3-Axis Accelerometer Sensors for Multiple Motion Input

I. Introduction

This paper reviews the types of low power 3-axis accelerometers that can be implemented to record the motions acted upon the device. A typical 3-axis accelerometer measures the instantaneous acceleration in the x-, y-, and z-directions by measuring the force on small crystal masses within the devices [1]. These devices are well suited to determine the tilt of a device by recognizing which direction gravity is pulling on the device as well as tracking other motions you could make such as flicking or shaking the device. Currently, an engineer can find many variations on the traditional accelerometer with different specifications to fit the need of the device regarding sensitivities, power operations, and sizes.

II. Commercial Applications

There are several products on the market today that utilize some variation of the low power 3-axis accelerometer. Smartphones typically are equipped with the smallest, cheapest units on the market to capture simple motions such as the tilt of the device [2]. These models are typically around $2 to $10 and about 4mm x 4mm; these chips also draw current on the order of hundreds of microamperes to keep power usage low within a battery operated device [3]. Other devices such as the Nintendo “Wiimote” have multiple sensors to more accurately capture fine-tuned motions. The “Wiimote” has a low power 3-axis accelerometer coupled with an infrared light sensor that interacts with a sensor bar to capture both where the device is pointed to in relation to the screen and the tilt of the device to give the system an accurate look at what the device is doing in real time [4]. A single “Wiimote” costs $27 and utilizes an IC accelerometer that is inexpensive at around $2 each, however this chip is nearly outdated despite proving to be reliable technology [4]. The wearable technology within the “Fitbit” also uses a low power 3-axis accelerometer to capture motion data in order to act like a step counter during walking or measure the amount of activity occurring during a more intense workout session [5]. The “Fitbit” has many different models, the lowest of which costing $100, due to its water resistant qualities; the actual accelerometer chip in the device is only $5 to $10. All of these devices and many more use the measurements from a low power 3-axis accelerometer to generate useful information relating to how the user is manipulating the device.

III. Underlying Technology

3-axis accelerometers can be fabricated in a multitude of ways to generate accurate acceleration data. Low power 3-axis accelerometers typically measure acceleration forces using the piezoelectric effect upon microscopic crystals which will generate a voltage output related to the acceleration experienced by the device. Other methods of measuring acceleration on devices exist such as chips that sense changes in capacitance across microstructures, utilize the piezo-resistive effect, and even some which take an optical approach; however, the chips utilizing the piezoelectric effect prove to suffice for most applications and typically costs the least. All of these methods are able to convert forces on a device into motion data on each axis by outputting a voltage relative to how much force the device is experiencing [2].

IV. Implementation in a Typical Device

Since these accelerometer chips have so many possible uses, most of the chips are relatively easy to actually implement. For example, the ADXL337 chip only costs $1.57 per chip or $10 if you get it with a simple to use breakout board [3, 6]. The breakout board allows for easy access to the pins on the chip to provide a proper supply voltage and easily tap into the output voltages from each axis. The output voltage measurements can then be interpreted on an analog input or PWM input pin on a microcontroller to be processed. This particular unit typically functions with a 3.3V supply which means that an output voltage of 1.65V across any access means that axis is experiencing 0g forces. If an axis output pin is reading either extreme voltage of 3.3V or 0V the device is experiencing at least ±3g force respectfully along this axis. Any value in between can be interpolated to give accurate motion data of the device. Using this technology, motions the device experiences can be tracked. For example, the tilt of the device can be determined using the arctangent function of the output voltage values on the appropriate 2 axes by simply tracking how the 1g of acceleration moves along these relevant axes.

References

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