663. Devices for position detection

D. Vybiral, M. Augustynek, M. Penhaker
VŠB– Technical University of Ostrava, Department of Measurement and Control
Ostrava, Czech Republic
E-mail: *david.vybiral.st@vsb.cz, martin.augustynek@vsb.cz, marek.penhaker@vsb.cz*

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Abstract. The work deals with design and implementation of a wireless device for position sensing. Part of this work is concerned with the analysis of the measurements. This study also provides an overview of the principles of measuring accelerometers and wireless transmission of data from the sensors to the PC. Selection of appropriate components, circuit design and programming applications in the Maltab is considered as well. The paper is finalized with the testing of the equipment on a game cube and evaluation of the obtained results.

Keywords: positron, measurement, vibration, accelerometer, bluetooth, game cube.

Introduction

This work is concerned with the project aiming at realization of wireless device for position detection. Three-axis digital accelerometer by Freescale Company is used for position detection. The measured data are transferred by the wireless communication Bluetooth module from Stolmann Company. This module is intended for medical applications and belongs to the second power class and in ideal case achieves the operational range of 50 m. The communication also solves an adjustment of communication levels through transducer SC18IM700, which converts communication from standard UART to I2C. The work also deals with an algorithm design for position detection and subsequent visualization of measured data and device position. The developed software enables calibration, communication setting, displaying of measured data and inclination measuring. For demonstration function measuring is designed a simple position simulator, which enables a functionality of the device and measuring software. The measuring software is designed in Matlab.

The realized device and software will be a part of laboratory works, which will be used in laboratory training. Their task is to demonstrate a problem of communication setting, detection algorithm and measuring. Similar device will find a wide use in the HomeCare System, for example, for detection of patient fall and movement.

Presently we are increasingly surrounded by modern technologies, which help us in industrial as well as everyday environment. One of such technologies is related to acceleration, vibrations or tilt detection by means of accelerometers, which are used, for example, for seismic activity monitoring, navigation or stabilization of images in a camera.

New Solution

A measuring string consist of a PC connected with a serial communication RS 232 connect one preparation contains a signal converter to TTL level and on the converter output is placed a wireless Bluetooth module. On the opposite end is placed another preparation with Bluetooth module, the UART to I2C converter and an accelerometer. Signals from modules are transferred to the converter, which has to control communication with accelerometer to modern bus I2C.

Fig. 1 provides a simplified scheme of a designed string. Fig. 2 displays measurement string and its components. Particular blocks of measurement string are described below.

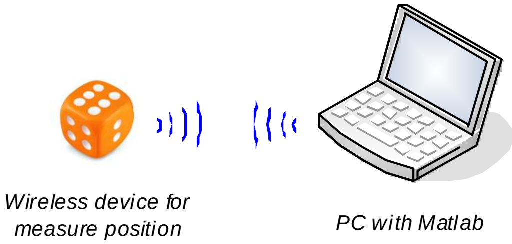

Fig. 1. Scheme of a considered measuring string for position detection

Acclerometer MMA7455

Three-axis capacitive accelerometer MMA 7455 from the Freescale Company is used for acceleration and tilt measurement. This accelerometer belongs to s. c. intelligent sensors. The output is digital and moreover we can choose between two types of bus: SPI or I2C. Switching mode bus between SPI and I2C is accomplished by hardware setting (by connect Log 0 (1) on pin CS). For communication with environment we chose the universal bus I2C.

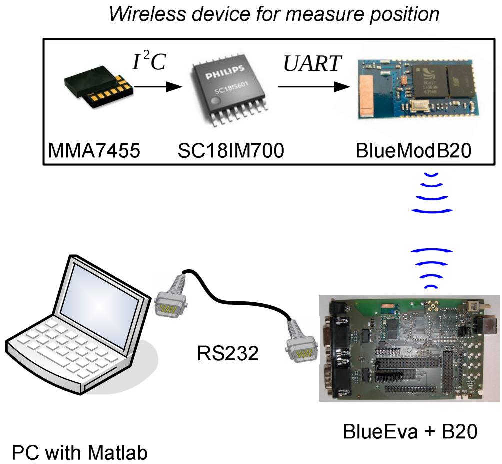

Fig. 2. Description of components of the measuring string

Converter SC18IM700

One of the possibilities to transmit communication with accelerometer is uPC. Most of them are equipped with the I2C bus and also UART for sending data to PC. If we need to read or write data fast and easy up to the I2C bus we can use a universal convertor UART to I2C. The converter works in 3 V TTL. The supply converter potential is the same as by the accelerometer – 3.3 V. The default speed of UART communication is set up to 9.6 kbit/s. In the case of need it is possible to increase speed up to 460.8 kbit/s.

Bluetooth module BlueMod B20

BlueMod+B20 is an embedded Class 2 module with an antenna and a working range of approximately 30 m (open field). The module has very small proportions, feeding is in the range of 2.8 – 3.6V. Consumption in transmitting mode is 30 mA. The module has a serial interface, asynchron TTL, 1.2 kbps – 2760 kbps, but also offers a possibility of using USB, SPI and PCM.

The module works in command or on-line mode. The command mode means that Bluetooth is not connecting to another module and accepts AT commands. If the module conjugates with another module, goes automatically to on-line status and does not answer to any commands. If we need to interrupt the Bluetooth communication we press a bottom “reset” for 5 ms or to interrupt a module feeding.

Software

An application creates a window which has two panels. The connection panel has a bottom for opening communication to serial communication, a popup menu for choosing COM port and an indicator of actual connection status. The main menu panel offer calibration, acceleration measurement, tilts measurement and display of a dice for demonstration. The main menu offer is inactive until connection with the serial connection.

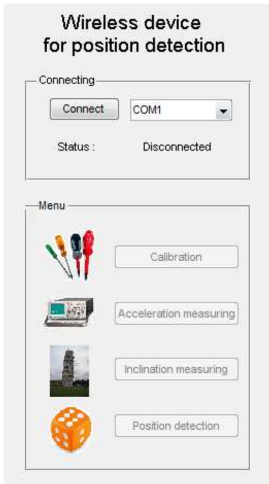

Fig. 3. Wireless device for position detection

Testing

For validation of the accelerometer utility and wireless transmission equipment we developed a mechanical movement simulator, which is illustrated in Fig. 4.

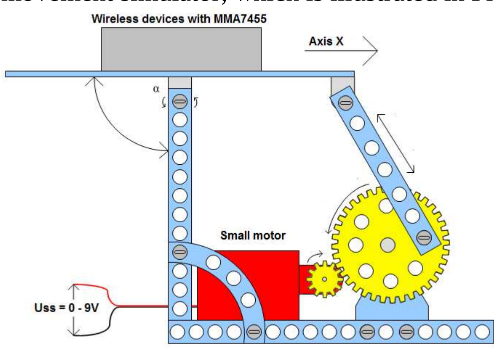

Fig. 4. Simulator of the mechanical movement

From theoretical premise is clear that if we place an accelerometer on moveable platform the accelerometer has to note on *X* axis a sinusoidal wave. Fig. 5 displays a record of the simulated movement.

The oscillations of the simulating movement program influence also the acceleration on Z axis. The Y axis is not in direction of motion so the acceleration does not change. The sinusoidal wave of the X axis is distorted because the measurement string cannot sufficiently read the acceleration values.

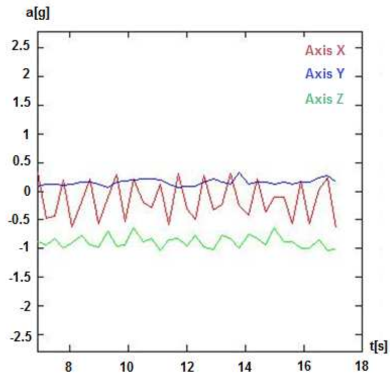

Fig. 5. The acceleration record from movement simulator in all accelerometer axes

During the static acceleration measuring we change step by step all positions of accelerometer displacements and in every position leave the accelerometer for a while at rest. Fig. 6 indicates that the acceleration values in particular axis correspond to the producer values. The noise is generated because the accelerometer cannot distinguish static acceleration from the dynamic one.

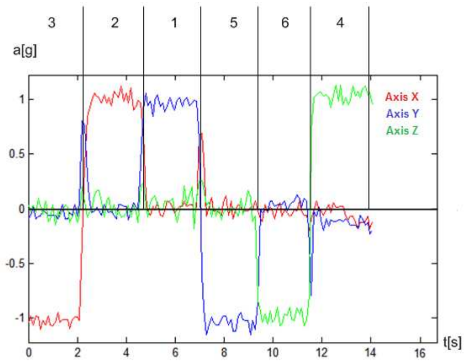

Fig. 6. The record of a static acceleration

The developed equipment with the wireless module and battery feeding is placed in a dice. Data from the accelerometer are transferred to PC and through the detection algorithm the developed software identifies the position of the dice.

Conclusion

The developed equipment is fully functional and is a part of laboratory work, which demonstrates the acceleration and tilt measurement by accelerometers and also demonstrates usage of wireless communications in a class work.

Equipment testing has conformed that the communication reaches a range of 30 m that is specified by the producer. In open space the reach up to 50 m was achieved. Disadvantage of equipment is insufficient fluency in data loading. In the future the equipment could be supplemented with the LCD display for showing values independently from the PC.

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