

Research on the Intertidal Zone Using Drone

Choi Dongwon (Researcher, National Research Institute of Maritime Cultural Heritage)

ABSTRACT

Surrounded by the sea on three sides, Korea is in a location of active maritime exchanges throughout history. Before the development of shipbuilding and navigation, people sometimes chose to navigate while visually observing surrounding land. However, the natural environment of the Southwest Sea, where tidal flats are exposed, is likely to have occurred. It may be wrecked by a reef, or the old ship may have been abandoned. The National Research Institute of Maritime Cultural Heritage (NRIMCH) has conducted seven surveys in the intertidal zone, which helped to establish a systematic investigation method. Our previous investigations involved manpower surveys. We sought a method for systematic and efficient investigation. Drones identify anomalies exposed in natural environments such as intertidal zones. However, we questioned the usefulness of drones in underwater archeology. Drones produced orthophotos. Our results present a new method of intertidal zone survey.

Keywords: intertidal zone, drone, survey

List of Tables and Figures

Table 1 Current status of intertidal survey

Figure 1 Flow chart of orthoimage production

Figure 2 Metashape program

INTRODUCTION

In Korea, mainly the southwest coast and especially the west sea, the intertidal zones have large tidal differences and the coastline is complicated.¹

In the intertidal zone, there is a natural environment that is blocked from the outside and oxygen, as clay sediments are distributed and have high cohesiveness. Unexposed/buried cultural resources are well preserved, but exposed ancient ships and artifacts are found damaged. Twenty-seven reported sites are located in intertidal zone. Seven of these have undergone archaeological excavation.

Table 1. Current status of intertidal archaeological excavations

No.	Year	Site	Recovered artifacts
1	1991-1992	Jindo Byeokpa-ri dugout	One Chinese dugout from the thirteenth to fourteenth centuries
2	1995	Dalido shipwreck in Mokpo	One Goryeo ship from the thirteenth to fourteenth centuries
3	2004-2005	Wonsan Island in Boryeong	179 items : early thirteenth century celadon incense burner
4	2005	Sinan Anjwa shipwreck	One Goryeo shipwreck from the fourteenth century, four items including Goryeo inlaid celadon
5	2006	Daebudo no. 1 shipwreck in Ansan	Pieces of a hull of Goryeo from the twelfth to thirteenth Century
6	2015	Daebudo no. 2 shipwreck in Ansan	One Goryeo shipwreck from the twelfth to thirteenth centuries, 48 items including Goryeo celadon
7	2020-2022	intertidal zone in Yangjam-ri, Taean	Six items including antefix and decoration of the part of a sword from Joseon era

¹ The area of tidal flats in Korea is 2,482 km², accounting for about 2.5 percent of the total land area. Among them, more than 80 percent of the total intertidal zone is distributed in the west coast, about 42.5 percent in Jeollanam-do, about 36.1 percent in Incheon and Gyeonggi-do, and about 36.1 percent in Chungcheongnam-do. About 13.7 per cent in Korea, and about 4.4 per cent in Jeollabuk-do (Marine Environment Information Portal 2003 <http://meis.go.kr/portal/main.do>).

The survey conducted in the intertidal zone has established a system to some extent. However, the research method for identifying the presence or absence of cultural properties before the investigation has not progressed significantly. The method was to directly enter the tidal flat and observe with the naked eye. However, since there are tidal channels in the tidal flats and the quality of the sediment is soft, the method can be inefficient as it is dangerous and it consumes a lot of time and manpower.

For an efficient investigation in an exposed state, a method using drones will be studied. A drone, also called an unmanned aerial vehicle (UAV), is an aircraft without a human on board. Drones are used in various areas because they are cheaper and more efficient than satellites or aircraft. In the marine sector, it is used for monitoring marine national parks and tidal flat farms. In the field of cultural properties, it has already been used to take aerial photographs of inaccessible places or survey sites at terrestrial archaeological sites. The use of drones in underwater archeology was not great because the drones could not identify invisible abnormalities at sea and were only used to take photos of the panoramic view of the investigation site. However, it is possible to use drones to investigate terrain at low tide, such as the intertidal zone. I will review the suitability of the intertidal zone investigation using drones, and present a new survey method through the investigation contents and results.

Aircraft and camera

The NRMCH has three Splash drones 3+, a waterproof drone and two Mavic Air2s, which can take off and land with human hands without a landing field. However, it has been used only to confirm the foreground or field conditions of the investigation site. The drones possessed by the institute are not suitable as aircraft for producing orthographic images of intertidal zone investigation². This is because there are various natural and physical conditions to be considered for aerial photography. First of all, drones need to be able to withstand weather conditions. Most drones have an excellent hovering function³, but an aircraft that can withstand strong winds is needed, because it is unknown what variables will occur in the weather on the coast. When taking photographs, it is important to have a camera capable of distinguishing artifacts among features such as stones and shells exposed in the intertidal zone⁴. When combining photos, there is a need to figure out where they were taken. The drone must be equipped with an RTK sensor that can identify the location. As a result of examining these necessary factors, DJI's Matrice300 RTK was selected as the aircraft to be used for the intertidal zone investigation, and Zenmuse P1 was used as the camera.

Table 2. Aircraft and camera specifications

Matrice300 RTK		
Size (mm)	810 x 670 x 430	
Weight (kg)	6.3	
RTK Accuracy	Horizontal 1cm + 1ppm	
	Vertical 1.5cm + 1ppm	
Maximum flight time	55 minutes	
Maximum speed	17 m/s	
ZENMUSE P1		
Size (mm)	198 x 166 x 129	
Weight (kg)	0.8	
Absolute accuracy	Horizontal 3 cm	

² Orthophotograph: An image obtained by correcting geometrical distortion due to topographical relief such as height difference or inclination for image information such as aerial photographs or artificial satellites, and transforming the appearance of all objects when looking down vertically.

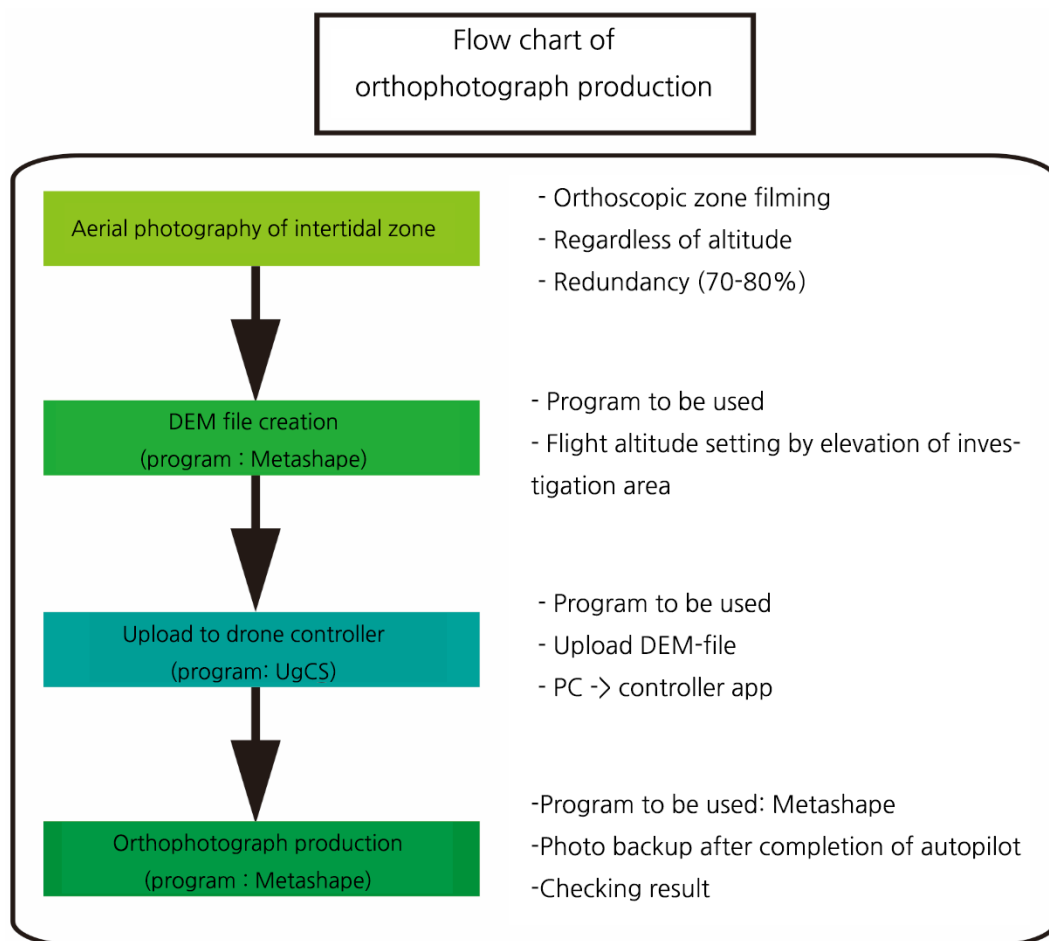
³ Hovering: A state in which an aircraft remains stationary while maintaining a constant altitude.

⁴ Images taken by UAV are largely subject to image distortion due to two influences. First, when operating an unmanned aerial vehicle at a constant altitude, external facial expression distortion occurs due to shaking and tilting of the aircraft due to the influence of wind. Second, image internal facial expression distortion occurs due to the characteristics of the camera and lens mounted on the unmanned aerial vehicle (Kim et al 2015, 461-471).

	Vertical 5 cm	
Sensor (still image, mm)	35.9 x 24	
Pixel	45,000,000 pixel	
Photo Interval (sec)	0.7s	

Investigation plan and contents

In the following year, 2022, three intertidal zones were selected for orthographic imaging. This is the intertidal zone located in Sinsi-do in Gunsan, Naesan-ri and Byeokpa Port in Jin-do. Since the intertidal zone in Shinsi-do, Gunsan is large of 520,000 km² and the shape is irregular rather than square, the shooting area was divided into three areas.



It is a large reef exposed even at high tide, which could interfere with drone flight. Therefore, aerial photography was conducted in advance regardless of altitude. Afterwards, after uploading the photos to the drone control program (UgCS), the flight plan was entered so that the drone could automatically take photos. This program plays the role of a mission planner and was used because there were variables that were confirmed during the intertidal filming of Sinsi-do. As there is a reef more than 15 m in the intertidal zone of Shinsi-do, when the existing flight program is used, the drone detected the reef as an obstacle and stopped filming without proceeding. Through the UgCS program, a digital elevation model (DEM) was made to recognize precise altitude changes, and the flight was planned after applying it to the program. The flight time considered the ebb tide, and all the investigated areas were photographed for three consecutive days to prevent errors in the results due to changes in the topography. The intertidal

GCP (Ground Control Point) because it is merged based on coordinates when producing orthophotographs.⁵

The automatic flight using a program with a mission planner function was conducted, and the results of the orthophotograph was checked. We collected the following results from our drone survey: 1) we can identify exposed artifacts with orthophotograph at 15 m. 2) artifact coordinates are possible; 3) minimize manpower and fieldwork hours; and 4) intertidal data can also be collected with orthophotography.

However, there are also evident challenges and limitations to be addressed. First of all, the orthoimage merging time is proportional to the intertidal zone investigation area. There is a need to think about how to store the data, as the size of the file increases in proportion to the time. And if there is a terrain feature caught in the middle of a flight at a certain altitude, there must be the process of creating a digital elevation model after aerial photography at a high altitude. Results are still early, with a lot of trial and error because the method option is new. In future, various data will be accumulated through more intertidal investigations which will produce more systematic and accurate research.

Acknowledgements

The investigation of the intertidal zone was carried out as the beginning of the underwater excavation. The investigation of buried cultural properties identified in the intertidal zone can be said to have been systematic with a lot of research experience. However, as for the investigation method before the buried cultural properties are identified, no new method other than the direct investigation by a person was suggested. The investigation method using drones was first proposed in 2021, and the research contents and results are still insufficient. There is a need to organize the direction of the intertidal zone investigation through drones, detailed survey methods, and limitations in the future.

Bibliography

Heo, Ui-Haeng. Lee, Wal-Yeong. A Study on the utilization of drones and aerial photographs for searching ruins with a focus on topographic analysis, *Korean Journal of Cultural Heritage Studies* 51, no. 2 (2018): 22-37 (In Korean).

Kim, Bum-Jun. Lee, Yoon-Hyunh. Choi, Jong-Kuk. "Investigating Applicability of Unmanned Aerial Vehicle to the Tidal Flat Zone" *Korean Journal of Remote Sensing* 31, no. 5 (2015): 461-471 (In Korean).

Lee, Jae-Bin. "Current status and future direction of marine surveying and GIS using drones" *The Korean Institute of Broadcast and Media Engineers* 22, no. 2 (2017): 53-66 (In Korean).

Oh, Jae-hong. Kim, Duk-Jin Lee, Hyo-Seong. "Use of Drone for Mapping and Time Series Image Acquisition of Tidal Zones" *Journal of Korean Institute of Intelligent Systems* 27, no. 2 (2017): 119-125 (In Korean)

Shim, Jae-Yeon. Chung, Jae-Young. "RTK-GPS Systems for Autonomous Drone", *The Proceedings of Autum Conference of Korean Society of Mechanical Engineers on Fusion IT*, 2018: 128-129 (In Korean)

NRIMCH. *Underwater Archaeology in Korea*, Mokpo: NRIMCH, 2016 (In Korean).

⁵GCP (Ground Control Point) refers to a triangular point that marks the location by surveying. As a photo merging factor, it helps to make the merge work well. In some situations the ground control point appears in the photo result.