(Form6)

論　文　要　旨
Thesis Abstract

(yyyy/mm/dd)　2016 年 07 月 01 日

※報告番号	第　　号	氏　名 (Name)	DAO VIET HUNG

主論文題名　(Title)

New Methods of Tilt Measurement
for Applications in Medical Devices

内容の要旨　(Abstract)

Tilt measurement is useful for a variety of applications. In medical field, the tilt angles can be used to determine inclinations of the human bodies, angles of human joints, as well as orientations of surgical devices. Tilt measurement is also necessary for consumer electronics, industrial electronics, avionics, and other applications in both civil and military, which require the inclinations of an object with respect to either vertical axis or horizontal plane.

Measuring the tilt angles with inertial sensors is a well-known technique. An accelerometer can sense any change in a linear velocity as well as measuring the constant gravitational acceleration. Hence, by using a triaxial acceleration sensor, three orthogonal projections of the gravity vector onto the sensor frame can be determined for computing the tilt angles. The calculation formulas depend on the definition of the tilt angles which can be classified into some major types.

Both analog and digital accelerometers are commonly utilized for measuring the tilt angles. Digital accelerometers are a good choice in many cases, whereas an analog accelerometer could be necessary when the system requirements are beyond the capability of the digital sensor. However, when using the analog sensors, the effects of the electromagnetic interference must be taken into account.

Another challenge in measuring the tilt angles is the influence of movement and vibration. Any linear acceleration can perturb the sensor data, and therefore can degrade the measurement accuracy. Consequently, additional sensors or algorithms should be integrated into the systems if the static or quasi-static conditions cannot be guaranteed.

※official use only

(Form6)

論　文　要　旨
Thesis Abstract

(yyyy/mm/dd)　2016 年 07 月 01 日

※ 報告番号	第　　号	氏　名 (Name)	DAO VIET HUNG

内容の要旨(Abstract)

The objectives of this work are to partially solve the limitations of the tilt measurement technique in the medical field. The whole work is divided into four elemental studies. The first three studies are proposed based on the same idea that is the interference cancellation can be achieved by changing the mounting orientation of the acceleration sensors. In each study, a rotation matrix is proposed to rotate the sensor frame and convert the calculation formulas. This change allows computing the tilt angles from the differences between the voltages of three sensor outputs. Thus, an advantage of the differential signaling technique, that is interference immunity, is taken within the single-ended systems. In spite of using the same mechanism, each study plays a dedicated role because they improve three major types of the tilt components.

In the last study, a new sensor-fusion method is proposed to reduce the effects of motion on the tilt angles. The key algorithm is a special predict-and-chosen process which combines the accelerometer readings and the output data of a triaxial gyroscope. During the dynamic states, this process predicts three gravitational components to estimate the tilt angles. Therefore, the dependence of the computed results on the motion can be reduced.

In each study, both simulations and experiments have been performed to validate the proposed methods. The results showed significant improvements in the output angles. Although there are some shortcomings that need to be addressed in a further research, the reported results may contribute to increasing the applicability of the tilt measurement technique in medical systems. Moreover, the advantages of the first three studies could be useful for applications in other fields.

※official use only