

Coastal topographic change analysis using quadrupedal robots and image processing

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INTRODUCTION

As centers of human habitation, biological habitat, economic activity, and recreational amenities, the shoreline and its surrounding areas play an important role as a buffer separating high waves and sea levels from coastal areas. Coasts, which are very important for human activities, are subject to fluctuations due to coastal currents and high waves. In addition, in the long term, shoreline changes may occur due to factors such as relative sea level rise, climate change, and development around the coast. Therefore, coastal management is a very important field of social interest not only in terms of human living space but also in terms of environmental conservation. The first step in coastal management is to accurately identify the continuously changing coast and accumulate that data. Coasts, as determined by beach width, beach area and volume, are continuously transitioning from in-situ measurements to remote sensing due to technological advances in surveying equipment and analysis methods. The impetus for remote sensing of coastlines began with the development of optical coastal imaging technologies such as Argus and related systems since the 1980s. In order to manage coastal areas where active changes are occurring, continuous monitoring of changes in coastal topography is necessary. However, coastal areas have heterogeneous and highly variable land surfaces, and there are many restrictions on access. A variety of methods are used to study coastal topographic changes, most used are satellite image analysis, aerial photo analysis, RTK GNSS surveying, and LIDAR surveying. Surveys using ground-based LIDAR have limitations such as time-consuming, accessibility, and equipment installation depending on the study area. In addition, aerial lidar was developed for large-scale surveying, and the costs required for surveying are enormous. In this study, quadrupedal robots and image processing were attempted to efficiently observe a wide coast with rapidly changing topography.

STUDY AREA

The study area was selected as Gangneung, located on the east coast of Korea. The study area is a representative tourist destination on the east coast and is known to be a place where coastal erosion occurs frequently due to high waves and coastal development.

METHOD

The main components of the quadrupedal robots and image processing system consist of three main equipment and software. Among the three devices, the laser scanning part is the Velodyne VLP16, the motion sensor (inertial measurement unit) IMU (Inertial Measurement Unit), and Unitree's quadrupedal robots. Lidar is a scanning-type 3D coordinate observation device that breaks away from the one-point reference method of the existing total station and scans countless laser beams at close intervals on the surface of the object to be observed

to obtain the 3D coordinate values (x, y) of the object. , z) It is an advanced laser surveying equipment that intuitively acquires the shape of an object using point data and the reflection intensity of the laser beam reflected from the target. IMU is an electronic device that measures the speed, direction, and gravity of a moving object, and measures movement in three axes: pitch, roll, and yaw. The quadrupedal robots, which are equipped with Lidar and can move along the coastline, are equipped with 4D lidar that can avoid obstacles and can adjust wide angles up to 360 degrees horizontally and 90 degrees vertically, minimizing blind spots.

REDULTS

The least squares method was used to check the standard deviation of the data from the ground-type Lidar and robot, and 1,000 corresponding comparative values were obtained and analyzed. The sum of the squares of the residual (distance between observed corresponding vertex objects) was minimized by adjusting and calculating the analyzed plane parameters and standard deviation and the orientation value of the scanner device. Through this system, effective precise survey monitoring can be carried out on coasts with severe erosion damage in the future, and if changes are identified based on more accurate topographic survey results and data, it will contribute to coastal management, thereby contributing to effective fish farming, safe marine leisure activities, and coastal management. It is believed that it can contribute to the creation of a beautiful and comfortable coastal space, including development management.

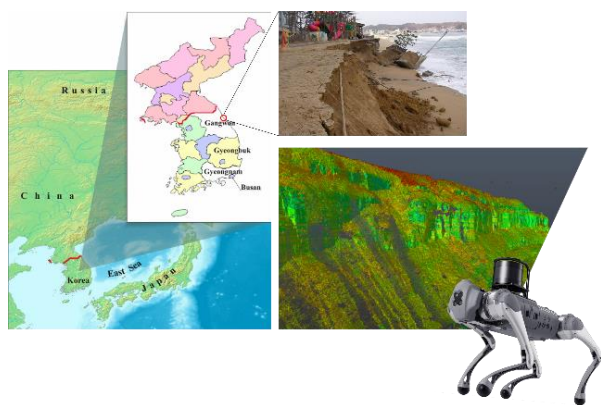


Figure 1 -The Study Area and quadrupedal robots

REFERENCES

Kaminsky, G.M., Baron, H.M., Hacking, A., McCandless, D. and Parks, D.S. (2015) Mapping and Monitoring Bluff Erosion with Boat-based LIDAR and the Development of a Sediment Budget and Erosion Model for the Elwha and Dungeness Littoral Cells, Clallam County, Washington. Washington State Department of Ecology, Coastal Monitoring & Analysis Program, Washington, 44p.