point which would have a positive influence and favour performance in the 800 metre race, in which it is necessary to develop all the components of the specific force identified by us. At this level of performance there are a number of independent variables, the values of which correlate very well with the average level of the athletes' results: jump step on a distance of 100 metres (no.steps); running 300 m high intensity, 30 sec.pause- deca- jump in place; 20 genuflexions with dumbbell with 50% of body mass; the relative force of the thigh protractors and thigh flexors.

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ETUDE DE L'INFLUENCE DE DIVERSES MÉTHODES BASE SUR LA FORCE ET LA RESISTANCE DE VITESSE SUR LE RÉSULTAT DU COURSES DE FOND (ANALYSE DE CORRÉLATION)

Résumé:
Le présent document se concentre sur l'étude du programme de formation spécial de demi-fond professionnelles coureuses et la mesure des capacités de résistance qui influencent la performance des coureuses en milieu courses d'endurance.
La recherche a été menée entre 2009-2010, sur la base des résultats des coureurs les plus précieux de course de demi-fond féminin en Roumanie.
***Mots clés**: force, puissance, entraînement sportif, le calendrier, de demi-fondfranceza*

USING THE KINECT SENSOR TO STUDY THE KINEMATICS OF THE HUMAN BODY

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***Abstract*:**
The human body is a complex mechanism which is composed by multiple kinematic chains. The purpose of those multiple chains is to maintain the human body in continuous motion necessary for everyday life. In this paper we will present a state of the art technology defined by its huge potential and accessibility to study the kinematics of the human body.
Our work investigates how the Kinect sensor is capable to take part in the study of the human body kinematics.
***Keywords:** biomechanics, Kinect sensor, depthsensor, kinematics, sport, human body, markerless motion*

INTRODUCTION

The kinematic analyses upon the human body are at the moment a significant source of information about how the kinematic chains which compose it behave in everyday activities or in sports.

It is very important to understand the behavior of the human kinematic chains because this way we can predict, control or solve problems which regard the musculoskeletal which leads in deficiencies of the human body equilibrium.

Asymmetries of the musculoskeletal appear when pathologies impact on one side of the human body. It is crucial to maintain the health of the musculoskeletal because this way we can avoid displacement of the body and joints or avoid strokes like is shown by Lisa D. Alexander in her study regarding the link between gait asymmetry and brain lesion [1].

To do so, over the years new technologies appeared such as Vicon cameras [2], ToF cameras [3], Kinect sensors [4], which help us to study more closely and more efficient the kinematic of the musculoskeletal.

PREVIOUS WORK

The Kinect Xbox 360 is a powerful depth sensor developed by Microsoft and released in November 2010. Its first purpose was to be used in videogame industrywith the Xbox console but its high potential leaded the usage in multiple fields.

Previous authors explained the high usage of the depth sensors in different fields like: intuitive human robot interaction [5], hand tracking and rendering in wearable haptics [6], recognizing hand gestures [7], scanning 3D full human bodies [8] and human activity detection [9].

A previous work introduced by Adso Fernández-Baena [10] uses a depth camera mounted above a tripod placed in front of the actor to study the upper-body and lower-body joint movements in order to evaluate the performance of the Kinect as a motion capture system. Actually they conducted a comparative experiment involving a Kinect camera end an optical motion capture system. The result was actually sufficient to guaranties precision for most of clinical rehabilitation treatments.

Another important characteristic beside the reduced price and portability is that the Kinect camera is a capture motion system without markers, as shown in [11] and by Kai Berger in the article "*Markerless motion capture using multiple color-depth sensors"* [12].

METHOD AND EXPERIMENT

The basic point of this method is data transfer from the Kinect sensor to a computer which processes the data through the OpenNi and PrimeScene library or Microsoft.

The Kinect camera is a sophisticated hardware consisting of:

- IR Emitter and a IR Receiver that forms the depth camera with the following characteristics:
  - Field of view: horizontal: 58˚, vertical: 45˚, diagonal: 70 ˚;
  - Spatial X/Y resolution: 3mm;
  - Depth Z resolution: 1cm;
  - Data stream: 30 frames/sec;
  - Operation range: 0.8m - 3.5m (Fig.2);
- RGB camera whit the following resolutions: 640X480, 320X240 in Linux and Mac and 1024X768, 640X480, 320X240 in Windows 7;
- A tilt motor with the range of: ±27 degrees, as shown in Fig.1.

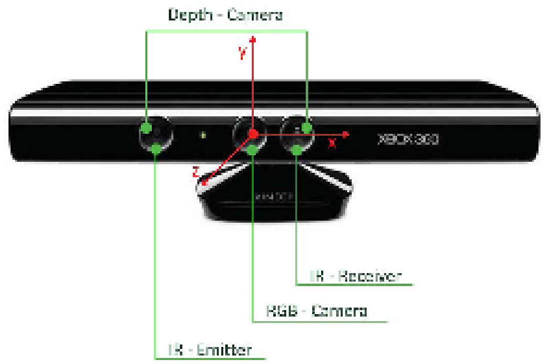

Fig. 1. Kinect Sensor components

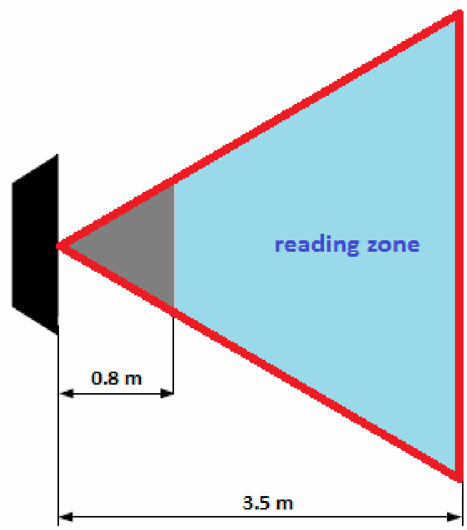

Fig. 2 . Operation range of the Kinect sensor

How the Kinect sensor works: the Kinect IR light Emitter sends a pattern of light form by 640*480 pixels (depends of the resolution). After the light is dispersed back to depth sensor by an object in range, the Kinect IR Receiver can distinct this light to the original pixel which the beam belongs (Fig. 3.a).

To calculate the depth of a point in view meaning the z-coordinate, we need to neglect the y-coordinate and work with the projection on the x z planes.

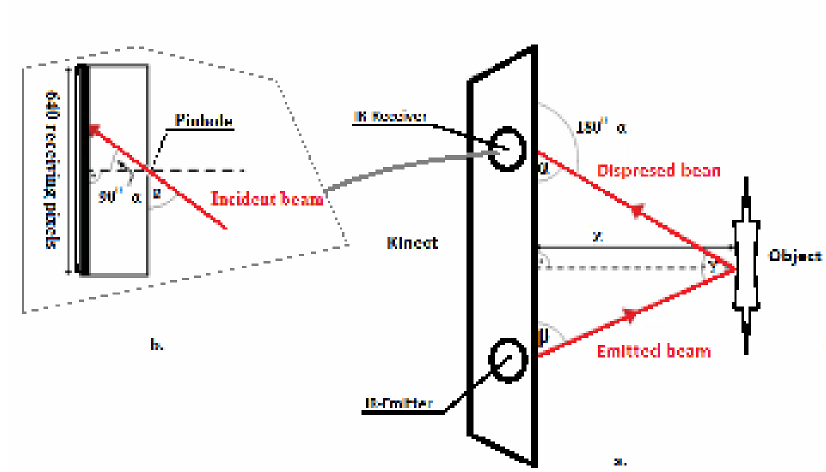

Fig. 3 a. The emitted and dispersed beams of the Kinect sensor; b. A model of Kinect sensor pinhole

The angle γ can be calculated by the sum of all angles in a triangle:

$$\gamma = 180^{o} - \alpha - \beta \quad (1)$$

where α is the angle of the dispersed and received beam andβ is the angle of the emitted.

Because the distance between the IR-Emitter and the IR-Receiveris permanently constant(b = 75mm) we calculate the length of the dispersed beam ***s*** with the following equation:

$$s = b \cdot \frac{\sin\alpha}{\sin\gamma} \quad (2)$$

Further, if we use the height of the rectangle we can obtain the depth of the point in view. This size is labeled ***z*** and can be expressed as follows:

$$z = s \cdot \sin\alpha \quad (3)$$

Using equations (1) and (2) to express equation (3) we get:

$$z = s \cdot \sin\alpha \cdot \frac{\sin\beta}{\sin\left(180^{o} - \alpha - \beta\right)} = b \cdot \frac{\sin\alpha \cdot \sin\beta}{\sin\left(\alpha + \beta\right)} \quad (4)$$

Then if the depth value (the z-coordinate) is known, for every pixel the x and the y coordinate can be calculated as linear functions of the z-coordinate.

$$x = 2 \cdot \left(\frac{X_{pix}}{V_{x\,\mathrm{Re}\,z}} - \frac{1}{2} \right) \cdot \tan\left(\frac{57^{0}}{2} \right) \cdot z \quad (5)$$

$$y = 2 \cdot \left(\frac{1}{2} - \frac{Y_{pix}}{H_{y\,\mathrm{Re}\,z}} \right) \cdot \tan\left(\frac{43^{0}}{2} \right) \cdot z \quad (6)$$

Where ***VxRez*** and ***HyRez*** represents the vertical and horizontal dimensions of the paten of light.

For e.g. $V_{x\,\mathrm{Re}\,z} \cdot H_{y\,\mathrm{Re}\,z} = 640 \cdot 480$

X_{Pix}andY_{Pix}represents the coordinates of the respective pixel in the Kinect sensors depth frame.

Beside using the Kinect camera to be able to establish a kinematic analysis of the human body we need to use a development tool like Microsoft Visual C# 2010 Express and the library from OpenNi and PrimeScene or Microsoft. In our case we have used the C# library from Microsoft to generate the human joints as in Fig. 4 (more details can be found at [13]).

Once the skeleton tracker is established after a certain pattern (Fig. 4) by using the Microsoft library or OpneNI and PrimeScenes the kinematic analyze can start (Fig.5).

To do so we need to develop a code in any of the following programming languages: C++, C# or Java. The next step is to determine the x, y,z coordinates of the joints, the angles between the human body segments, angular velocities, accelerations and trajectories.

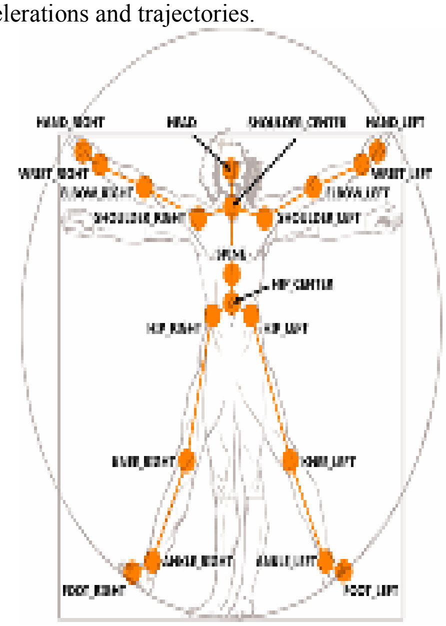

Fig. 4. The joints position generated by the Kinect sensor

Fig. 5

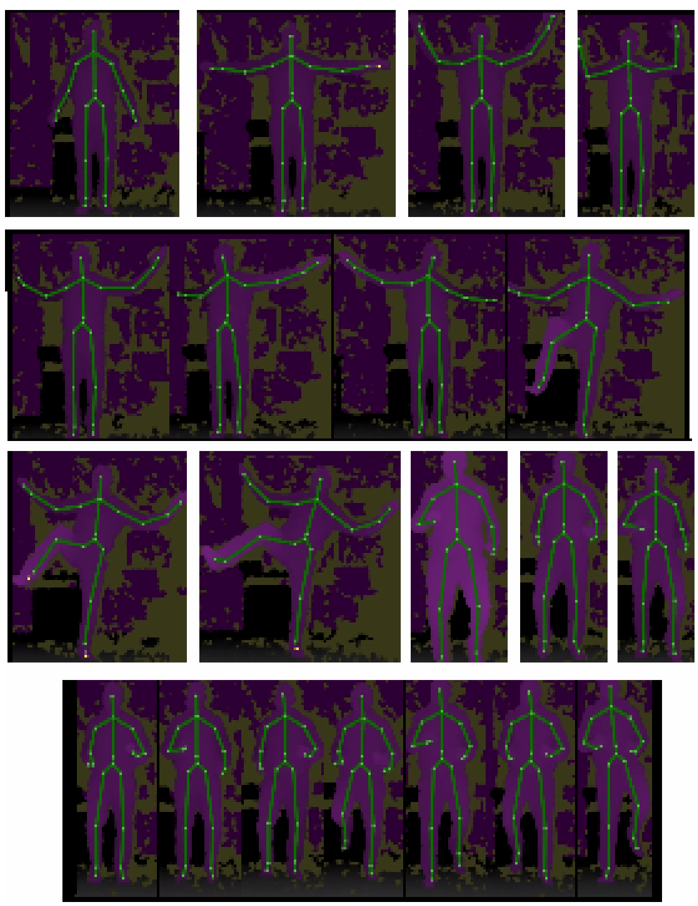

Fig. 6

DISCUSSION AND CONCLUSION

The need to maintain the health of the musculoskeletal is crucial because this way we can prevent or solve deficiencies and anomalies of the human body activities.

To do so we need to use, find or develop new kinematic analysis systems like Vicon cameras, ToF cameras or in our case the Kinect cameras.

Comparing the Kinect camera point of view of accuracy, availability and price with others specialized motion capturing system we can conclude that the sensor in question is a very capable tool to study the kinematics of the human body in everyday activities or in sports with the aim to prevent or solve deficiencies of the musculoskeletal.

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UTILISATION DE CAPTEUR KINECT POUR ETUDIER LA CINEMATIQUE DU CORPS HUMAIN

Résumé:
Le corps humain est un mécanisme complexe qui se compose de multiples chaînes cinématiques. Le but de ces chaînes est de multitude maintenir le corps humain en mouvement continu nécessaire pour la vie quotidienne.
Dans cet article nous allons présenter un état de la technologie de pointe défini par son un énorme potentiel et de l'accessibilité pour étudier la cinématique du corps humain.
Notre travail étudie la façon dont le capteur Kinect est capable de prendre part à l'étude de la cinématique du corps humain.
***Mots-clés**: biomécanique, Kinect capteur, capteur de profondeur, la cinématique, le sport, le corps humain, le mouvement sans marqueurs*

ESTABLISHING THE 3D ACTIVE SPACE OF THE HUMAN UPPER LIMB USING AUTOLISP

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Abstract:
The paper presents a graphical method for determining the 3D active space of the human upper limb. The method is based on AutoLISP features and provides an accurate description of the active space. The main disadvantage is related to time computing which can be very large due to the amount of points describing the active space. We can also reveal the limitation of active space for persons having upper limb disabilities.
***Keywords:** upper limb, 3D active space, AutoLISP*

INTRODUCTION

The human skeleton is not a perfectly rigid mechanical structure, articulated with idealized spherical or axial joints. In order to simplify the calculation routines, we assume that kinematic links are rigid bodies. Thus, some errors might occur in the kinematic analysis (Zhang, 2002) and in inverse dynamics as well (Risher et al., 1997).

It is well known that in time, most people lose a certain percentage of mobility of their joints. As a consequence, the active area of the upper limb is shrinking. This method provides the expression of the percentage of mobility loss for older persons or for disabled ones with respect to a normal person.

DESCRIPTION OF THE METHOD