IMPLEMENTATION AN IMAGE PROCESSING TECHNIQUE FOR VIDEO MOTION ANALYSIS DURING THE GAIT CYCLE CANINE

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Abstract. Nowadays the analyses of human movement, more specifically of the gait have ceased to be a priority for our species. Technological advances and implementations engineering have joined to obtain data and information regarding the gait cycle in another animal species. The aim of this paper is to analyze the canine gait in order to get results that describe the behavior of the limbs during the gait cycle. The research was performed by: 1. Dog training, where it is developed the step of adaptation and trust; 2. Filming gait cycle; 3. Data acquisition, in order to obtain values that describe the motion cycle canine and 4. Results, obtaining the kinematics variables involved in the march. Which are essential to determine the behavior of the limbs, as well as for the development of prosthetic or orthotic. This project was carried out with conventional equipment and using computational tools easily accessible.

1. Introduction
The walk is considered as one of the activities most commonly performed by quadrupeds and bipeds. This kinematic analysis describes the movements without considering the forces that produce them [1]. The development of this analysis only considers the sagittal plane.

Through gait, bipedal and quadrupeds may be moved from one place to another at different speeds. For these movements are carried out, quadrupeds (for this case) use the locomotor system. It includes musculoskeletal structures of various parts of the body. Highlighting the forelimbs and hindlimbs [2].

Quadrupeds are able to perform various types of gait; walk, trot and canter. In each case, the limbs perform a cycle of step. It is considered a step cycle the period from the instant that a limb is detached from the floor until it is touch again. Each of these cycles of step it is divided into two phases; advance and support [3].

In walking, the limbs are in contact with the ground more than 50% of the time. Each movement is independently, they are not synchronized. Usually two or three limbs support the weight of the animal [4]. The analysis is limited to gait dog when is walking. Because is the simplest and natural activity that performed by the dog.

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2. Methodology
This section describes the steps for the project and the equipment that it is used. The characteristic of the test subject are: Australian Shepherd, female, approximate age 4 years, height 50 cm, length 57 cm, body mass: 18 kg.

The height of a dog is measured from the cross to the ground. Where the cross is located at the base of the neck and the highest points of the shoulder blades form it. The length of the dog is measured from the shoulder to the ischial tuberosity [5]. The estimated height for males is 51-58 cm, for females is 46 to 53 cm [6].

2.1. Training
To perform the analysis, the animal had training for walking comfortably on the electric treadmill. The training time was 3 or 4 months because the dog has a nervous character that way the dog could perform the assigned activity. To achieve the goal, it is used the following equipment: Chain 2 m long, Food rewards (positive reinforcement) and Dog Toys.

With the help of positive reinforcement in other words motivate the dog with positive experiences and awards to achieve the goal successfully without the dog suffer any physical injury and/or trauma, it taken precautions and all kinds of care.

2.1.1 Shooting gait cycle
For the gait cycle shooting, it is adapts a large stage for placing equipment well as lighting sufficient. Where gait recordings were made in the electric treadmill (in horizontal position without declivities without inclination) at a constant speed (0.1 km/h). The digital camera is located to 1.2 m from the electric treadmill and a height of 25 cm as it is shows in Figure 1. Table 1 describes the devices used and the requirements.

![Figure 1. Distances of equipment for the filming.](image-url)
Table 1. Elements and requirements.

| Element             | Description                                                |
|---------------------|------------------------------------------------------------|
| Digital video camera| GoPro Hero 4 Silver Resolution 1280x720 pixels              |
| Electric treadmill  | Flat base, Model E318N, variable speed, dimensions 1.02 x 0.33 m |
| Circular markers    | Diameter 30 mm                                              |
|                     | Forelimb: Blue, Hindlimb: Gold                             |

As it is mentioned above, to walk is the most natural movement of a living being to move from one place to another. That is why this paper focuses only on the gait cycle to walk. It is considered the minimum set speed on the electric treadmill, in order to have a better appreciation of the cycle.

2.1.2 Data acquisition
The canine gait analysis has the intended to indicate the clinical condition of the patient or specimen to be treated. With the joints movement in each limb. They can be obtained kinematic variables involved in driving tests. With the joints, movement in each limb can be obtained kinematic variables involved in gait tests.

Before shooting, markers are placed on the joints of the dog. The order of placement for markers is shows in Table 2. Then Figure 2 shows the markers placed in joints of dog. These are placed in all four limbs.
Table 2. Marker location.

| Forelimb                  | Hindlimb                  |
|--------------------------|---------------------------|
| Shoulder joint (AH)      | Hip joint (AC)            |
| Elbow flexion (FC)       | Knee flexion (FR)         |
| Carpal bone (HC)         | Flexing of tarsus (FT)    |
| Metacarpal bones (HM)    | Metatarsal bone (HMT)     |

The videos obtained from the canine gait. One for hindlims and one for forelimbs in right and left side. They are digitized to be processed by the mathematical program.

Upon detecting the marker positions represented in a virtual way (in two dimensions), it can see the trajectory of biomechanical model of segment for each markers.

For better quality of video, a setting of 1280 x 7000 pixels at 60 fps (frames per second) is used. This is the best option in terms of size for the generated file. At a higher frequency, better video quality is obtained but requires more computational resources to process video file.

The results are obtained by the mathematical software, which calculates the position values, performing arithmetic difference of the angles generated.

3. Results
In Figure 3, it observed the forelimb results and Figures 4, 5 and 6 show the corresponding graphs of results for the kinematic variables; linear velocity of shoulder, angular velocity of elbow. Also the kinetic variable is shows; carpus joint angle.
Figure 3. Results obtained in forelimbs

Figure 4. Linear velocity of shoulder.
4. Conclusions
With this technique, was achieved implement a system that allows viewing kinematic variables as: linear velocity and angular velocity. In addition, the kinetics variable: angles of articulations, which they were detected in the cycle of canine gait.

The analysis developed in this work, is a simple procedure economic and reliable. Is a tool with that it can obtain various variables (kinematics and kinetics) of the joints of limbs of a quadruped (in this case dog). With the help of a conventional camera of low cost and a computational tool, it can improve the data acquisition.
The idea of developing this technique is justified due to the high demand that today presents this type of analysis. There are certainly various sophisticated equipments of those can get the same results. With the research work that is presented here, it exposes another perspective of the various equipment with those can perform this type of studies. In such a way that any person interested in the area of biomechanics or other related areas, can obtain reliable results of this analysis.

It should be noted that, with the results of this analysis were taken decisions and clarify expectations about potential designs and manufacturing of prototypes of prostheses for hindlimb and forelimb in canine.

5. References
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