Study on Applicability of Mobile Measurement in a High-Density Urban Area -Measurement for Detailed Temperature Distribution in Shinjuku-

*Hiroki Yokoyama[1], Ryozo Ooka[2], Hideki Kikumoto[2]

1.School of Engineering, The University of Tokyo, 2.Institute of Industrial Science, The University of Tokyo

Recently, urban environmental issues related to heat and aerial pollutants have been become more serious. Atmospheric properties such as air temperature, wind velocity, and pollutant concentrations are typically measured at meteorological observation stations. However, due to the low spatial resolution of meteorological observation stations, it is difficult to observe urban environmental issues occurring on a scale relevant to people's daily lives. To overcome this, mobile measurement is an effective method of investigating the distribution of environmental conditions in urban areas. However, there are two problems with mobile measurement. (1) Obtaining accurate position data is essential during sampling. However, due to the reflective properties of building surfaces, Global Positioning System (GPS) data collected in urban areas tends to include a large degree of error. (2) There has not been enough discussion in the scientific community to form a consensus around representativeness of measurement values obtained by mobile measurements. Therefore, in this study, we investigate the range of GPS errors and the spatial distribution of air temperature obtained during mobile measurement in a high-density urban area. We discuss the applicability of the method to a high-density urban area based on results.
The mobile measurement was conducted from August 25-28, 2015 in cloudy days. The measurement site selected is one of the densest urban areas in Japan, several city blocks in Shinjuku, Tokyo. The site, which is essentially laid out on a grid plan, covers an area of 26.2 hectare (ha) and has a mean building height of 17 m. The site is contiguous to Shinjuku Gyoen, a large green space (58.3 ha). To make the measurement, we equipped bicycles with platinum resistance thermometers, a temperature logger, and a GPS logger. Additionally, the bicycle was outfitted with a cycle computer to confirm travelling speed, and a time-lapse camera to record experiment conditions. The sampling interval of the measuring devices is 1 s and the spatial resolution is approximately 3 m (mean travelling speed of the mobile platform is 12 km/h). Additionally, we installed a weather station in Shinjuku Gyoen as, a fixed measurement point, to record weather conditions during the measurement period.
Results showed that the average GPS error in an urban area was 20 m (std: 50 m) when GPS position data was corrected by the method which we developed. Within the site, we identified spatial variations of air temperature on an hourly-average basis. The standard deviation of the variation was approximately 0.2 ºC and the range of the variation was approximately -0.9 to 0.9 °C. We could figure out a general spatial distribution of air temperature when the mesh size of spatial resolution was 100 m. However, a mesh size of 10 m was necessary to observe hot spots in the densely developed urban area. We found the mobile measurement was the effective method in a high-density urban area when GPS position data was appropriately corrected.

Keywords: Mobile Measurement, Urban Area, Spatial Temperature Variation, GPS