MECHANISM TO LINK TWO INERTIAL MEASUREMENT UNIT TO A POTENTIOMETER: IMPROVEMENT OF MEASUREMENTS BETWEEN PELVIS AND TRUNK IN MOTION

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INTRODUCTION

Inertial measurement unit, or IMU, that combine accelerometers, magnetometers and gyroscopes are used to measure human motion. However, one component, the magnetometer, is particularly sensitive to local magnetic fields and is sometimes inaccurate. To overcome this problem, a potentiometer between two sensors could help to improve the level of accuracy in the presence of local magnetic fields. The mechanisms linking the potentiometer to IMUs has to be non magnetic (μr near 1), to transmit relative rotation between those sensors along longitudinal axes and it has to take into account the back's elongation.
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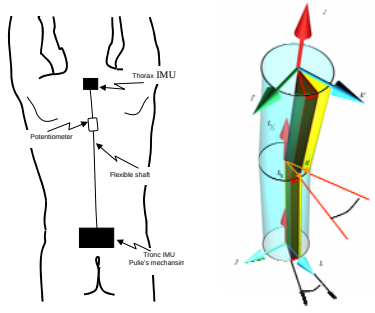
METHODS

A first IMU was placed over the sacrum and a second one on the upper part of the thorax. Both sensors were linked by a flexible shaft with a potentiometer. The potentiometer was added to have a other source of information, to measure the relative rotation between both IMUs in order to improve the validity of the system. A complementary quaternion filter algorithm was used to estimate trunk orientation by taking advantage of the nine components of each IMU [1]. The IMU's orientations were compared to those obtained from a 3D optoelectronic system. The IMUs consisted of two 3D inertial sensors (Microstrain 3DM-GX2, Burlington). The two sensors were used to measure the orientation of the thorax relative to the pelvis. Each sensor consisted of three orthogonally aligned gyroscopes that measured the angular rate of rotation, three orthogonal accelerometers that sensed the gravitational acceleration, and three orthogonal magnetometers that were sensitive to the Earth's magnetic field. The potentiometer was used to measure the longitudinal rotation between the two sensors. The angle measured by the potentiometer is the torsion along a flexible link similar to the torsion that one would have in a flexible tube (figure 1). Such angle is calculate by using the Crawford 's approach[2].



$$\vec{A}xe_z = \begin{bmatrix} \cos\left(\phi/2\right) \\ -\sin\left(\phi/2\right)\sin(\theta) \\ \sin\left(\phi/2\right)\cos(\theta) \end{bmatrix}$$

Figure 1: flexible link with Crawford's approach

RESULTS AND DISCUSSION

An aluminum pulley is winded up tight in torsion using a latex tube as a spring (Figure 2). This winding mechanism forces the flexible shaft to runs inside the groove of the pulley, in the opposite circular direction of the latex tube. The mechanism works similarly to a measure tape. Thus the mechanism (a box of 20 X 12 X 4cm) fixed at the sacrum, automaticly ajust the length of the flexible shaft to the distance between the IMUs while transmitting rotation to the potentiometer on the longitudinal axes

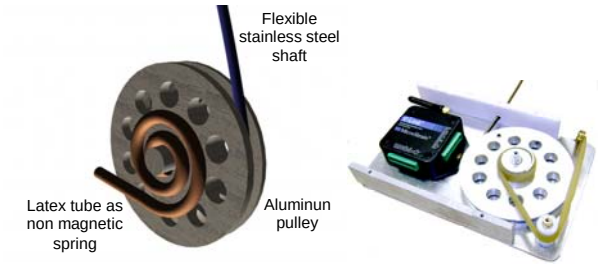


Figure 2: a) Stainless flexible shaft + Latex tube as spring
b) The real system

CONCLUSIONS

The use of aluminum, stainless steel and latex tube as a spring, contribute in non magnetic system (do not disturb the magnetometers). The system transmitting rotation along IMU's longitudinal axes meets the needs of the back 's elongation, covering a large population base. The use of a potentiometer (NovoTechnik P2200) with extremely low torque (0.003 Ncm) allow to transmit the longitudinal rotation without twisting the shaft (helical effect).The prototype works well but should be reduce. The latex's elasticity makes possible to preserve a good tension in the flexible shaft, thus relative longitudinal torsion between the pelvis's sensor and the trunk's one is well reproduced by the potentiometer.

REFERENCES

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