

# Usage of Acceleration and Angle of Rotation of Hand for Wireless Control of Computer

Volodymyr Dutka, Stanislav Starychenko, Mykhaylo Melnyk, Andriy Kernytskyy

CAD Department, Lviv Polytechnic National University, UKRAINE, Lviv, S. Bandery street 12, E-mail: Melnik@polynet.lviv.ua

**Abstract** – the article describes how to use accelerometer and gyroscope as an alternative to a computer mouse to control computer wirelessly. The use of the proposed device to switch presentation slides presented as an example.

**Keywords** - Remote Bluetooth control, Accelerometer and Gyroscope, MEMSTECH 2016.

## I. INTRODUCTION

Nowadays there is a variety of input devices in computer industry. They include positioning devices like mouse manipulator. Use of mouse is commonplace when working with any computer. For laptops there are various manipulators that replace mouse. For example, touchpad, trackpoint or multisensor screen or hands gesture recognition [1-3]. However, there are very few [4-7] devices which allow transferring angles and speeds of inclination along the axes and they usually are very expensive [8]. Therefore it was proposed to design and develop such device. The main requirements to the device were: it should be inexpensive, user friendly, and ensure long battery life.

## II. RATIONALE FOR USAGE OF DEVICES

Controller in developed design is Arduino Pro Mini [11] because of a set of required characteristics, such as small size, presence of the required communication interfaces, ease of programming. To measure angles and angular accelerations MPU-6050 was selected. This device consists of a 3-axis accelerometer, gyroscope and temperature sensor. Temperature sensor can be used to identify whether the device is at hand. This would allow switching device in a standby mode to save power. Transferring data to PC is organized through Bluetooth module BC417 (protocol UART). Therefore, connection to a virtual COM port should be open in the PC application software and system will read data from it. The Bluetooth module can be transcoded allowing its usage as a HID compatible device. All these design parts are also relatively cheap. Their cost does not exceed 8 USD.

## III. CONNECTIONS SCHEME

For the read function of data from accelerometer, gyroscope and temperature sensor the address of MPU-6050 (0x68) must be transmitted to the I2C bus. After the device address the cell address in which required data are stored and the number of registers that will be scanned sequentially. Therefore, the connection between the controller and the MPU-6050 is bilateral. It is known that to control computer the feedback is not required. That is why it was decided to organize one-way transmission in Bluetooth module and then by radio to the computer. Fig. 1 shows a block diagram of the developed device.

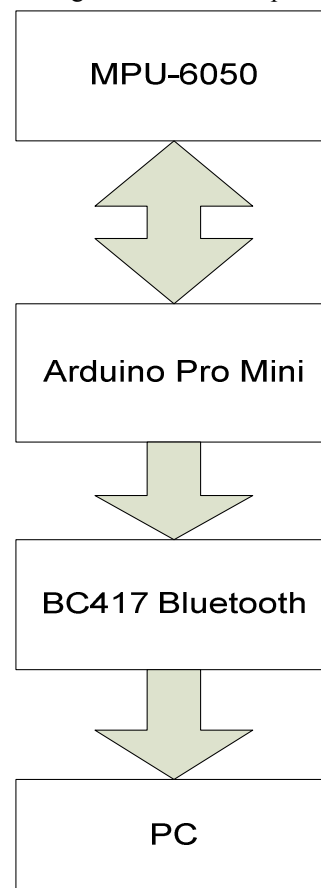


Fig 1. Device structure

Fig. 2 shows the interconnection between the controller, a set of sensors and Bluetooth module.

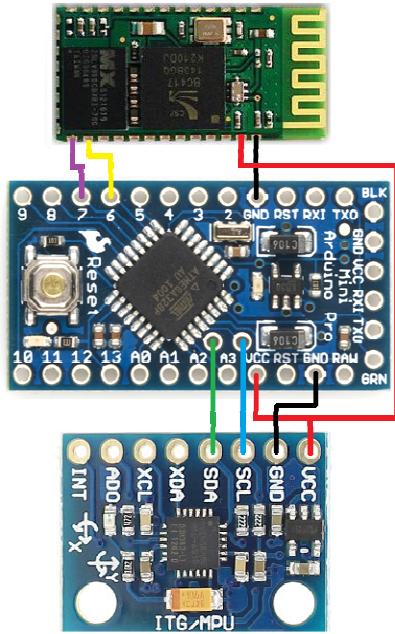


Fig.2 Connection scheme.

#### IV. ALGORITHM OF WORK

The algorithm of device work (Fig 4) is the following: when a device connects to the power supply the MPU-6050 module and UART port are initialized; after this calibration of results of accelerometer and gyroscope is conducted; then the program gets into the main loop in which checks whether the device is in operational or pending mode. In the main body of the cycle data are read from the registers MPU-6050 (Fig 3); to received data complementary filter is applied and depending on the device mode device generates information packets to be sent through the UART port to Bluetooth module and then to application software on the computer. The algorithm repeats the cycle until the battery is discharged or not the mode stand by.

Figure 3 shows part of the source code for consecutive read of data from 14 registers.

```
void GetAGT()
{
  Wire.beginTransmission(0x68);
  Wire.write(0x3B);
  Wire.endTransmission(false);
  Wire.requestFrom(0x68,14);
  AccelX=(Wire.read()<<8) + Wire.read();
  AccelY=(Wire.read()<<8) + Wire.read();
  AccelZ=(Wire.read()<<8) + Wire.read();
  Temp=(Wire.read()<<8) + Wire.read();
  GyroX=(Wire.read()<<8) + Wire.read();
  GyroY=(Wire.read()<<8) + Wire.read();
  GyroZ=(Wire.read()<<8) + Wire.read();
}
```

Fig 3. Reading from registers

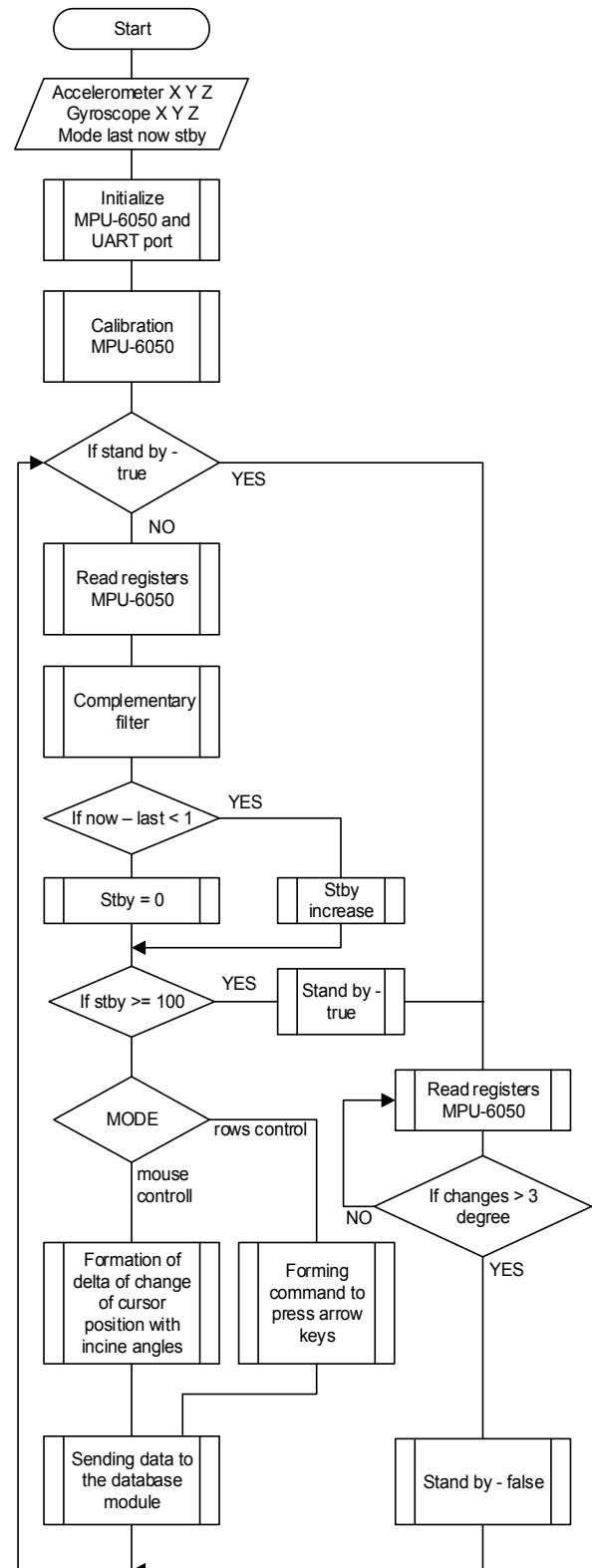


Fig 4. Algorithm of work

#### V. TIMING OF DEVICE BATTERY LIFE

Bluetooth module consumes most power than any other part of the device. Therefore we disabled it in a standby mode. It was mentioned that the MPU-6050 also includes a temperature sensor which we can use to identify that the

device is not in use and temporarily switch off Bluetooth to save power.

The research found that the rate of reaction to temperature change of 3 degrees is about 15 seconds. Therefore, the proposed change in track is 1 degree. Studies have shown that under a temperature difference of  $36.6 - 22.5 = 14$  degrees the 1 degree difference in average achieved for 4 sec if the sensor has a contact directly with the heat source.

The device can work in standby mode up to 24 hours. Submitted voltage to Bluetooth module should not exceed 3.6V and should not be less than 1.8V. These limits are not the basis for the entire system as the MPU-6050 module is in the range of 2.375V to 3.46V. These limits are key for the whole system because Atmega328 operates within 1.3V to 2.5V.

Battery lifetime = Battery capacity / Device Consumption x 0.7

Battery lifetime =  $1500 \text{ mAh} / 45 \text{ mA} \times 0.7 = 24$  hours  
where 0.7 is external factors that may affect battery.

## VI. DELAYS IN WORK AND ABILITY TO WORK IN REAL TIME

All wireless control unit to a greater or lesser extent work with delay. That is the response time to a change has a certain delay. The presented device is of no exception. Since this device will be used at a greater distance from the computer than other known devices that operate on a radio channel and is used to control a computer, an important parameter in the cursor mode is to perform shift on the screen with a small delta response time to external effect, because under delays the cursor will move jerkily on the screen.

## VII. USAGE OF DESIGN CONTROL DEVICE

The simplest version of the developed device is to control a mouse and switch slide presentation. Employment that is more difficult is to transfer angles of an object to control the movement of the object in space. The plans for the future is to implement a device that can turn the design object and tracking pen movements in space and transfer this information to modeling object [9]. A 3D image editor can use the discussed approach as well [10].

As an example of the designed device usage two operating modes are presented. One mode controls the mouse cursor and other one implements simple switch MS PowerPoint presentation by emulating keyboard arrows.

## REFERENCES

- [1] R. Poppe, "A survey on vision-based human action recognition," *Image and Vision Computing*, vol. 28, no. 6, pp. 976–990, 2010. [21] S. Sathyanarayana, G. Littlewort, and M. Bartlett, "Hand gestures for intelligent tutoring systems: Dataset, techniques evaluation," in *IEEE Intl. Conf. Computer Vision Workshops*, 2013.
- [2] Pushkar Dhawale, Masood Masoodian, and Bill Rogers. Bare-hand 3D gesture input to interactive systems. In Mark Billinghurst, editor, *CHINZ*, pages 25–32. ACM, 2006.
- [3] Daniel Keefe, Robert Zeleznik, and David Laidlaw. Drawing on air: Input techniques for controlled 3d line illustration. *IEEE Transactions on Visualization and Computer Graphics*, 13(5):1067–1081, 2007.
- [4] R. Lockton, A.W. Fitzgibbon, Real-time gesture recognition using deterministic boosting, *Proceedings of British Machine Vision Conference (2002)*
- [5] E. Sanchez-Nielsen, L. Anton-Canalis, M. Hernandez Tejera, Hand gesture recognition for human machine interaction, *Journal of WSCG*, Vol.12, No.1-3, 2003.
- [6] R.-D. Vatavu, "User-defined gestures for free-hand tv control," in *European conference on Interactive TV and Video*, 2012
- [7] C.-Y. Kao and C.-S. Fahn, "A human-machine interaction technique: Hand gesture recognition based on hidden markov models with trajectory of hand motion," *Procedia Engineering*, vol. 15, pp. 3739–3743, 2011.
- [8] E. Ozcelik and G. Sengul, "Gesture-based interaction for learning: time to make the dream a reality," *British Journal of Educational Technology*, vol. 43, no. 3, pp. 86–89, 2012.
- [9] Luigi Lamberti, Francesco Camastra, (2011). "Real-Time Hand Gesture Recognition Using a Color Glove", *Springer Proceedings of the 16th international conference on Image analysis and processing: Part I ICIAP*.
- [10] Guan, Y., Zheng, .M. (2008). "Real-time 3D pointing gesture recognition for natural HCI. *IEEE Proceedings of the 7th World Congress on Intelligent Control and Automation WCICA 2008*, doi: 10.1109/WCICA.2008.4593304
- [11] [http://media.digikey.com/pdf/Data%20Sheets/Sparkfun%20PDFs/ArduinoProMini3.3V\\_GettingStarted\\_Web.pdf](http://media.digikey.com/pdf/Data%20Sheets/Sparkfun%20PDFs/ArduinoProMini3.3V_GettingStarted_Web.pdf)

## VIII. CONCLUSION

This article describes the device for human-computer interaction that uses angles and acceleration; the algorithm described; opportunities and prospects of the developed device discussed.

## ACKNOWLEDGEMENTS

Results presented in the paper are supported by Marie Curie International Research Staff Exchange Scheme Fellowship within the 7th European Community Framework Programme - - EduMEMS - Developing Multidomain MEMS Models for Educational Purposes, no. 269295.