Smart Construction Monitoring for Disaster Prevention Based on Spatial Information and GNSS/USN/IoT

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Abstract –
The monitoring technique by combination of the measurement method with the fine precision of the sensor collecting the satellite-based information that can determine the displacement space, is available to a variety of diagnostic information. The measurement method by a GNSS with the sensors is being requested. The progress of natural disasters by various environmental factors and the surroundings is occasionally caused. Such attempts are carried out nationally by distributed torsional displacement of the terrain and facilities. The various sensors and instruments track to diagnose this spatial information. Such information contains the precise displacement of the main facilities and the first reference point in the Geospatial or more three-dimensional available map and location information using the installed sensors or the like bridges and tunnels produced by a USN/IoT change at any time. Each sensor installed on the facility is to collect and integrate the precise positioning and environmental factors. In other words, Combining of the various positioning analysis of mm-class for the facility of main area observed is to be required constantly in real time information of the USN/IoT environment sensors and to be able to utilize such information as a precisely fine positioning information for the precisely fine displacement of the semi-permanent main facilities. It's to be one of the efficient information management. In this study, for the installation of the receiving system, relatively easy access is available to the USN/IoT base line positioning for the target bridges. Transmitting hourly from the received data is also executed in real time using the wireless Wi-Fi/Bluetooth bridges and related facilities to automatically process a fine position displacement. The results obtained from a method can be analyzed by real-time monitoring for a large structure or facilities to disaster prevention.

Keywords –
GNSS, USN, IoT, Construction Disaster Monitoring, Spatial Information

1. Background

It is gradually increasing exposure to the risks to the deformation of the structure aging facilities and increasing natural disasters and unpredictable global warming is a quote that greatly increased the demand for diverse emergency management system to prepare for this in advance. Nationwide construction of bridges and dams, very high buildings, factories, etc. into aging of the various structures are those widely distributed it is happening largely a problem of the collapse and demolition level each year and requires a rational management technique to solve them. While such solutions are increased significantly in recent years various disasters dam, reservoir, pre-diagnosis and safe repair for several facilities and maintenance work on the embankment and has been actively conducted. Nationwide 50-year-old reservoir and the situation that primarily carry out maintenance and ground reinforcement for some areas judged dangerous by the structural diagnosis of the levee, or not monitoring for understanding the ongoing changes and the displacement statement of the situation to be done.

Using a variety of test and measurement equipment in order to check the ongoing security situation, the related building facilities in real-time of 24-hour data acquisition in less mm, combined with the USN/IoT environment factors to be sent through the wireless network. As a

result, the obtained data in real-time by diagnosing the conditions of the various irrigation risk reinforcement for the main structure of the facility is expected for repairs and disaster prevention measures and for support to be capable of preventing and prevention of various disasters and accidents in advance. It can be applied to new emergency management techniques demonstrated.

2. Research Contents and Methods

This study sets up a system to select a three-point displacement of the existing bridge. A GNSS goes into the access and acquisition to the target desired. In case of Bangwha Bridge (1000m) in han-river that station is opened in a few years ago, the real-time receiving from the wireless transmission of data is possible for repair of dams and bridges to the related facilities by the fine displacement measurement and analysis process. The obtained GPS data relays information and data transmitted wirelessly about a geospatial information infrastructure irrigation (dams, reservoirs, embankments) the fine-motion and displacement in the 24-hour real-time on those as well most of them will measure the displacement behavior of the corresponding repair facility during a certain period and do not always identified as dangerous situation. In this study, the corresponding facilities receive GNSS satellite signals that can observe the whole region in real time, and the displacement and behavior characteristics of the structure.

Measurement of the occurrence to sudden displacement as well as a fine long-term trends is both enable to the continuous measurement and the web-based service that you can check where you want it. Also, to minimize the measurement error due to weather conditions and poor GNSS environmental factors, you can take the reinforcement work, safety measures, etc. against the preventive measures due to the long-term trend analysis of measurement results and measuring the abrupt behavior of displacement. For example, the pre-set emergency and alert set up are possible.

But the GNSS method has a disadvantage in that it can only track the displacement of a precise base line over a long period of time. Therefore, the measuring method with an accelerometer is still preferred. Recently, with the development of smart sensor technology, a small mote is applicable and is able to be installed in a place where environmental factors such as changes of temperature, humidity, vibration, illuminance, fine dust, carbon monoxide, nitrogen and wind intensity etc. are desired. In other words, while tracking the fine positional displacement due to GNSS, it is possible to simultaneously monitor by the USN / IoT sensors collecting the changes of the related values at the same time and analyzing how the constructed facilities can be displaced and collapsed from external natural factors and disasters (Fig.2).

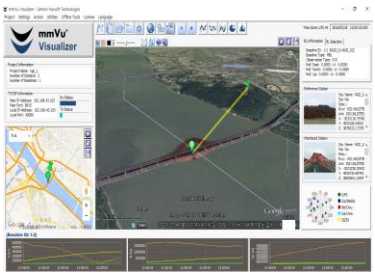


Figure 1. GNSS measurement at the bridge using VRS in Korea

Figure 2. GNSS results after processing

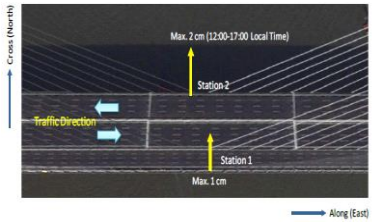


Figure 3. GNSS baseline confirm and 3D axis monitoring

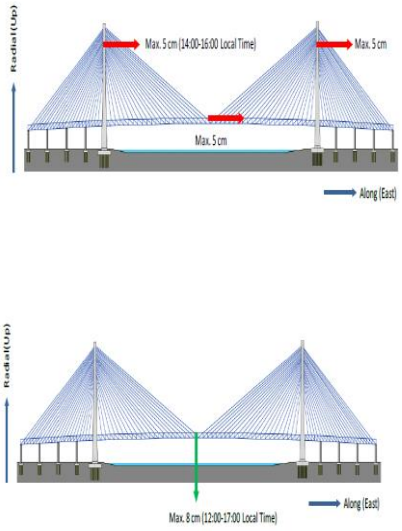


Figure 4. Test diagram at the bridge design sites

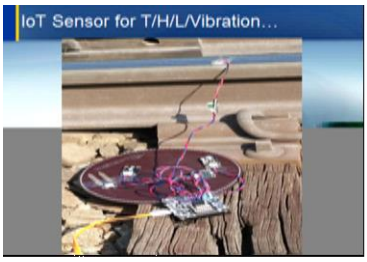
In case of bridges, there may be some variation depending on the measurement day and time. However, in case of the east and the west (X) and the north and the south (Y), traffic volume, traffic direction, wind strength, temperature and humidity, it can be seen that the repetitive displacements are continuing and the repetitive displacements occur in the vertical direction as well (Fig.4).

3. Construction Site Measurement

Type of slopes and the displacement of existing structures to install the GPS device and the receiver on the main point are suspected. The neighborhoods of the ground to install on a safe place for reference stations to the exact point by correcting the position information over the other party are received at various points (Stations) for continuously collecting the position information. The old structure continuously observed at least for three months in a year in order to make a fine displacement. The behavior of bridge structures are treated by tracking the displacement. Thus, in this study the relatively easy access to Cheongpung Bridge of Jecheon to install a GPS subject to the GNSS and the related data is transmitted using the wireless Wi-Fi in real time and the received data to the research laboratories hourly. The results from the corresponding Bridges to process fine positional displacement in real time are monitored and analyzed. The related GPS data is measured by calculating in a manner as to post-treatment such as by incomplete installation of the wireless Wi-Fi. Tracking the vibration changes in this case is tried on a valley river near Jecheon of selecting the iron bridge piers after two years of the demolition plan of Chuo-ku railroad track that run for decades over when there are no traffic of trains and the measurement of vibration by a sensor based on the IoT to diagnose conditions was performed for the test (Fig.6).

USN sensor and IoT sensor board are fabricated to collect the environmental factors such as temperature, humidity, roughness, carbon dioxide and nitrogen in the vibration displacement of railroad bridge over 50 years. The observation points for the real-time measurement are located with a wireless communication router. In addition, the environmental condition of the main facilities such as general roads and railways can be known so that they can be used in a fused manner. However, in the case of the expressway, a survey vehicle is applied for real time checking and the video imaging in the location information with various sensors.

Figure 5. Measurement devices for inspection of road condition on the express way



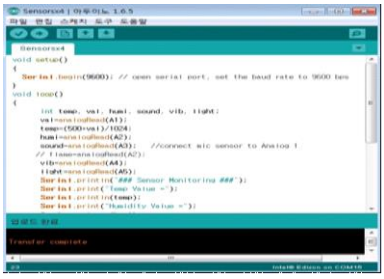


Figure 6. Measurement results from IoT on the railway bridge point

4. Results

Development and application of advanced technology that can monitor the precise displacement and the behavior of the terrain and structures with GPS and GNSS approach is one of a research fields that has a lot of attentions at nations, so its utilization is very extensive national government agencies and the academic practicality to receive much attention from research is a high technology research. Therefore, it provides the proposal studies to the Korea Research Foundation and of the disaster prevention research and support for national projects in this study. In addition, the practical application technology plan, precise safety diagnostics and prevention of observations are expected to be utilized in the corresponding areas that require a multidisciplinary.

As a result of attempting automatic matching of information that can be delivered in real time to environment sensor on the basis of digital information of object internet and remote sensing image, it is found that temperature, humidity, It is possible to integrate practical application technologies by collecting and analyzing the illuminance, carbon dioxide, nitrogen, moisture ratio, noise vibration, etc. simultaneously in real time using the wireless IoT / USN sensors.

In the near future, it is expected to be used in various fields requiring safety diagnosis and disaster prevention of medium to large-sized structures requiring precise displacement observation.

For the construction safety and disaster prevention, it is necessary to monitor the continuous state displacement by the smart sensor in addition to the periodical diagnosis of the construction structure. In recent years, the lifetime of the construction material may be changed due to the increase of environmental pollutants. It would be desirable to use a smart sensor appropriately. As we confirmed by applying in this study, it will be possible and necessary to collect desired data in real time by combining satellite sensors and various environmental sensors rather than past survey tools and methods.

5. References

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