MINIATURE WIRELESS DEVICE FOR INERTIAL MEASUREMENT

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Abstract

This paper presents a design of a miniature wireless device equipped with 3D accelerometer and gyroscope with possible application in a broad range of applications especially in fields of assistive technology and health care. The first version of the device fits onto a printed circuit board with size of 40 × 25 mm, offers single-module 12-bit 3D accelerometer and gyroscope, Bluetooth 2.1 class 2 module and 32-bit Cortex M3 MCU.

Keywords

accelerometer, inertial measurement, Bluetooth, embedded design

Introduction

Improvements in MEMS technology have enabled significant miniaturization of wide range of sensors while decreasing their prices at the same time. This has led to a revolution not only in industrial applications but also in the area of consumer electronics. Today applications of accelerometers, gyroscopes, barometers and magnetometers span many devices starting from low-cost single-purpose devices as pedometers or inertial sensing game controllers to high-end multipurpose devices as tablets and smartphones or professional industrial and military equipment.

IC manufacturers offer many different sensors and even sensor combinations in one SMD package which are to be used in a variety of applications depending on their parameters and characteristics. This presents an opportunity of using these sensors to create new affordable devices which could be used in nursing and health care in the area of rehabilitation and patient monitoring. These sensors can also be easily used in any wearable device which makes them ideal for use in assistive technology, personal safety or security systems.

This paper deals specifically with a wireless device design capable of 6 Degrees of freedom (DOF) body movement measurement using combination of 3D accelerometer and gyroscope. There are already some commercial solutions from companies like MemSense, XSens or MotionNode with complete hardware and software support for this task with only drawback being currently a price of thousands of dollars for the measurement system. Presented project aims to deliver comparable solution sufficient for measuring human body movement using affordable modern consumer oriented integrated circuits.

Device overview

The device presented here was designed as a wireless Bluetooth based battery powered device with universal application in position monitoring and inertial sensing. It comprises class 2 Bluetooth 2.1 module, 32-bit ARM Cortex M3 microcontroller and 6 DOF inertial sensor module LSM330DL. It is intended to be powered by embedded single cell 3.7 V lithium ion or lithium polymer battery which can be easily charged by connecting the device to a computer or a DC wall adapter using standard USB cable. Simple circuit for battery voltage measurement has also been added to the device utilizing MCU's integrated analog-to-digital converter.

Intended device functionality is relatively simple. Sensor module samples and digitizes inertial data which are then read by a microcontroller, sent to a communication module and then sent wireless to remote host system for further signal processing and data analysis. Functional block diagram of the device can be seen in the Figure 1.