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Application on the New Technology of Construction Structures Disaster Protection Management based on Spatial Information

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Abstract

The disaster monitoring technique by combination of the measurement method and the fine precision of the sensor collecting the satellite-based information that can determine the displacement space is available in a variety of diagnostic information and the GIS/GNSS by first sensor it is being requested from them. Be large and that the facility is operated nationally distributed torsional displacement of the terrain and facilities caused by such natural disasters progress of various environmental factors and the surroundings. To diagnose this spatial information, which contains the various sensors and instruments tracks the precise fine displacement of the main construction structures and the first reference in the Geospatial or more three-dimensional detailed available map and location information using the installed or the like bridges and tunnels produced to a USN/IoT change at any time, by combining the various positioning analysis of mm-class for the facility main area observed is required to constantly in the real time information of the USN/IoT environment sensor, and to utilize this as a precise fine positioning information by UAV/Drone to the precise fine displacement of the semi-permanent infrastructures. It managed to be efficient management by use of new technologies, analyzing the results presented to a method capable of real-time monitoring for a large structure or facility to construction disaster prevention.

Keywords: *Spatial Information, GNSS, USN, IoT, UAV, Drone, Deformation Prevention*

1. Introduction

This study investigates and compares the application of spatial information for disaster prevention management of construction structures and the technology gap between GNSS and USN / IoT by the combination of new technologies. Especially, and to utilize the new technology of information and communication for disaster prevention in traffic facilities. To do this, we conducted research to derive new technologies and techniques that are convergent in various new technologies by linking the applications of national spatial information technology in the field of disaster prevention and the measurement of GNSS of satellite new technology based on location. By constructing digital maps, aerial photographs, satellite images, GPS and GNSS positioning, which are currently held in the laboratory, the old bridges and the underwater

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dam of the Han River, which have already undergone survey research, can be constructed and matched to the basic geospatial information It is time to try various methods to manage the disaster prevention of the structure. In addition, in order to investigate the possibility of disaster prevention using the drones that have recently been attracting attention, and to apply the UAV to the test application, it is possible to reconstruct the terrain spatial information and the position information of the structure by digital image, It is possible to compare and analyze various object information in four dimensions. By constructing the digital map, aerial photograph, satellite image, GPS and GNSS positioning of the existing bridges and underwater dams and reservoirs, and it is possible to come up with feasible measures for the disaster management of the structure. In the case of UAV (Unmanned Aerial Vehicle) application, first of all, the terrestrial information and the position information of the structure are restored to three dimensions through renting. This allows the user to compare and analyze the various disaster information collected in the computer space in four dimensions. Conventional surveying methods are vulnerable to continuous observation such as earthquakes, floods, typhoons and rainy weather, have problems in system maintenance, and have problems in reliability of surveying and sensors. Recently, the observation monitoring system which can use many GPS satellites by GNSS is able to overcome the limitation of existing surveying method by means of absolute coordinate observation, and to observe ground displacement, earthquake, flood, typhoon, I think we can do that. One GPS uses WGS 84 coordinates, which makes it possible to obtain absolute coordinates. It is also possible to evaluate the safety of the structure by observing the relative displacement in the structure through the absolute coordinates. 24 + 3 GPS satellites operated by the US government have no satellite fee, and if you have a GPS antenna and receiving equipment, you can make high-precision positioning anywhere in the world as well as in the world. The use of GPS slope measurement system for landslide prevention, cutting slope, and embankment area is useful for measuring the relative behavior of the ground as well as the relative behavior. In addition, the use of multi-antenna GPS, thermometer, stretching displacement meter, and tilt sensor can complement the disadvantages of relatively expensive GPS measurement. Especially, it is necessary to develop a low-cost and reliable sensor for measuring slope and road slope because it is impossible to obtain sufficient effect when the measurement system is installed, which costs more than tens of millions of won for monitoring landslides in Korea. In the case of artificial structures, fine displacement due to various factors in the internal state and external impact of the structure can be slowed down by the repair and reinforcement steps, and the collapse time point is diagnosed and eventually reached the stage of disassembly. In such a process, it is necessary to be able to provide judgment data that can determine the point of time of optimum repair and reinforcement. The ultra-precise GNSS based on the latest spatial information provides a result of tracking the minute displacement to mm. The purpose of this study is to investigate the feasibility of the new technology development in the disaster management through the comparison of various new technologies and its application experiment.

2. Research Contents and Comparing of Tests

2.1 Experimental study on restoration of construction site by spatial information

We selected Ippo district in Gyeonggi - do, which is currently undergoing the 4 - river river improvement project, and conducted 7 field trip observations together. To construct a three-dimensional construction site, aerial photograph 1: 5000, digital map, and Arirang satellite image were used (Fig.1). In order to confirm the undulation and distribution of the terrain, So that the undulations of the terrain can be confirmed at a glance. (Fig. 2)

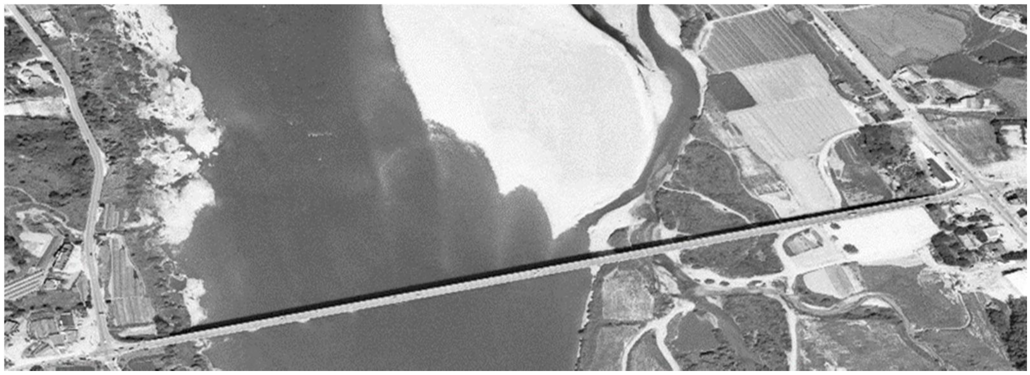

Figure 1. Entire Construction Site Photo

First, the aerial photographs including the bridge structures are ortho-corrected and the files are regenerated with two-dimensional ortho-photographs. After generating the DEM from the contour lines obtained from the digital map, (Fig.3) We used the GTX-1000 Laser Precision Scanner for precise observation of the facility using the 3-D scanner, and carried out precise observations on the new underwater weighing about 150m in the whole construction site of Ipo district . Although the laser measurement can be performed at intervals of 10 centimeters, the 3D image is completed by measuring both sides of the underwater beam at intervals of about 30 cm because the data amount is large and the time is long (Fig.4)

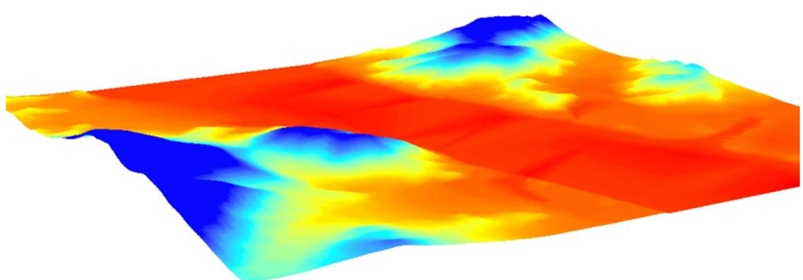

Figure 2. DEM RGB pseudo Image perspective

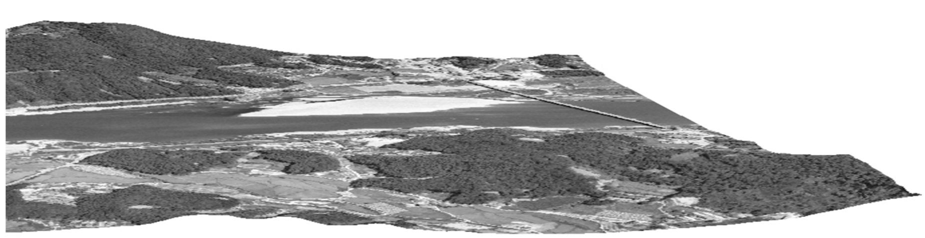

Figure 3. 3-D topographic perspective view of underwater Dam construction area

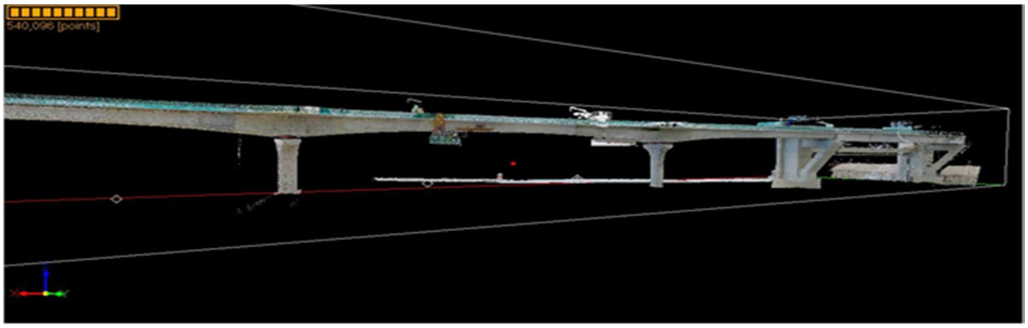

Figure 4. 3D Digital Image of Hangang Submerged Bridge Structure

We selected some sections of the vast construction site to create an environment that allows intensive field surveys and scenarios, and to build a ubiquitous infrastructure so that construction environment surveys can be conducted in areas where structures are being constructed. A sensor node was installed to measure the amount of CO_2 mainly based on the temperature, humidity, illuminance, and infrared state of the site.

2.2 Measurement of USN system for automatic management of construction site environment change

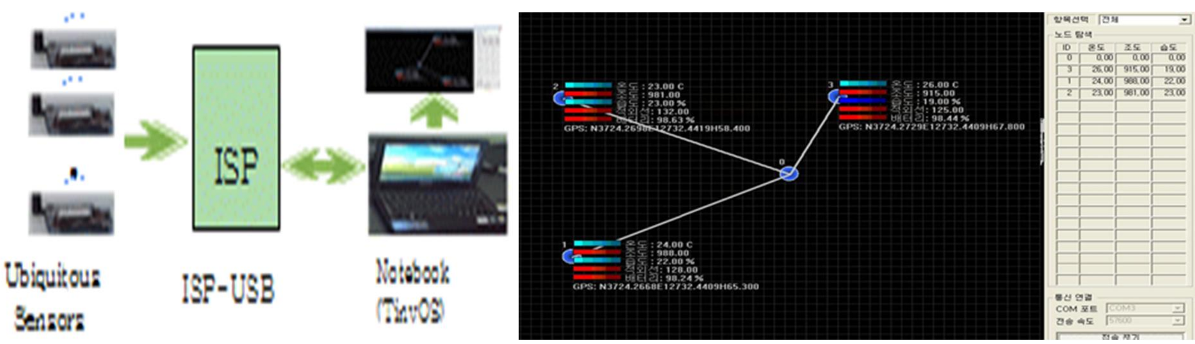

Figure 5. USN system for measurement of construction site environmental data

Today, with the development of high-performance small-sized sensors and wireless communication technology, ubiquitous computing has become possible. USN (Ubiquitous Sensor network) technology which not only smart equipment of the future but also wireless communication can recognize surrounding situation and process necessary information to feed-back to field construction, It is possible to provide necessary information. In this study, we implemented a series of interface methods that can process information by converging USN technology by wireless communication and TinyOS - based LabView programming technology. The transmitted and received data processing results are displayed on a PC running TinyOS based on graphs. The advantage and convenience of a graphics processing based microprocessor system fused with the USN technology for wireless communication is required to identify and change the progress of a construction site. And provides feedback on construction site information. As a result, it is proved to be very useful for precise diagnosis and management of USN and structures in construction site investigation and management

USN (Ubiquitous Sensor Network) environment sensors capable of wireless communication are configured to interface with the notebook or PC of TinyOS-based Windows system through the adapter for program downloader and to process measured data from each node sensor. The measured data shows the output and the change to the image or data of the appropriate unit. Figure 5 shows the configuration of the USN system for environmental data measurement.

2.3 Application of IoT to Diagnose Environmental Factors of Construction Structures

2.3.1 IoT measurement results on river bridges for repair and disaster prevention

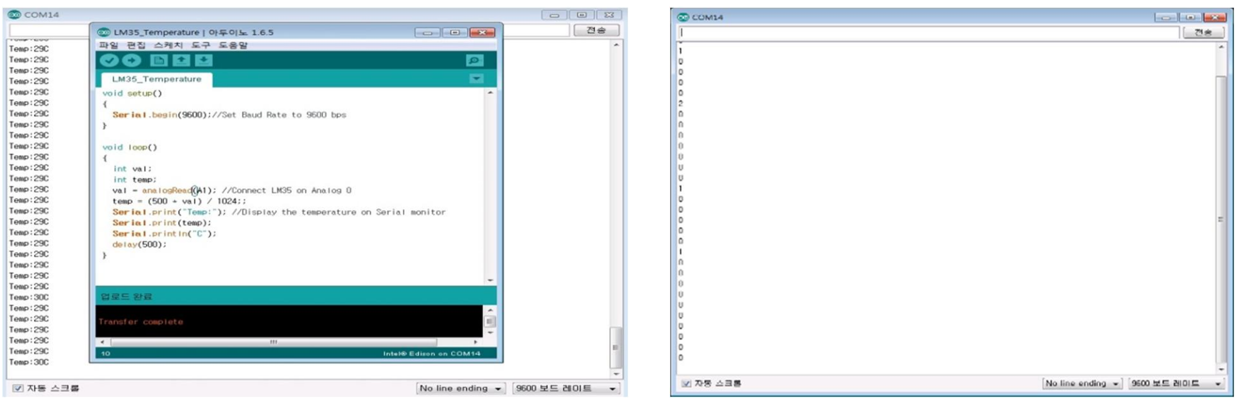

Figure 6. IoT measurement results for disaster prevention at Cheongpung old bridge

Two sites were selected on Cheongpung Civet which were installed in Cheongpungho water for more than 30 years and vibration conditions were measured and compared. In order to achieve this, we developed an object program that can operate by combining IoT various environmental sensors made for testing like the photographs at similar points measured in the USN method in the past so that the measurement data can be collected easily in the field. Since it is a wired system compared to the USN system, artificial intervention is inevitable at present, but it is expected to be gradually improved and replaced with a wireless communication system. Since the sightseeing cruise ship runs under the Cheongpung Bridge, the IoT-based sensor was installed to monitor the vibration changes during normal and cruise ships and to diagnose the vibration condition on the IoT. The result is as follows

2.3.2. IoT measurement results in old railway bridge for the prevention of valley river bridge

To confirm the condition of the old railway facilities passing through the scenic site of Jecheon, the Chuncheon railway, which has been constructed in the valley stream for more than 50 years, is pushed by the double track railway that is being constructed and selects the bridge pier of the railway track to be demolished next year IoT - based sensors were installed to track the vibration changes when there was no traffic and when the train was passing and to diagnose the vibration condition.

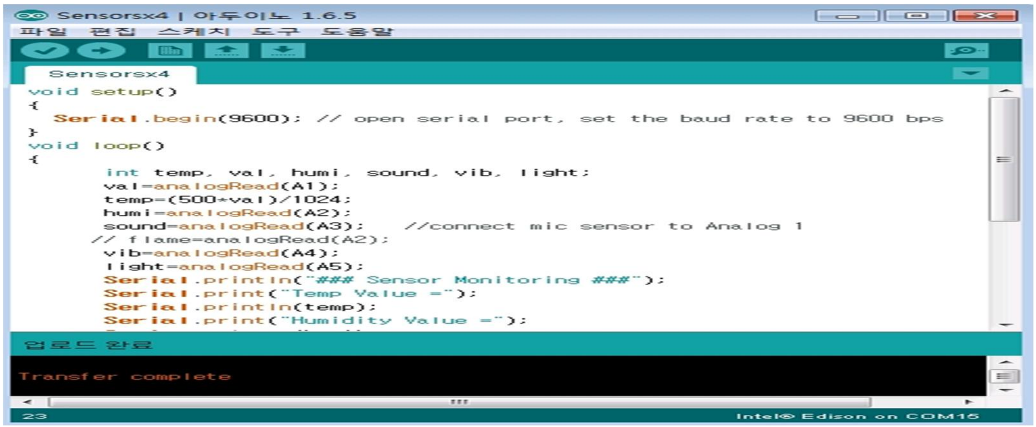

Figure 7. Screen Design Program for surveying on the old railway's bridge condition

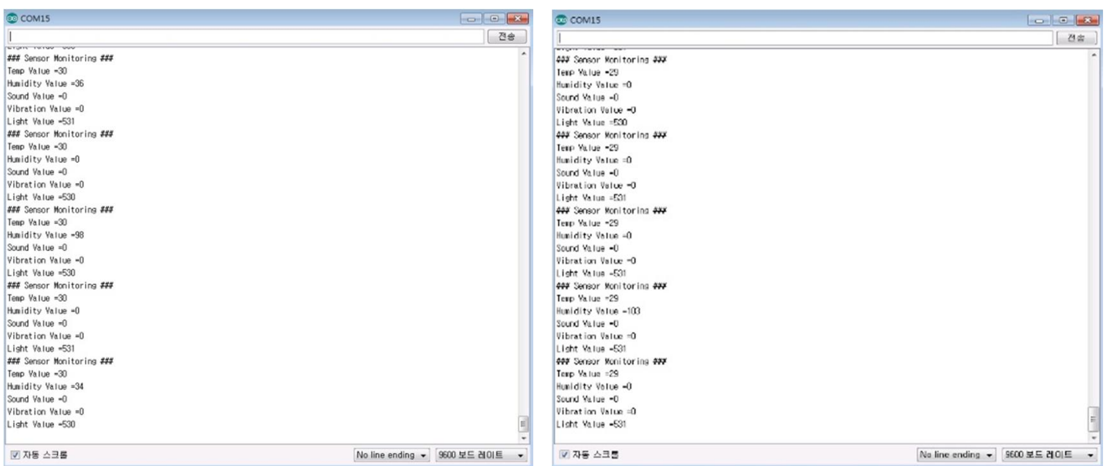

Figure 8. IoT sensor measurements on railway bridges (temperature / illumination / humidity detection)

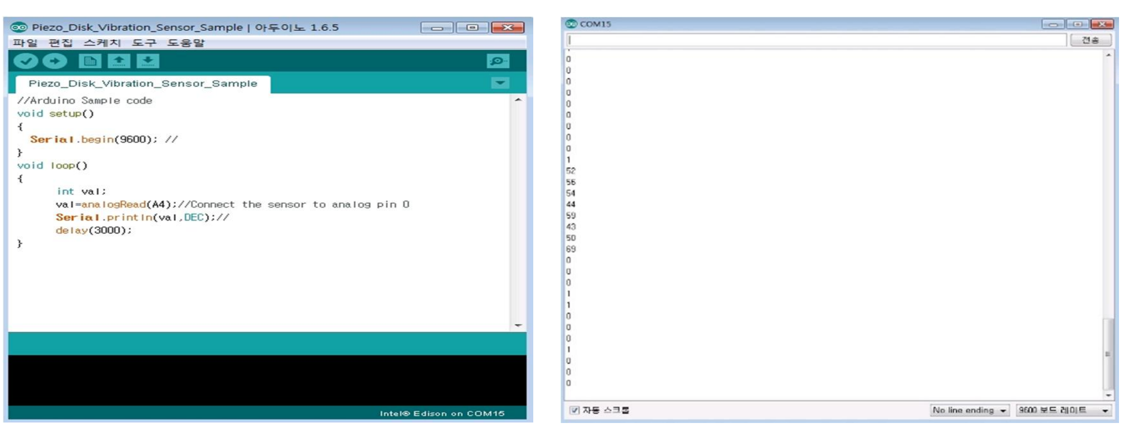

Figure 9. IoT sensor vibration measurements on railway bridges ((Vibration (43 ~ 69))

2.4 GNSS application tests to diagnose the fine deformation of construction structure

It is possible to monitor the behaviors of the structure anywhere in the world through the system built on the internet based on the measurement and maintenance measurement during the construction of the structure, and it is always possible to observe the deformation of the structure by GPS. It can be supplemented. The three-dimensional behavior of the facility can be obtained with an error of less than 1cm in absolute coordinates, so that it is possible to accurately measure the three-dimensional displacement with time including the lateral displacement of the slope ground which was difficult to measure in the past. In the displacement measurement for disaster prevention by GNSS, the baseline displacement of the fire bridges over the Han River can be traced to the sub-millimeter units in each east-west, north-north, and bottom-high direction, can be monitored up to mm units or less.

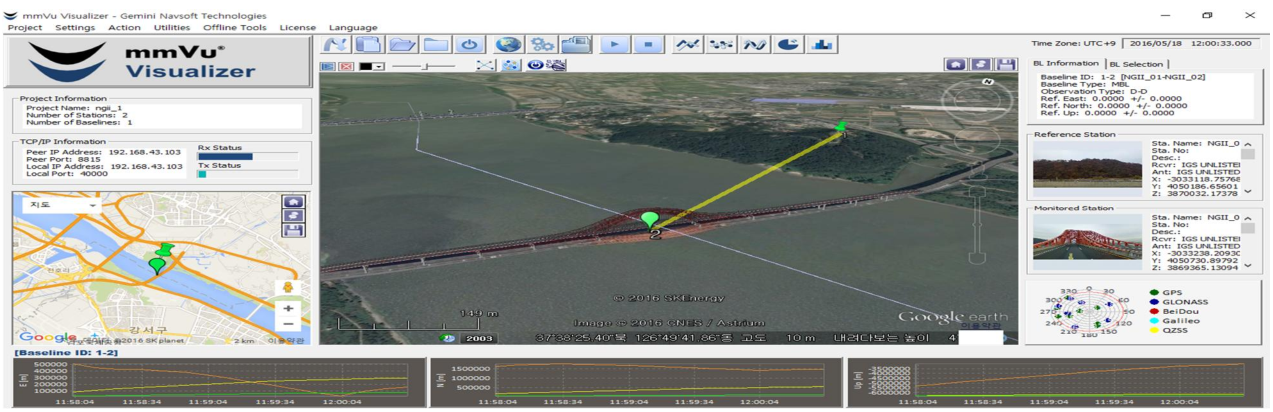

Figure 10. Experimental results of GNSS observation on the Hangang Bridge (May 2016)

In case of Bangwha Grand Bridge, it is a relatively recently constructed Han River Grand Bridge, so it shows very fine displacement and it is confirmed that the displacement is repeatedly progressing at the instant moment. It can be confirmed that the displacement between the minimum point of 0.4 mm and the maximum point of 0.12 mm is tracked in the X direction (E) of the first and second baseline by connecting the midpoint of the fire bridges and the known points with the VRS method and real- (N) to track displacements between 0.1mm and 0.6mm and track displacement from 0.1mm to 0.5mm in Z direction (up & down).

2.5 Experiment on Application of Safety Management on Construction Site by Unmanned Near-Field Remote UAV

The creation of the spatial information required for disaster prevention can use the publicly available data. According to the need of spatial information of high resolution, it is possible to acquire the latest accurate information by using remote sensing satellite image, aerial photograph and UAV, and regenerate it as numerical information. In the case of a narrow area, since the spatial information can be constructed on the construction site on the fly by using a drone or the like, the demand thereof is gradually increasing. In this study, spatial information was collected and regenerated to utilize the construction site as an accurate digital image map by the photogrammetry technique using the UAV method. It is possible to fly at any time at the construction site, to collect spatial information easily, and to have a merit that the image information can be grasped relatively and precisely by simple image matching.

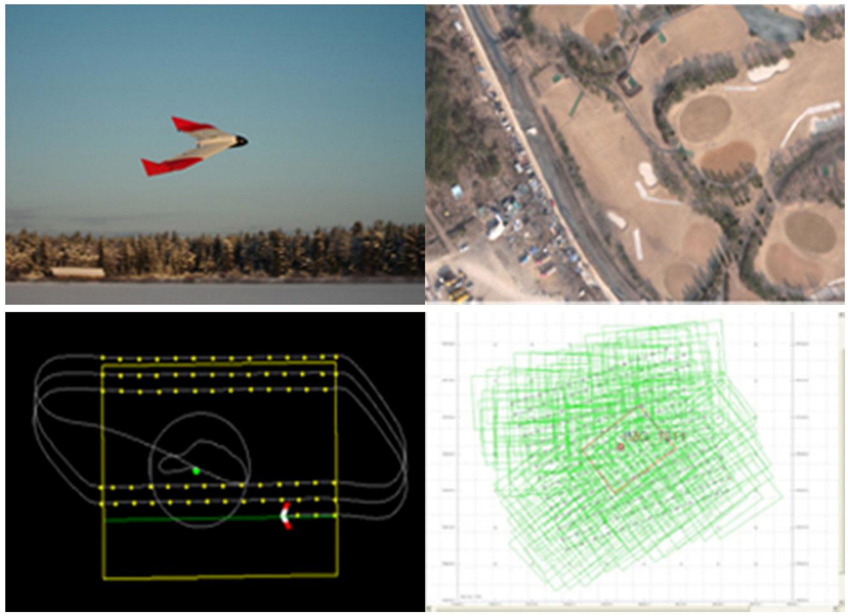

Figure 11. Collection and processing of spatial information by UAV / Drone

3. Analysis and Conclusion

Some years ago, it is more difficult to measure the safety of multi-faceted facilities based on possible spatial information, rather than merely measuring at the time of accident, frequent railway accidents, and old nuclear structure safety problems. It is time to look for a disaster prevention that can prevent large-scale accident by a practical method by observation. Therefore, this study also transforms the construction site of large disaster prevention into digital spatial information, and collects near-real-time information by Ubiquitous and Object Internet, Unmanned Aerial Vehicle (UAV) and Drone We have applied the USN / IoT / UAV which can be used for disaster prevention as a new technology of safety diagnosis of construction structures and emergency disaster prevention in the best way. Therefore, the following conclusions were drawn through this study

(1) Integration of GNSS and USN / IoT at any time, each wireless sensor installed in a construction structure can collect and integrate accurate location measurements and environmental factors. We have confirmed that monitoring and monitoring less than mm of the surveillance area of the continuously observed structures need to apply accurate and precise positional information to real time information of USN / IoT environmental sensor continuously by combining class location analysis is very effective for the safety diagnosis of construction structures and disaster prevention management rather than the collection and utilization of spatial information for a wide range of cities and regions by satellite .

(2) Preliminary safety diagnosis of major large-scale construction structures requiring observation of micro-displacement of GNSS by spatial information and GPS combination, and real-time tracking by internet environment or wireless communication for proactive monitoring of disaster-prone target areas And it is expected to be used in various fields in fields requiring disaster due to other natural disasters and external impacts.

(3) The integrated application of GNSS / USN / IOT / UAV / Drone is very effective for the safety diagnosis

of construction structures and disaster prevention management rather than the collection and utilization of spatial information for a wide range of cities and regions by satellite .

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