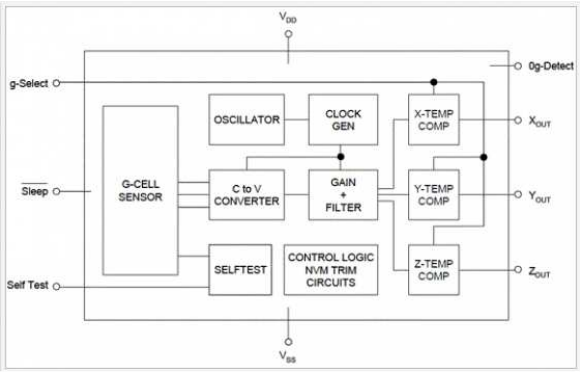

Fig. 2: Internal block diagram of the sensor.

Further, the sensor provides 0G output which detect linear free fall. Technically, MMA7361LC is a low power, low profile capacitive micro machined accelerometer featuring signal conditioning, a 1-pole low pass filter, temperature compensation, self-test, 0g-Detect which detects linear freefall, and g-Select which allows for the selection between 2 sensitivities. Zero-g offset and sensitivity are factory set and require no external devices. The Fig.2 shows the internal block diagram of MMA7361.The MMA7361LC includes a Sleep Mode that makes it ideal for handheld battery powered electronics. The module can be directly powered with a 5V dc supply. Note that it can also be directly powered from any 3.3V 'clean' dc supply.

3.3 HC-06:

This module permits any microcontroller with a standard RS232 serial port to communicate with a PC or a Smartphone equipped with a Bluetooth Master module.

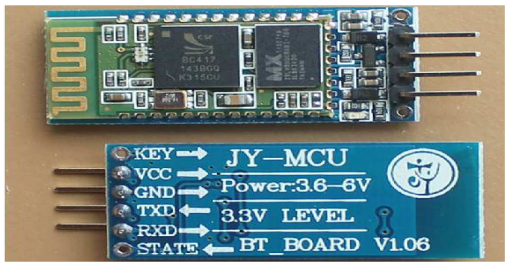

Fig.3: HC-06.

The Fig 3 shows the top and the bottom view of HC-06.

Features:

Bluetooth protocal: Bluetooth Specification v2.0+EDR
Frequency: 2.4GHz ISM band
Modulation: GFSK (Gaussian Frequency Shift Keying)
Emission power: ≤4dBm, Class 2
Sensitivity: ≤-84dBm at 0.1% BER
Speed: Asynchronous: 2.1Mbps(Max) / 160 kbps, Synchronous: 1Mbps/1Mbps
Security: Authentication and encryption
Profiles: Bluetooth serial port
Power supply: +3.3VDC 50mA
Working temperature: -20 ~ +75 Centigrade

4. Software Used:

4.1 LabVIEW:

LABVIEW, a system developed by National Instrument, employs a Graphical interface for signal acquisition, measurement analysis, and date presentation. The graphical interface is used in conjunction with a data acquisition board (DAQ) and a hardware workstation. LABVIEW is a graphical development environment with built-in functionality for simulation, data acquisition, instrument control, measurement analysis, and data presentation. LABVIEW gives one the flexibility of a powerful programming language without the complexity of traditional development environments. LABVIEW delivers extensive acquisition, analysis, and presentation capabilities in a single environment, so one can easily develop a complete solution on the platform of your choice.

4.2 Code Composer Studio:

Code Composer Studio is an integrated development environment (IDE) that supports TI's Microcontroller and Embedded Processors portfolio. Code Composer Studio comprises a suite of tools used to develop and debug embedded applications. It includes an optimizing C/C++ compiler, source code editor, project build environment, debugger, profiler, and many other features. The intuitive IDE provides a

single user interface taking you through each step of the application development flow. Familiar tools and interfaces allow users to get started faster than ever before. Code Composer Studio combines the advantages of the Eclipse software framework with advanced embedded debug capabilities from TI resulting in a compelling feature-rich development environment for embedded developers.

5. Block Diagram(Font Size 10, Times New Roman, Bold, Lowercase)

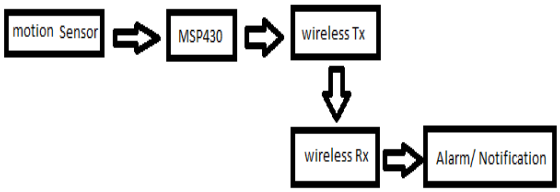

Fig. 4: Block Diagram of the system.

Fig.4 shows the block diagram of the system.

The wireless sensor node is placed on the object whose motion is to be detected. The wireless sensor node comprises of the MEMS 3 axis accelerometer sensor, ultra-low power microcontroller msp430, and wireless module.The pins of microcontroller are configured as input. The x, y, z axis pins are given to the ADC pins of the microcontroller. MSP430 registers are used to control the A to D conversion. The converted value will be available at ADC10MEM register from where they are transferred to the UART TXD pin for transmission. The UART TXD pin is connected to the wireless module. The data will be transferred to the computer through that module. Once the data is available at the computer terminal it is plotted using LabVIEW.

In LABVIEW the serial port needs to be configured properly and the baud rate is kept at 9600. In LABVIEW it is first separated into 3 parts corresponding each of the axis and then it is plotted. Since this data is noisy we need to denoise this data. After denoising this data, thresholding algorithm has to be applied to detect the motion. Once the motion is detected, alarm or sms/email notification can be generated.

6. Implementation& Results.

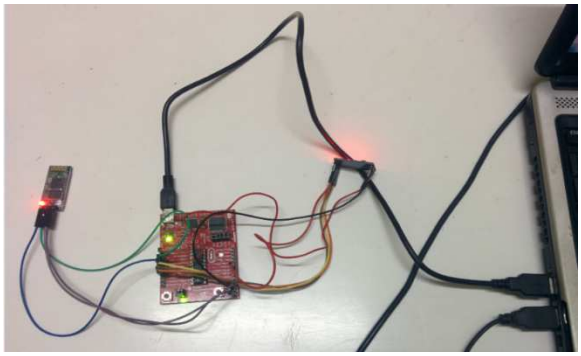

Fig. 5: Hardware connection

The Fig.5 shows the implemented hardware connection of the system. As earlier discussed, the accelerometer sensor is placed such that the motion of the object is recorded and is displayed in the LabVIEW as shown in fig.6.

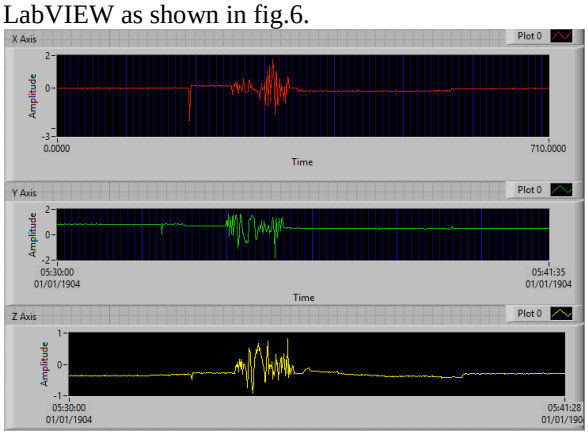

Fig. 6: Motion Detected

As it is shown in the fig.6 there is complete flat line when the object is at rest and it is not moving.
This system can be used for monitoring purposes.

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