Realization of the experimental stand for the identification of angular velocities at the lower limbs

Tulică Alexandru- Constantin, Roșca Ileana- Constanța

1, Universității St. Braşov 500068 Romania

alexandrutulica@yahoo.com

Abstract. In this paper, we will see how an experimental stand was made to identify biomechanical parameters in human limbs. This experimental stand features two data acquisition boards, namely the Arduino Uno and the orientation (motion) board. The source code is written in the Arduino IDE program, and the data acquisition can be done using the MS Ofice program - the Data Streamer module.

1. Arduino Uno and 9-axis motion shield

Arduino Uno R3 (figure 1) is a data acquisition and processing board so that prototypes of some devices can be made so that we can later develop them.

This type of data acquisition board features an Atmel 16U2 microprocessor, which helps to take over from the environment, the desired parameters, temperature, humidity, and gas types, as well as determine the movements.

Arduino Uno can be connected to a PC or laptop using an A-B serial cable, with which it can retrieve information and power it during operation. Arduino Uno R3 is programmed with the help of the Arduino IDE program, which presents the C / C ++ language this is a program for writing source codes, which will later be uploaded/implemented in the Arduino data acquisition board. The instructions given by the code and implemented will be received, then Arduino Uno will execute these functions, the programs previously written for Arduino, are called "Sketches". [1]

Figure 1. Arduino Uno

The second data acquisition and information processing board in the environment is the 9-axis motion board, identified in Figure 2. This board has an absolute orientation sensor called BNO099 from Bosch Sensortec GmbH, it has an accelerometer 14-bit, a 16-bit, and 32-bit triaxial gyroscope for geomagnetism.

With its help, you can measure the acceleration, speeds, and gravitational accelerations, on the 3 axes; Ox, Oy, and Oy. At the same time, this type of plate can provide information such as Euler angles, and rotation vectors. [2]

Figure 2. 9 axis motion shield

The gravitational force is the only force acting on this Arduino-compatible board, so the types of accelerations, namely linear ones, can be calculated without errors, it is important that the BNO099 sensor does not show a blockage of the output data during the measurements, so it is very important to install it. The axis of this device may have a new reference axis, during the measurements, see figure 3.

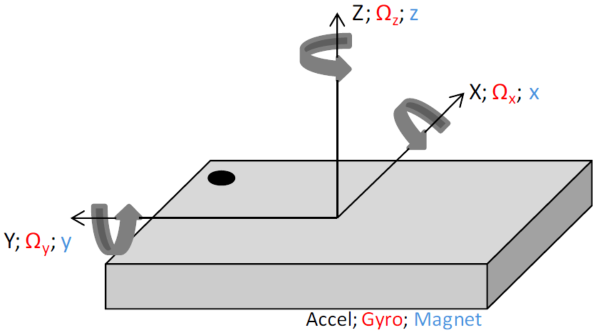

Figure 3. 9-axis plate position [3]

2. Experimental stand

The experimental stand is made of the environmental information acquisition and processing board, the Arduino Uno R3, and the 9-axis motion board.

The overlap of these boards is done through all the pins of the board (figure 4).

Figure 4. Arduino Uno R3 (left) and 9-axis Motion Shield (right)

In figure 5. it can be seen how the two boards are connected to a data analysis program.

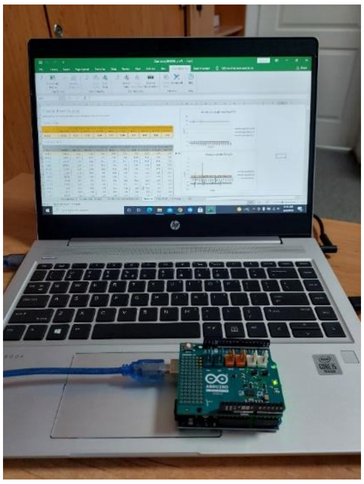

Figure 5. Experimental stand connected to a laptop

The experimental stand is programmed in such a way that the output data can be entered into the Microsoft Excel program, with the Data Streamer module, test measurements were carried out to identify the angular acceleration and angular velocity, as shown in Figure 6.

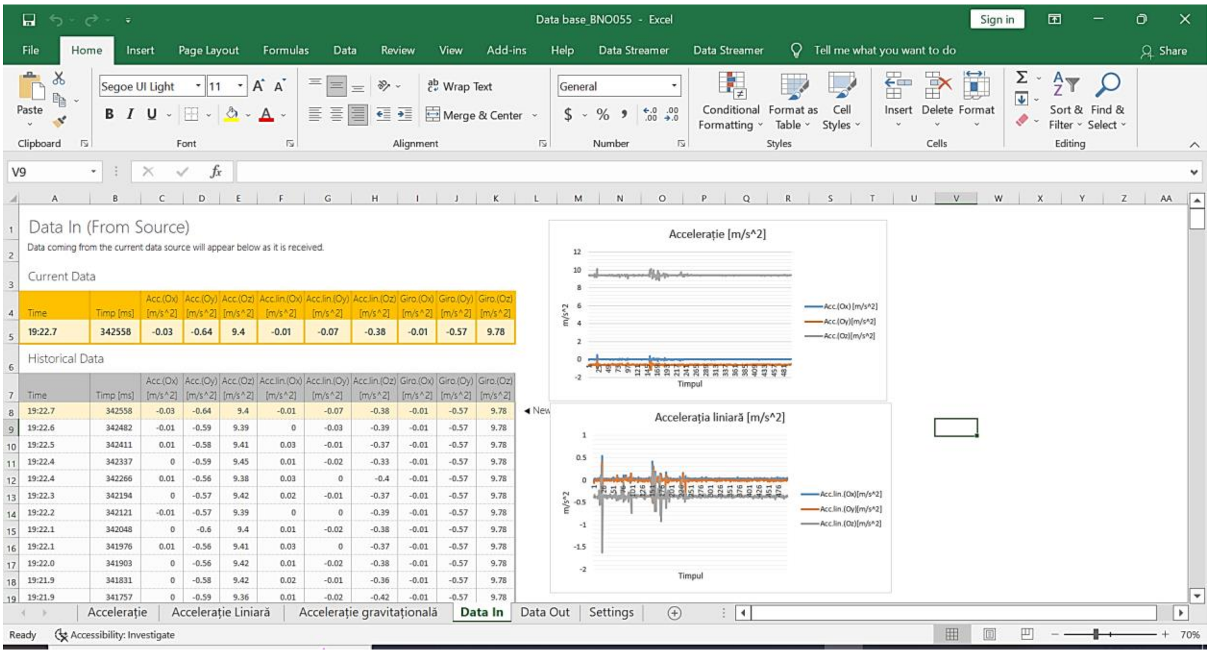

Figure 6. Data streamer

3. Results

Figure 7 shows the graph recorded by the experimental stand in the frontal plane, Figure 8 shows the graph made when the sensor was positioned in the sagittal plane, then in Figure 9 the sensor was positioned in the transverse plane.

The gravitational acceleration changes according to the positioning of the experimental stand, i.e., if it is positioned in the frontal plane, Gy= -9.81 m/s^2 (fig.7), if we talk about the sagittal plane (fig.8.), we identify Gx=-9.81 m/s^2. Finally, the stand is positioned in the transverse plane, and Gz=9.81 m/s^2 (fig.9).

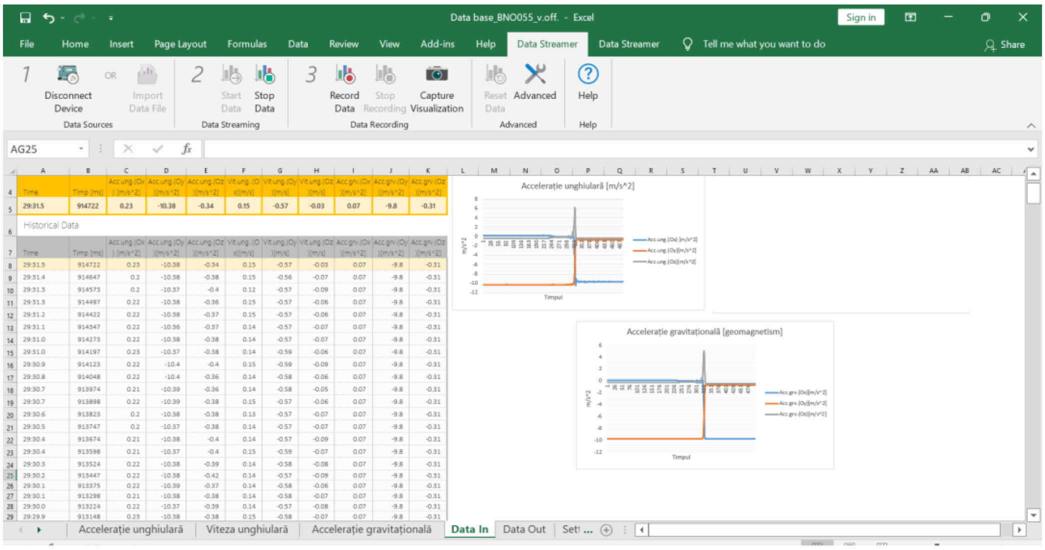

Figure 7. Experimental stand-front plane

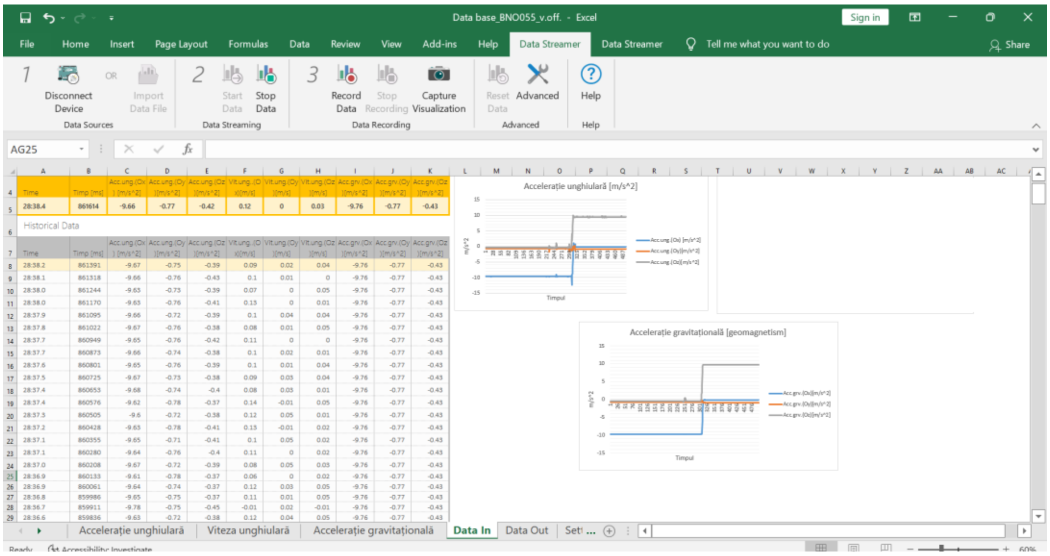

Figure 8. Experimental stand-sagittal plane

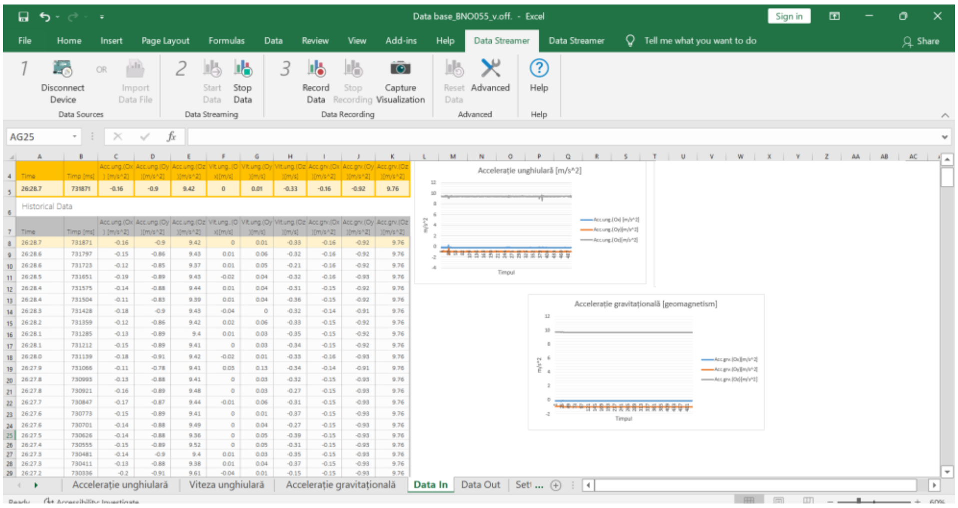

Figure 9. Experimental stand-transversal plane

The experimental system was tested in the 3 planes, to verify the gravitational acceleration, to verify it on the 3 axes, as follows: Gy = -9.81 m / s^2, Gx = -9.81 m / s^2, Gz = 9.81 m / s^2.

For example, for the frontal plane, the system has been positioned according to figure 10. In the case of the transverse plane, the experimental system is positioned according to figure 11.

Figure 10. Front plane positioning

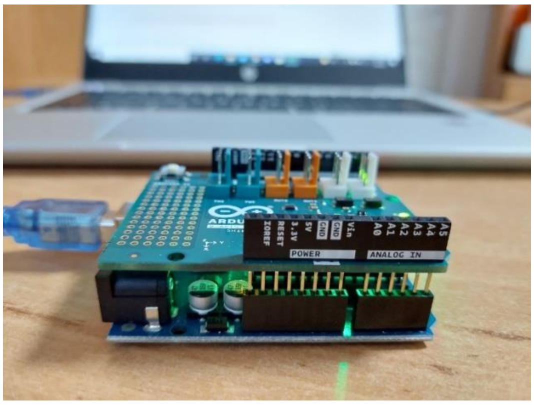

Figure 11. Transversal plane positioning

References

[1] M.R.McRoberts, Arduino Starters Kit Manual-A Complete Beginners guide to the Arduino [carte] 2009, [p9-p10], Editura Earthshine Design.
[2] (2022) *Docs.arduino.cc*. Available at: https://docs.arduino.cc/hardware/9-axis-motion-shield (Accessed: 5 April 2022).
[3] (2022) *Cdn-shop.adafruit.com*. Available at: https://cdn-shop.adafruit.com/datasheets/BST_BNO055_DS000_12.pdf (Accessed: 5 April 2022).