Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MTT05-P01 Room:Convention Hall Time:May 27 18:15-19:30

Development of Pedestrian Navigation System Using Short-Term Rainfall Prediction on Smartphone

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Nowcasting is good for short-term weather prediction because its description of the current state of the atmosphere and the prediction of how the atmosphere will evolve during the next several hour (Clifford Mass, 2012).

With advanced features such as high-speed Internet connection device, Global Positioning System (GPS), high-resolution screen, and good computational capabilities, nowadays smartphone can be one of solution for distributing real-time weather information in almost any location. This system is expected able to help students planning their trip from campus to train station by providing specific rainfall prediction, in order to avoid getting rain in the middle of their trip, and can take part in disseminating weather information.

In this study, we would like to combine short-term rainfall prediction from Furuno X-Band Doppler Radar that located at Kobe University and smartphone's advanced features, together with apple's API services to produce a specific rainfall prediction. This system will check rainfall prediction for the next 30 minutes, turn-by-turn based on walking route from departure place to user-selected train station. Final output of this system is giving user advice whether start the trip now or wait for certain minus to avoid rainfall.

Currently, this system is developed using XCode Swift Framework and running only on Apple devices. At the beginning system will identify user's location/departure location by utilizing GPS features on smartphone, then using apple's API system smartphone gets full address of departure location through reverse geo-location method. Process continued by requesting nearby station from departure location, user select one of station as their destination location. Using departure and destination data, system generates walking route and combine route information with short-term rainfall prediction data to check minute-by-minute rainfall along user's walking route.

Current result is that system able to combine two kind of information: user location, map, route direction with rainfall prediction data and giving advise to user best time to start their trip. The next development plan is allowing user to stop in the middle of their trip for example convenience store or bus stop.

Keywords: navigation system, short-term predicition, smartphone

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Water vapor monitoring over the ocean using a shipborne GNSS receiver

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Experimental cruises were conducted with a global navigation satellite system (GNSS) antenna installed facing the zenith on the deck of the research vessel to investigate the accuracy of precipitable water vapor (PWV) and benefits of multi-GNSS processing. Also, more than 100 profiles were observed by radiosondes released from the ship during the experiment. Using multi-GNSS signals improved the estimation accuracy of PWV on the vessel. The root means square (rms) and bias of PWV between GPS and radiosonde observations was smaller in the case of multi-GNSS.

Although some microwave satellites observe oceanic water vapor, they are insufficient for in-depth study of air-sea interaction. GNSS-PWV is advantageous because of its high accuracy and temporal resolution, and it would be useful for numerical weather predictions, such as for typhoons or hurricanes.

Keywords: GNSS, precipitable water vapor

MTT05-P03 Room:Convention Hall Time:May 27 18:15-19:30

Characteristics of time and spatial variations of precipitable water vapor observed with a dense GNSS receiver network

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According to the IPCC report, the number of localized torrential rain is projected to increase recently because of global warming, which sometimes gives serious weather hazards to our society. It is requested to establish an early warning system for severe rain events. Although a meteorological radar and surface rain gauge (AMeDAS) can detect rain clouds and precipitation, respectively, they can only detect rain clouds after their formation. We aim at developing an observation system to monitor the behavior of water vapor before it condenses to form a cloud, by employing the GPS meteorology technique.

We estimate PWV (Precipitable Water Vapor) from the radio propagation delay of GPS signals. We deployed a dense GNSS receiver network in Uji for this study using 15 receivers with 1-2 km horizontal spacing. We obtained the GNSS data from April 2011 to March 2013. We also downloaded the surface precipitation data observed at AMeDAS station in Nagaoka-city.

We computed PWV at every observation points, and analyzed time and spatial variations of PWV.We compared these parameters with the AMeDAS data. In order to investigate a relationship between PWV and local torrential rain, we analyzed PWV on 40 days when much precipitation was found in the AMeDAS data. In particular, we selected three cases on August 13, 18 and September 15, 2012. We found both the averaged PWV value and the variance of PWV between GNSS points increased before a passage of a rain cloud which was detected by the meteorological radar. When more precipitation occurred, both the averaged PWV value and the PWV variance increased more rapidly, suggesting their positive correlation.

We analyzed the 40 cases statistically. Then the maximum value of the average PWV and the amount of precipitation show a linier relationship. In addition, we noticed that precipitation occurred when the variance of PWV between observation points was large. Thus, we consider that we have to analyze both the averaged PWV value and the variance of PWV, therefore, the dense GNSS network is useful for forecasting a local heavy rain.

Keywords: GPS, PWV, dense network observation at Uji

MTT05-P04 Room:Convention Hall Time:May 27 18:15-19:30

Estimation of Local-scale PWV Distribution Around Each GNSS Station Using Slant Path Delay -Method and Evaluation-

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A procedure for estimating the precipitable water vapor (PWV) distribution around ground-based stations of the global navigation satellite system (GNSS) on a scale of several kilometers is presented. This procedure utilizes the difference between the zenith total delay above a GNSS station and the zenith mapped slant path delay (SPD). This difference can be used to estimate the PWV gradient in each SPD direction by assuming an exponential distribution for the horizontal water vapor gradient.

The procedure was tested using an estimation of the PWV variation associated with the parent storm of an F3 Fujita scale tornado that occurred in Ibaraki prefecture on May 6, 2012. Differential reflectivity observed by a dual-polarimetric radar indicated the existence of a developed parent cloud approximately 1h before the tornado occurred. A high-resolution numerical weather model simulation suggested the existence of a strong PWV gradient around the parent cloud, made evident by the co-existence of a strong updraft and downdraft within an approximately 5-km radius. The PWV gradient, calculated using the GNSS observation network with an average spacing of approximately 17km, could not detect such a small-scale, strong PWV gradient. The PWV gradient estimated using the proposed procedure revealed a strong PWV gradient and its enhancement. In this case, a higher-order inhomogeneity component of each SPD played a critical role.

To evaluate this new method, we simulated GNSS SPDs using a high-resolution numerical weather prediction model result, emulated GNSS analysis, retrieved PWVs and compared their accuracy against conventional method for a severe tornado case occurred in Japan on May 6 2012.

The comparison results demonstrate the validity of the new method for this case. The conventional procedure introduces a 0.3-0.7 mm root?mean?square-error (RMSE) at the GNSS site location, errors made by simple extrapolation increased with distance and reached 1.5 mm at about 1-3 km. The distance dependency of PWV errors in the new procedure varied with the SPD elevation angle. Using an SPD with an elevation angle of higher than 15 degree, we were able to estimate PWV with about 1.5 mm or better RMSE within a 6-km distance from a GNSS station.

Keywords: GPS/GNSS Meteorology, Mesoscale Meteorology, Satellite Geodesy, Precipitable Water vapor, Slant path delay, Cumulus convection