Case study of a handwriting recognition base on accelerometer and gyroscope

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Abstract: - Nowadays with technology progress, in terms of construction, there are more and more all sorts of smart devices, designed to make our lives easier. More and more usual devices transforms in smart devices because they use own operating systems and a lot of sensors, all for the benefit of the user. Almost all phones, tablets, etc have inside at least one accelerometer on two or three axes, maybe a two or three axis gyroscope, a magnetometer, a compass, a proximity sensor, or a mixture of them. Given these developments, we propose an online handwriting recognition system using some of the existing sensors on this devices, a combination from an accelerometer and a gyroscope.

Key-Words: -Write recognition, microcontroller, accelerometer, gyroscope, processing

1 Introduction

Motion tracking devices are rapidly become omnipresent in all new devices like smartphone, tablets, laptops, gaming consoles, smart TV, and represent a new way for people to interact with these smart devices, by tracking human movement and with the help of the microcontroller, to transform these action in inputs command. For a complex tracking only one type of sensors is not enough, always exist some pair of sensor formed from: gyroscopes, accelerometers, compasses, pressure sensors, flex sensors, temperature sensor, barometric sensor, etc.

The first 6 axis motion devices that is designed for low power, low cost and high performance is the MPU6000 from Inversense, device the has 3 axes gyroscope and 3 axes accelerometer with the fallowing characteristics that make it suitable for slow but also for fast motions. (table 1.)

Gyro full scale range (°/sec)	Gyro Sensitivity (LSB/° /sec)	Accel full scale range (g)	Accel sensitivity (LSB/g)
250	131	2	16384
500	65,5	4	8192
1000	32,8	8	4096
2000	16,4	16	2048

Table 1. MPU6000 characteristic

That characteristics and the use of programmable interrupt make him useful in gesture recognition, panning, zooming, scrolling, free fall interrupt, high-G interrupt, zero-motion detection, tap detection, and shake detection application.

It is available on market, an orientation solution called ARDUIMU (Fig.1.) that is a gyroscope and an accelerometer (MPU-6000) combined with a compass. That combination have 9 degree of freedom (DOF), and is an orientation solution large spread among the RC enthusiast for driving airplanes, helicopters, quadrocopters, octocopter, rocket, and other devices that need a stabilization. This device is suitable for any application from rockets to simple movement detection

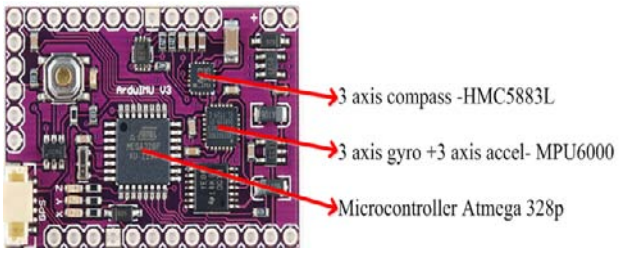

Fig.1.The development board used

2 Problem Formulation

Handwriting recognition (HWR) is the ability of the computer (with microprocessor) or other type of mobile solution (with microcontroller) to interpret handwriting from various type of source like paper

documents, touch-screens, photography, or other type of physical supports.

There are two type of handwriting technique. First method, "off line" from paper with the help of optical scanner, then applying optical character recognition (OCR) or intelligent word recognition (IWR). The second method is "on line" where is recorded and interpreted the movement of a pen on different surfaces.

Complete handwriting recognition handled also formatting, performs correction of character and offers some plausible word for the sentences.

The early optical character recognition was centered on two aspects: the expansion of the telegraph and the creation of reading devices for the blind. One of the first pioneers in OCR using, was an Israeli physicist and inventor named Emanuel Goldberg, who invented and patented in 1912 a machine that read character and convert those in standard telegraph code and then transmit telegraphic messages without human intervention.

In 1914 was invented the optophone by Fournier D'Albe, a device the produce a specific sound for different character.

For the handwriting recognition offline systems, the entire process should fallow some steps in the process like:

***Pre-processing;**

Digitization, binarization;

Noise elimination, thinning, normalizing;

***Feature Extraction (by character, word part, word);**

Segmentation (explicit or implicit);

Detection of major features (top-down approach);

***Matching;**

Recognition of character;

Context verification from knowledge base;

***Understanding and Action;**

3 Problem solution

There are a lot of solutions for write recognition. In this paper we propose a new and innovative solution, maybe not the cheapest from all solution but is mobile and flexible.

We attach the ARDUIMU to a pen and start some pattern recognition for numbers. It can be observed that each of the number has a different pattern. Maybe some numbers studied here like 0 and 6 have same pattern on the axes that represent accelerations but is different on axes recorded and traced from the gyroscope.

In figure 2 a capture form the program that represent pattern for number 1,2,3 each letter is write twice.

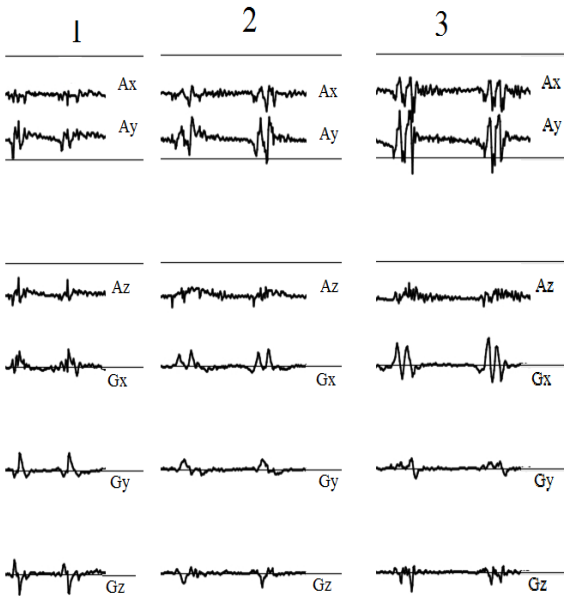

Fig.2. Number 1, 2, 3 pattern

Figure 3 is for number 4 ,5, 6 pattern. Numbers with almost the same shape will raise problems. It can be observed the difference between all other numbers with the different shape, this will not raise any problem in pattern recognition.

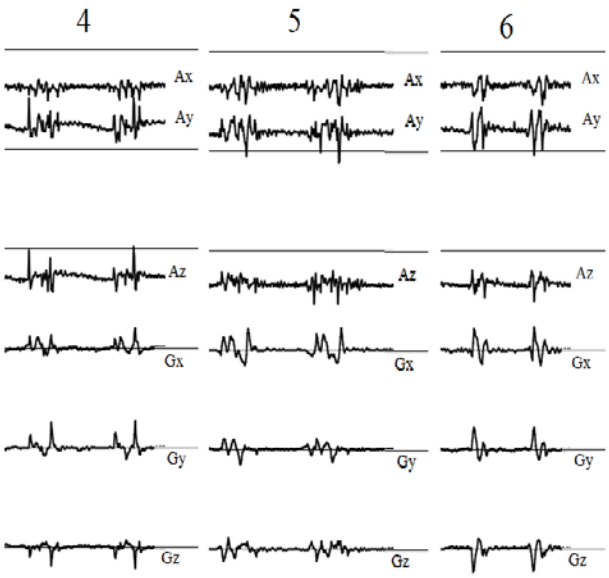

Fig.3. Number 4,5,6 pattern

The number 7,8,9 can be seen in the figure 4. Our pattern recognition method raise some problem, the pattern will be different in heights and will be affected by the speed of the writer. This is a feature work for us, to integrate a compass to eliminate this problem.

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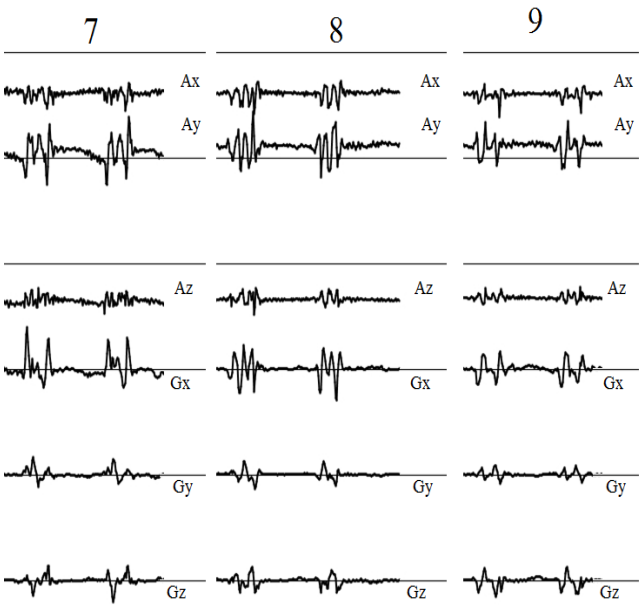

Fig.4. Number 7,8,9 pattern

Figure 5 is the figure for number 1, 0, and 10 for the purpose of recognition numbers more than one digit. If we look closer we can see that pattern for number 0 and pattern for number 1 can be recognized in the pattern for number 10, if it is possible to recognize numbers with 1 digit, then will be no problem to recognize with more than 1 digit.

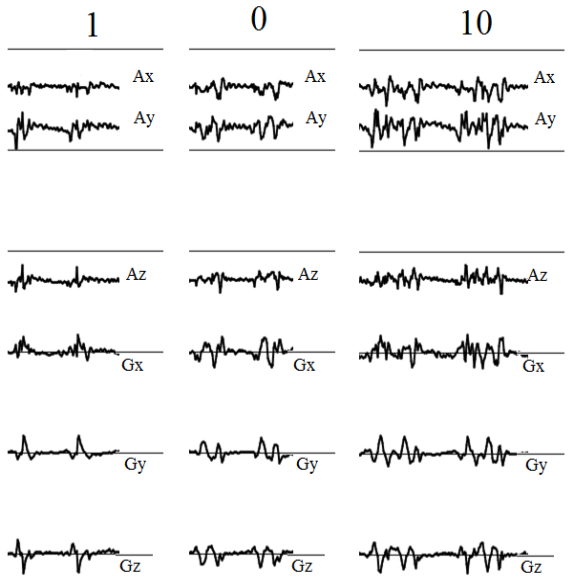

Fig.4. Number 1,0,10 pattern

The ARDUIMU is connected through a FTDI programmer to USB port. The Atmega 328P, that is used is a high performance, low power AVR, 8-Bit microcontroller. It has a RISC architecture with 131 instruction that works up to 20 MHz, speed that assure a good capability to send the signal to computer. It read samples, form accelerometer and gyroscope, every 23 second, enough to take every movement of the hand, in order to provide a good pattern to interpret. In figure 5 is an example of microcontroller program that read the MPU-6000 register to extract the acceleration data for all three axes.

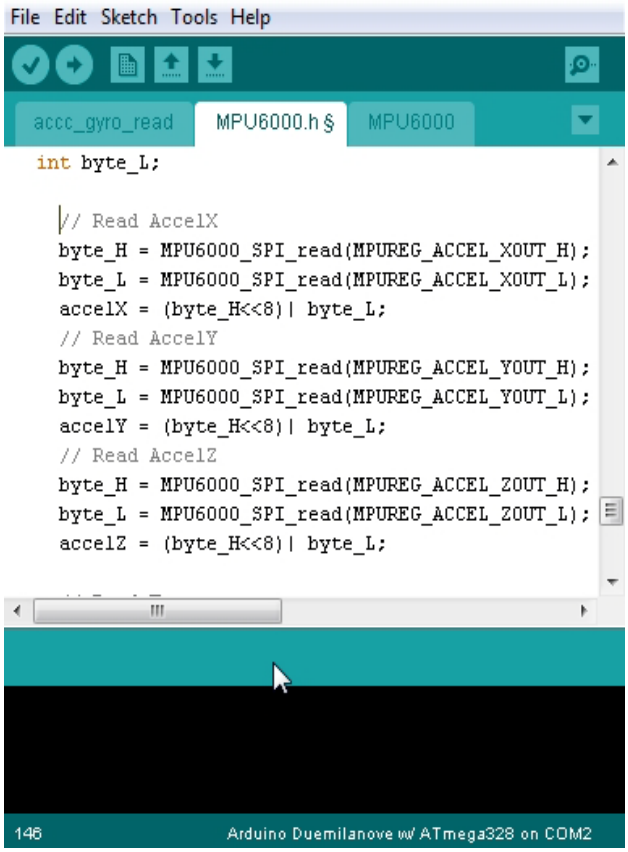

Fig.5. Arduino programming language

To computer, the data is sent through USB port to a program called Processing, a similar like Arduino programming language. There the data are taken and with the help of some low pass and high pass filter, the data are represented. In the figure 6 is described the algorithm for a low pass filter implemented where α is the coefficient formed from the value of R and C and the time, y[0] is the output value of the filter at time i-1, y[i], is the output value at time i, x[0] is the input value of the filter at time i-1 and x[1] is the input value at time i.

function lowpass(*real[0..n]* x, *real* dt, *real* RC)
  var *real[0..n]* y
  var *real* α := dt / (RC + dt)
  y[0] := x[0]
  for i **from** 1 **to** n
   y[i] := α * x[i] + (1-α) * y[i-1]
  return y

Fig 6. Low pass filter algorithm

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An example of programming in Processing can be seen in the figure 7.

Fig.7. Processing programming language

The two language look like the same, it's have the same Java base.

4 Conclusion

For the interpretation of the patterns, we think at two possibilities, to integrate the signal from the ARDUIMU in Matlab Simulik, and try several filters to transform the patterns, or to implement an algorithm in Processing to interpret the patterns. Anyway, the result of the study are encouraging and we continue the work to handwriting recognition of the obtained patterns.

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