Gait Analysis and Pedestrian Navigation Using a Foot-Mounted Inertial Sensor

Supervisor: Professor Young Soo Suh

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Submitted to the Graduate School of Electrical Engineering in partial fulfillment of the requirements for the degree of

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by

Duy Duong Pham

Department of Electrical Engineering

UNIVERSITY OF ULSAN

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Approved by:

Prof. Hee Jun Kang, Chair of Committee

Prof. Young Soo Suh, Committee Member, Thesis Advisor

Prof. Kang Hyun Jo, Committee Member

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ABSTRACT

Motion tracking is used in military, entertainment, sport, medical applications, and for validation of computer vision and robotics in which gait analysis and pedestrian navigation are popular problems.

For gait analysis problem, we present a methodology to improve the accuracy of foot pose estimation using two low-cost distance sensors (VL6180) in addition to an inertial sensor unit. The distance sensor is a time-of- ight range nder and can measure distance up to 20 cm. A Kalman lter with 21 states is proposed to estimate both the calibration parameter (relative pose of distance sensors with respect to the inertial sensor unit) and foot pose. Once the calibration parameter is obtained, a Kalman lter with nine states can be used to estimate foot pose. Through four activities (walking, dancing step, ball kicking, jumping), it is shown that the proposed algorithm signi cantly improves the vertical position estimation.

For pedestrian navigation problem, to improve the accuracy of pedestrian location, we propose a method using a distance sensor (LIDAR) in addition to an inertial measurement unit (IMU). The distance sensor is a time of ight range nder with 30 m measurement range (at 33.33 Hz). Using a distance sensor, walls on corridors are automatically detected. The detected walls are used to correct the heading of the pedestrian path. Through experiments, it is shown that the accuracy of the heading is signi cantly improved using the proposed algorithm. Furthermore, the system is shown to work robustly in indoor environments with many doors and passing people.

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