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GEARS MODELLING BY A HUMAN FOOT ANKLE JOINT

Adrian-Constantin Buta*, Ionel Ştefan**
Transilvania University of Braşov, *acbuta@unitbv.ro, **simst7@yahoo.com

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Abstract: The paper presents the rotation movements on the human foot permitted by the ankle's joint on the ground, drafts of models through gears, through which one can reproduce the ankle's movements, preserving the direction of the rotation axis.

1. BIMOBILE MODELS

Between the three rotations of the foot (fig. 1), the flexion (around y), the pronation (around x) and the pivot (around z), the most important is flexion (angle β - fig. 2) [1, 2], and the least characteristic is pivot (angle α).

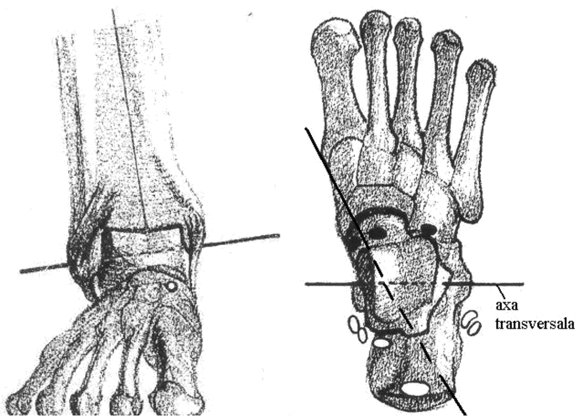


Fig. 1. Physical model.

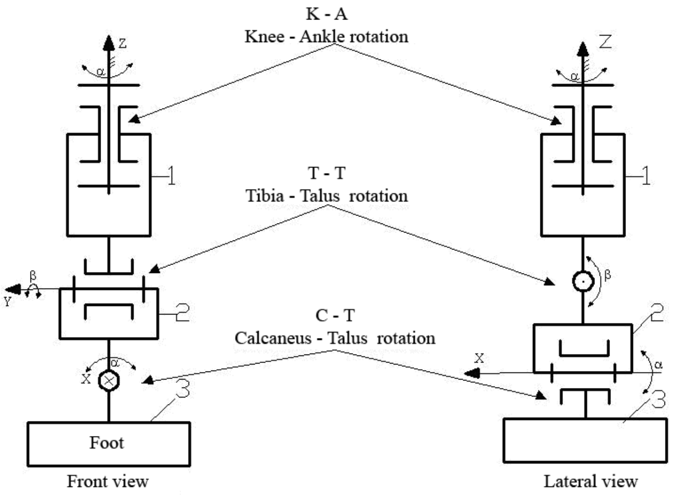


Fig. 2. Structural model.

Bimobile models will consider two of these three movements [3]:

α - β combination, respectively pivot - flexion, joints permits of the knee - ankle (KA), and tibia - talus (TT), is modeled in figure 3.a, and took to the sketches in figure 3.b, 3.c and 3.d, thus: in figure 3.b the rotations ***α*** and ***β*** are independent of line 1 or 2; in figure 3.c the rotation ***α*** depends only on drive 1, and the rotation ***β*** depends the drives 1 and 2; in figure 3.d the both angles ***α*** and ***β*** depends on the drives 1 and 2.

α - γ combination, respectively pivot - pronation around axes ***zx***, as suggested in figure 4.a, is reflected by the sketches in figure 4.b, 4.c and 4.d - ordinary and planetary bevel gear. In the figures 4.b and 4.c rotations ***α*** is transmitted from one through two conical gears and rotation ***γ*** comes from driving 3. The figure 4.d is a combination by differential rotation of the satellite's own degree angle ***α*** and the rotation angle ***γ*** gives portsatelit arm.

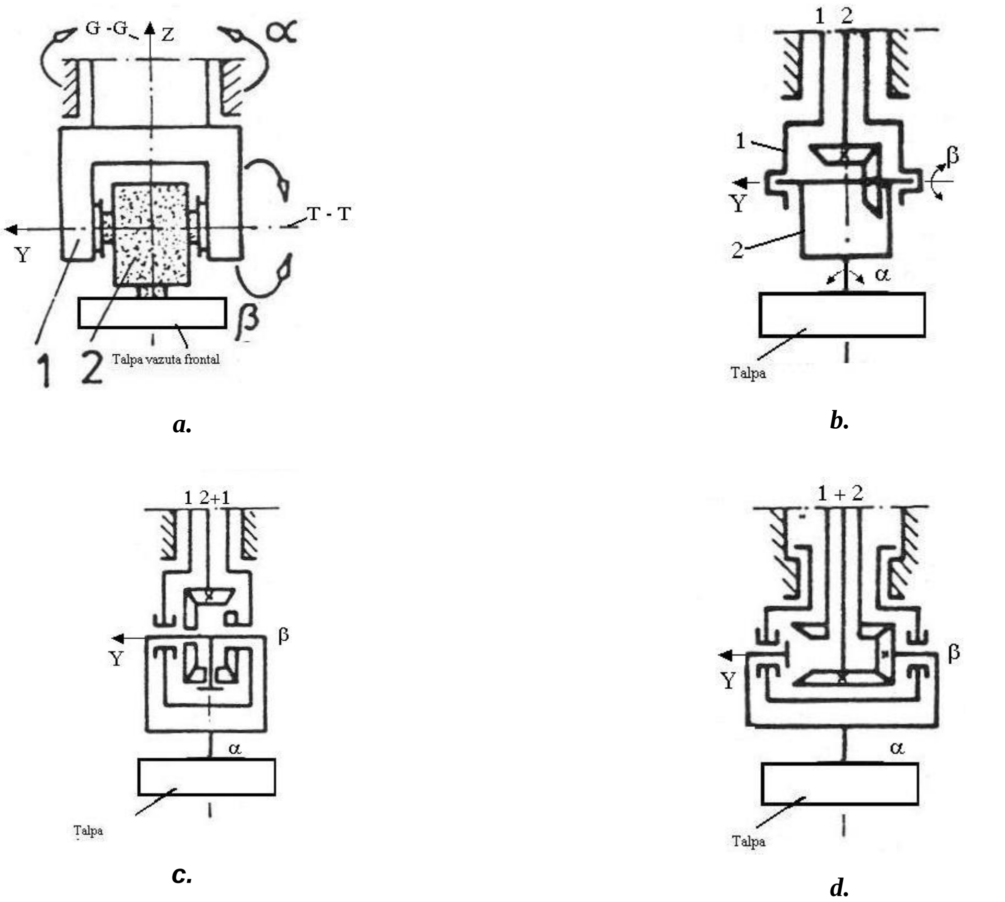


Fig. 3. The pivot – flexion combination.

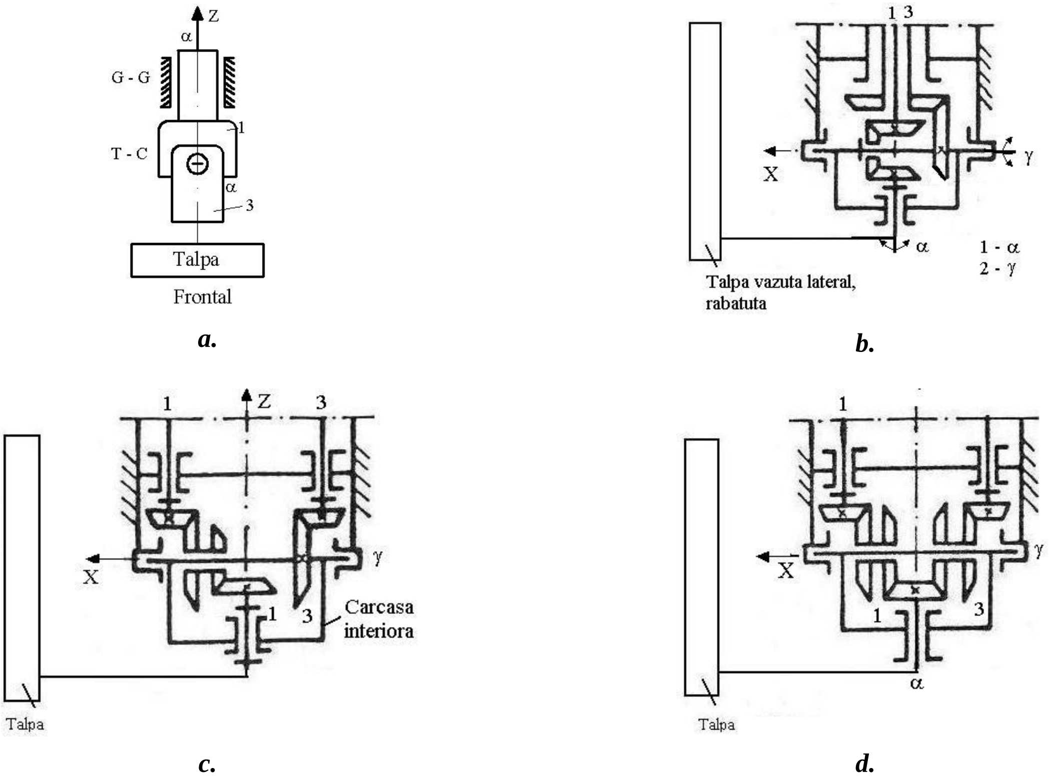
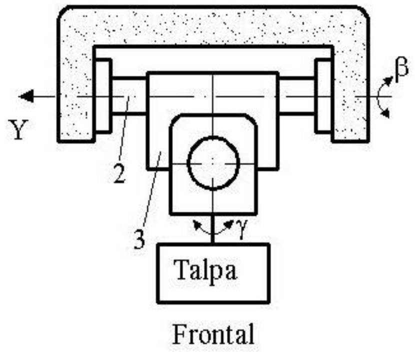
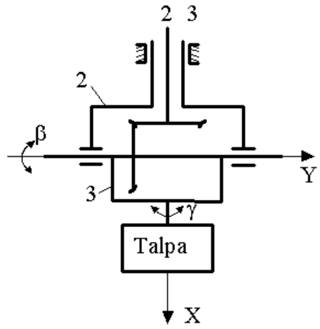


Fig. 4. The pivot – pronation combination.

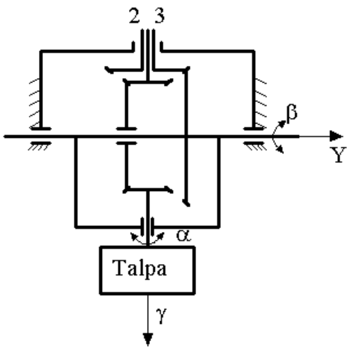
β - γ combination, respectively flexion - pronation around the ***yx*** axes, as suggested in figure 5.a, is the most important and can be made available by the sketches in figure 5.b, 5.c and 5.d. The figures 5.b and 5.c the drive 2 produces the angle ***β***, and the drive 3 produces the angle ***γ***. In the figure 5.d the angle ***β*** corresponds to the rotation arm, and ***γ*** - planetary rotation of the central satellite.



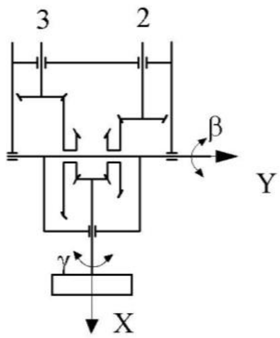
a.



b.



c.

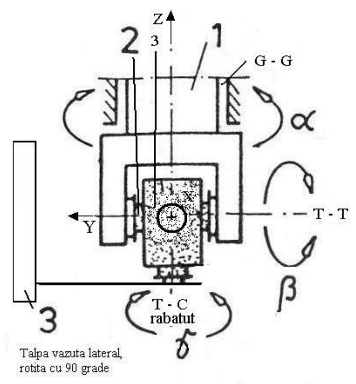


d.

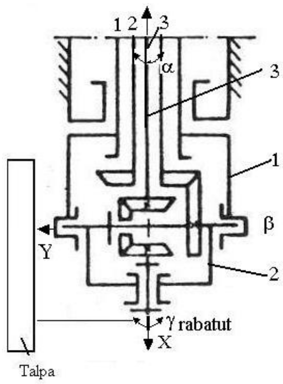
Fig. 5. The flexion – pronation combination.

2. TRIMOBILE MODELS

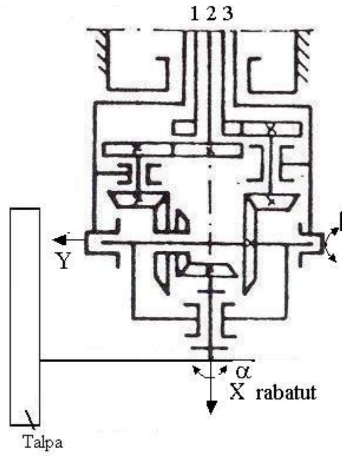
All the rotations can be modelling like in figure 6.a, with in the sketches in figures 6.b, 6.c and 6.d. The structure is relatively complicated, requiring three entries by 1, 2 and 3.



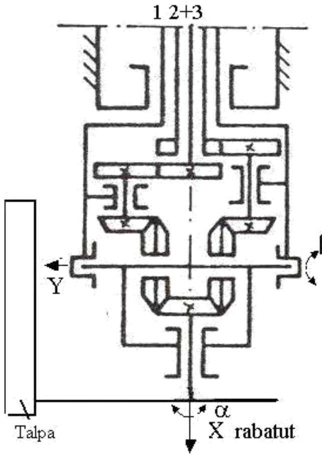
a.



b.



c.



d.

Fig. 6. The pivot – flexion – pronation combination.

The drive 1 produces rotation around the ***z*** axis with angle ***α*** of the all assembly. The drive 2 produces the main movement in ***y*** axis with the angle ***β***. The drive 3, on the central axis produces rotation around the ***x*** axis with the angle ***γ***.

3. CONCLUSIONS

Since the structure of the lower limbs, including their joints are particularly complex in terms of mechanical movements can not faithfully reproduce the human skeletal system that runs as a driver for the model geometry was simplified. To achieve the main movements were used torque having a structural modeling much easier and allows both flexion, pronation and pivoting. Observe all the movements so that the existing model in the ankle involves a triple joint rotation but it can not be a spherical joint operating difficulties.

Schemes presented can be used to model human leg movements, following a cinematic process optimization and matching drives. Given the major movements, consider ***β - γ combinations***, flexion - pronation. These structures (see fig. 11) are relatively simple, so easily adopted.

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