**Improving 3D Orientation Tracking in Gyroscope Sensors**

Gyroscopes are important tools for measuring the orientation and rotation speed of rigid, moving objects. Traditionally, they are made up of a spinning disc, mounted onto a circular support – which is free to rotate about the disc’s axis.

Today, many gyroscopes are based on microscopic, vibrating mechanical elements, which are integrated with electrical components.

When combined with accelerometers, gyroscopes have numerous applications. Because they can measure changes in orientation and speed, they are essential components of many navigation systems, including those used on board ships, aircraft, space telescopes and planetary rovers.

Gyroscopes are also used as motion sensors in smartphones, virtual-reality headsets, and wearable fitness trackers.

Despite the crucial roles that gyroscopes play, Sara Stančin and Sašo Tomažič at the University of Ljubljana argue that current techniques for interpreting their measurements are imperfect.

The problem stems from the ‘sequential’ interpretation of the three gyroscope rotations.

This approach breaks the apparent rotation of the gyroscope into rotations around three axes, and assumes that these occur one after the other. In reality, the rotation takes place about all three axes simultaneously.

Breaking rotations into three-part sequences simplifies the calculations, but Stančin and Tomažič show that this approach introduces errors in the measured orientation.

These errors arise since rotations are generally not ‘commutative’, which means that changing the order of the successive rotations also changes the final orientation of the rotating body. Since there are six possible sequences of rotations about three axes, there are also six possible final orientations. However, none of these final orientations is correct if the rotations are simultaneous.

As a result, the researchers explain that accuracy can be improved by correctly assuming that rotations take place about all three axes simultaneously.

Stančin and Tomažič next aimed to establish a reliable basis for incorporating simultaneous rotations into the methods currently used to track the orientation of rigid bodies.

They showed that a gyroscope measures the three components of the rotation vector that is aligned with a rotation axis, and whose magnitude is equal to the rotation velocity. If the rotation axis does not change during the measurement, the final orientation of the object can be calculated by multiplying the rotation vector by the time interval of rotation. The vector determined in this way is called the simultaneous orthogonal rotation angle – or ‘SORA’.

These results present a promising outcome – that the errors introduced by sequential measurements are avoidable. Stančin and Tomažič have shown that SORA is well-suited to calculating the orientations of rigid, moving bodies in real time – a capability that could have far-reaching consequences for navigation systems and smart devices.

Summary of the paper ‘On the Interpretation of 3D Gyroscope Measurements’, in Journal of Sensors. [doi.org/10.1155/2018/9684326](https://doi.org/10.1155/2018/9684326)

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