

Screening method for environmental human stability behavior studies

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Abstract-In this paper it is presented the screening method to study the behavior of the human body in different situation: relaxed, before and after an effort in the environmental space. The human subjects have a good health and the recordings are made using a special system for record and analyze the human body stability behavior answer. It is very important to establish in these researches the methodology to record the information's taking in account the interactions of the human body with environment (with or without open eyes, with or without the sounds in background, temperature, air pollution or external vibrations and noises). The results are presented in the final part of the paper.

I. Introduction

Stability is defined mechanically as resistance to both linear and angular acceleration, or resistance to disruption of equilibrium.

According to Newton's second law of motion ($F=ma$), the more massive an object is, the greater is the force required to produce a given acceleration.

The greater the amount of friction is between an object and the surface or surface it contacts, the greater is the force requirement for initiating or maintaining motion.

Different mechanical factors affect a body's stability, also different environmental factors like light, sound, temperature, vibrations or noises affect the entire human body's stability.

Another factor affecting human body stability is the size of the base of support. This consists of the area enclosed by the outermost edges of the body in contact with the supporting surface or surfaces. When the line of action of a body's weight (directed from center of gravity (CG)) moves outside the base of support, a torque is created that tends to cause angular motion of the body, thereby disrupting stability, with the CG falling toward the ground.

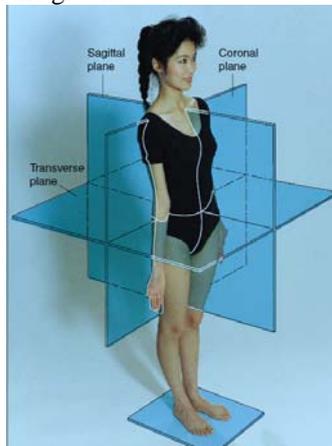


Fig.1. Schematic presentation of the principal plans into human body on the surface of stability [1]

The horizontal location of the CG relative to the base of support can also influence stability. The closer the horizontal location of the CG is to the boundary of the base of support, the smaller is the force required to push it outside the base of support, thereby disrupting equilibrium. Alternatively, if a horizontal force must be sustained, stability is enhanced if the CG is positioned closer to the oncoming force, since the CG can be displaced farther before being moved outside the base of support. The height of the CG relative to the base of support can also affect stability. The higher the positioning of the CG, the greater the potentially disruptive torque created if the body undergoes an angular displacement.

Although these principles of stability are generally true, their applications to the human body are made only with the recognition that neuromuscular factors are also influential.

A. Experimental setup

The experimental setup proposed by this paper it is presented in the fig.2.

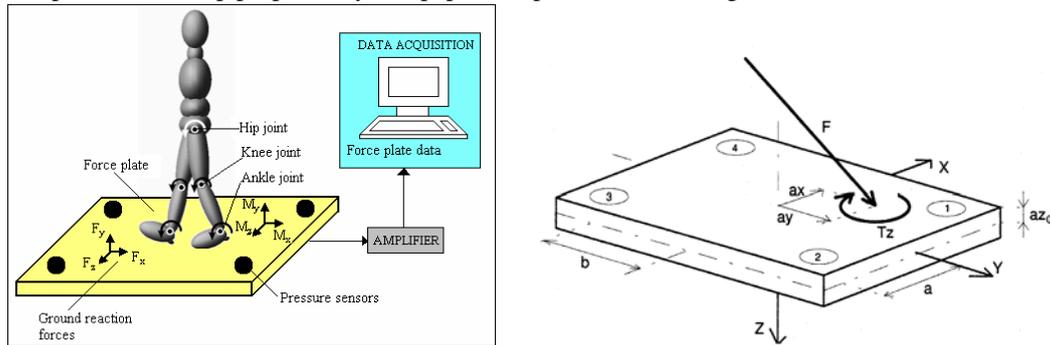


Fig.2. Experimental setup to record the stability of the human body and the measurement-coordinate system for Kistler force plate

To record the stability of the human body we use a Kistler force plate with 4 (four) piezoelectric sensors to measure the forces and the moments from 3 (three) directions. This force plate is equipped with an amplifier with 12 channels and we can use also 2 (two) similar force plates in the same amplifier. The specialized software for recording and manage the data it is also available. For that a very good and performing computer it is necessary to be used because there are many and bigger recordings of the response signals from acquisition system and also from high-speed video-cam. The measurement and coordinate system it is showing in fig.2.

B. Methodology of data acquisition

In these activities we establish a compact methodology to record the data in different conditions and with different persons. In the first time we're recording the physiological information's about weight, high, blood pressure, temperature, oxygen quantity in the blood, lactic acid, quantity of glucose and pulse, level of the noises and vibrations and also the structure of the skin (fig.3.)



Fig.3. The recording of the subjects' physiological information's

Each person participated to this investigation was recording in three daily time (morning, afternoon and evening) to have all kind of information's about the variations of these parameters in the day time or about the values for different human body weight. It was very important to know and to record the special situations for the people who came from outside, in different moments of the day (morning, afternoon or evening). For that we're simulating in the laboratory such conditions using an ergometer bicycle and a spiroanalyzer to obtain the information's about the quantity of effort develop by each person and the influence of the urban environment.

For recording the stability of the human body it was necessary, also to establish the size of contact base and the sort of external stimulus (open and close eyes, source of sound)



Fig.4. The recording of the subjects' postural behaviour in the close eyes situation

In these two initial conditions (with big and with small contact base) the recording are made in two stimulating situations: with eyes open and with eyes close and also we want to know how the stability of human body will change if the arms are near body or they are in lateral or in front of human body.

C. Results

In the following graphs we present the recordings made with different subjects (high and weight) but in the same conditions (position of hands, day time-morning after a relaxed period, the same environment physical conditions etc.).

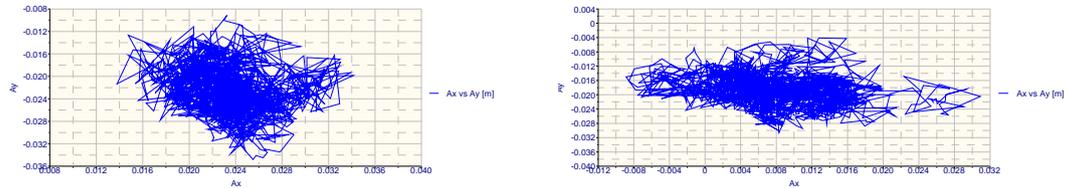


Fig.5. The stability area in initial conditions, open eyes and the second with closed eyes, person with his hands in front direction, big support base,.

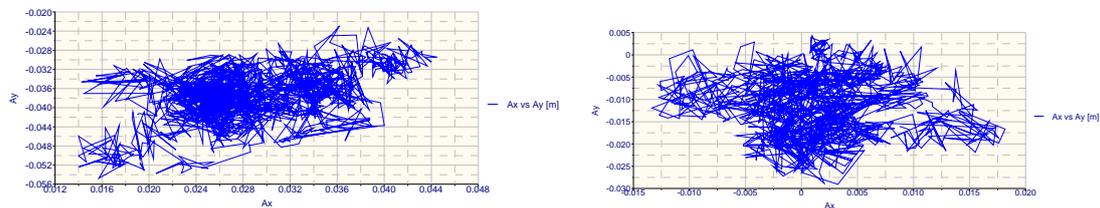


Fig. 7. The stability area for the same human subject with a small support base, with open eyes and with closed eyes (hands in the front)

Another sort of experiments and recordings are made with the person using an external support to observe the behavior of the human body in balance from the front of the leg to the back, taking in account some external stimulus, like environmental activities. In these experiments we record the forces variations, the stability area, the force and moment in the same direction in different situations – with big (test no3.) or small (test no.4) support base, but with open eyes in the time of recordings.

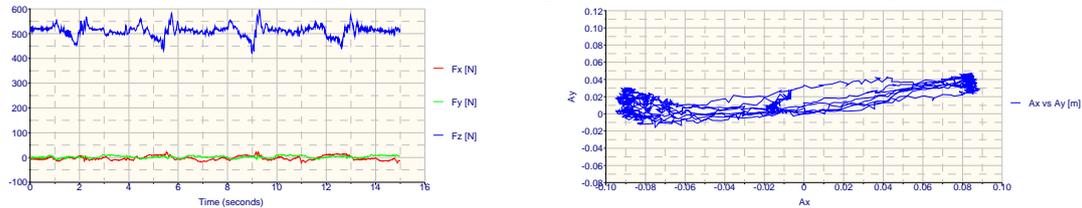


Fig.8. The forces graph for all directions (x, y, z) and the stability area for the test no.3

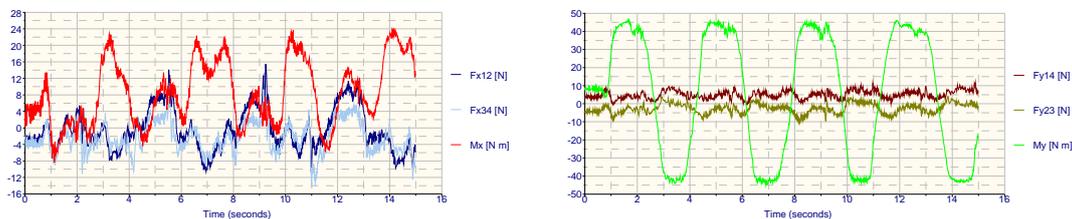


Fig.9. The force and the moment for Ox direction, also for Oy direction in the test no.3

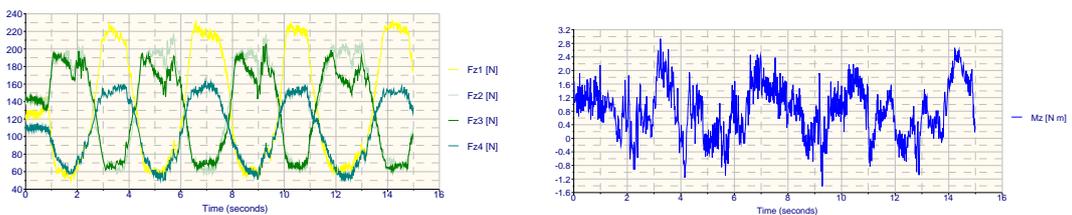


Fig.10. The force components and the moment variations (Oz – vertical direction) for test no.3.

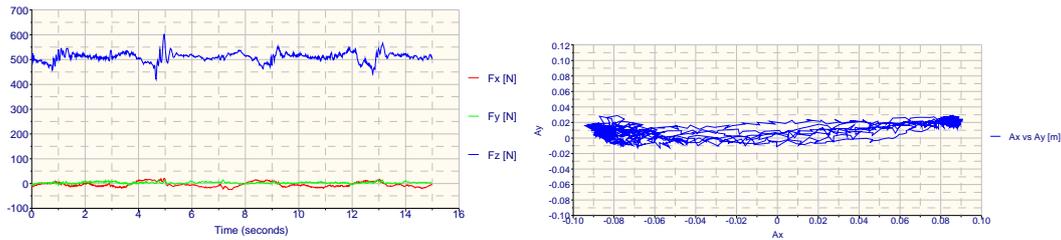


Fig.11.The forces graph and stability area for all directions (x, y, z) (test no.4.)

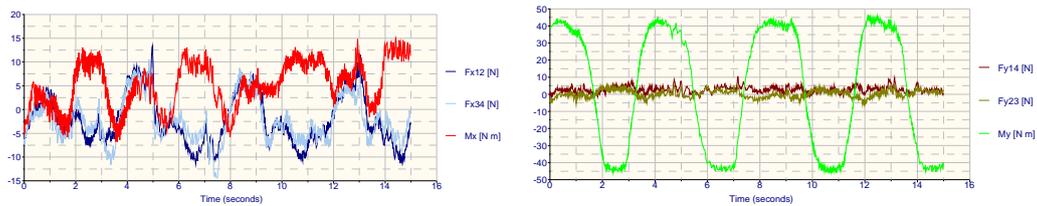


Fig.12.The force and the moment for Ox direction, also for Oy direction in the test no.4

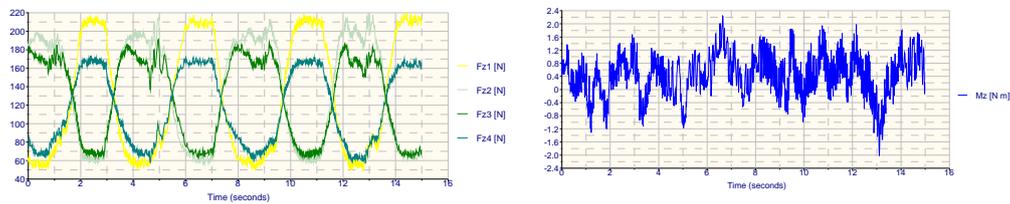


Fig.13. The force components and the moment variations (Oz – vertical direction) for test no.4.

II. Conclusions

From these recordings and in according with the initial conditions and the demands of the researches we can conclude:

- changes in foot position have been found to affect measurements of standing balance, the location of the line of gravity and the postural sway;
- under normal conditions the size of the base support is a primary determiner of stability;
- the height of the CG relative to the base of support can also affect stability;
- the most important values of the forces are the force components from direction Oz because they can establish the amplitude of the balance in other two directions Ox and Oy;
- changing the size of the support base from small to big one it can observe that the stability areas are different like shape, but almost the same like values;
- the influence of the position of the eyes are also the most important because the instability will be bigger in the open eyes position than the closed eyes position. This situation is due of the visual or audio external stimulus from environmental space.

References

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