## Graduate School of Science and Engineering, Aoyama Gakuin University

Title: Road Monitoring by Cyclists Wearing Smartphone

Student Name: Yusuke Kobana
ID Number: 35614127
Degree: Master of Engineering
Course: Intelligence Information
Thesis Advisor: Guillaume Lopez

## Abstract

Since Chuo-Expressway Sasago tunnel celling collapse accident in 2012, much attention is paid to roads maintenance. For safety reason, roads' damages should be detected and repaired as soon as possible. However today roads' status is investigated by a car with special sensors embedded. Considering the cost, it is difficult for road authorities to monitor roads' status extensively and continuously.

To reduce the roads' maintenance cost, we have proposed a system called YKOB (Your Kinetic Observation Bicycle) focusing on participatory sensing by cyclists wearing a smartphone. We have proposed and evaluated the methods of extracting road signal, detecting road damage, and classifying damage types which are the analysis parts of the roads' status in YKOB.

In extracting road signal method, we have proposed the methods for pants' side pocket (P1), chest pocket (P2), and bag in a front basket (P3) from the questionnaire survey about position of smartphone during cycling. The extraction methods were evaluated by comparing with the acceleration signal of the smartphone at the hip because the acceleration is rarely affected by cyclists' motion. In P1, the correlation coefficient was about 0.6 by using Independent Component Analysis. In P2, the correlation coefficient was about 0.7 by the selecting the acceleration signal having the gravity component. However, in P3, the correlation coefficient was only about 0.3 by the same method as P2. The result suggests the necessity to build an extracting method depending on the smartphone position that is either near a front wheel or a rear wheel.

In detecting road signal method, we have built the algorithm based on the acceleration signal collected from actual roads' damages. The algorithm is focusing on the two peaks of the acceleration passed by a front and a rear wheel. The experiment was conducted for 42 roads' damages in actual situation. The result shows that roads' damages can be detected with 67% accuracy. However it also shows the problem that the false detection was 48%. To avoid the false detection, road classification is needed.

In classification method, we try to classify four kinds of basic roads' damage types: positive step, negative step, convex step, and concave step. We built two kinds of the classification algorithm, TCA (Time-feature based Classification Algorithm) and RCA (Real signal mother wavelet based Classification Algorithm). The experimental result suggested that TCA was easily effected individual difference. On the other hand, RCA has the accuracy than 70% and it was not effected by individual difference.