

Applications of Satellite Imagery to Surveying Archeological Sites and Remains

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요 약

선조의 유골 매장지와 함께 고구려 왕조(37BC~771AD)의 산성과 이조 왕조(1392~1910AD) 때의 봉화대와 같이 중국 동북부 지역 만주와 한반도에 산재한 유적지들의 소재지들을 확인하기 위해 위성영상을 적용했다. 이러한 유적지에 관한 정보는 여러 문헌들에서 접하게 되지만 이들 문화재의 실체들은 최근의 지역 개발 프로그램들에 의해 점차 사라지고 있는 실정이다. 이번엔 답사하면서 측정한 위성위치정보(GPS) 자료를 사용하여 위성영상에서 일부 역사 유적지들의 위치를 확인해 보았다. 이들의 상세한 위치 정보는 좀 더 확인이 필요할 것으로 판단된다.

키워드 : 위성원격탐사, 봉화, 산성, Ground Penetrating Radar

ABSTRACT

Satellite imagery was applied to locating archeological sites and remains around northeastern areas of China, called as Manchuria, and Korean peninsular, such as Mountain Fortress of Goguryeo Dynasty era(37BC~771AD), and firing torch and smoke beacon signal sites at mountain tops in Josun Dynasty era(1392~1910AD) as well as burial sites below the ground level in the modern era. Information on archeological sites, fire posts and burial places could be found in various literatures, but real figures of such cultural assets have been disappearing due to land development programs and human activities in recent years. Some of these historical sites were identified in satellite images using GPS(Geographical Positioning System). Real locations of these sites would be further necessary to be verified.

Key Words : Satellite remote sensing, smoke beacon signal site, mountain fortress, Ground Penetrating Radar

I. Introduction

Various archeological sites, such as historical Mountain Fortresses, firing torches and smoke beacon signal sites, can be found in Korean Peninsula and Manchuria, northeastern China. These sites were described in many references[1, 2,3]. Recently, some of smoke beacon signal sites(see Figure 1) at mountain tops in Josun Dynasty era(1392~1910AD) had been surveyed and locations of 627 sites were verified in the literature[1].

Locations of surveyed sites were identified in Google maps. 'Google Maps' is a free web mapping service application and technology provided by Google [6]. Google Maps provides high-resolution satellite images for most urban areas in the world. Most images shown in Google Maps' satellite mode are at least a year old and in some places date back to 2001. Google has,

however, blurred some areas for security because of complains from various governments (mostly in the United States). The GIS(Geographic Information System) data used in Google Maps are provided by Tele Atlas and NAVITEQ, while the small patches of high-resolution satellite imagery are largely provided by Digital Globe and its QuickBird satellite, with some imagery also from government sources.



수원봉수대

Figure 1. Picture of a smoke beacon signal site [1]

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2. Analysis of Archeological Sites

The smoke beacon signal sites were used to inform the status of invading enemy soldiers to the base command post in forms of 5 steps using smoke. Locations of smoke beacon signal sites in Josun Dynasty era were mapped in Daedongyeo-jido as shown in Figure 2 [1]. Some of these locations around the northeastern border of North Korea had been shown in Figure 3 of Google Map[5]. Their latitudes and longitudes are listed in Table 1.



대동여지도 병축상

Figure 2. Daedongyeo-jido[1]

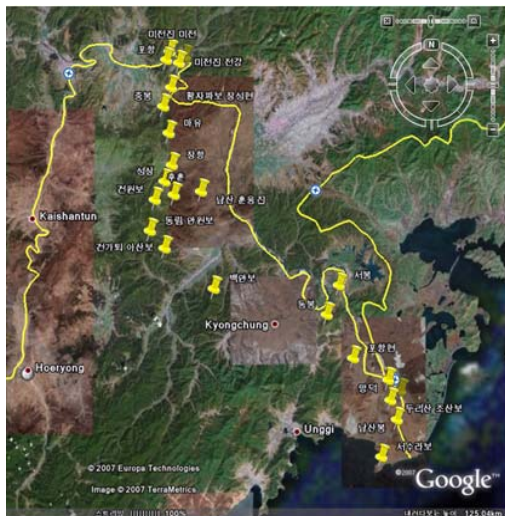


Figure 3. Locations of some smoke beacon signal sites shown in a Google satellite map [1]

We toured some sites of Goguryeo's Mountain Fortresses and historical features scattered over

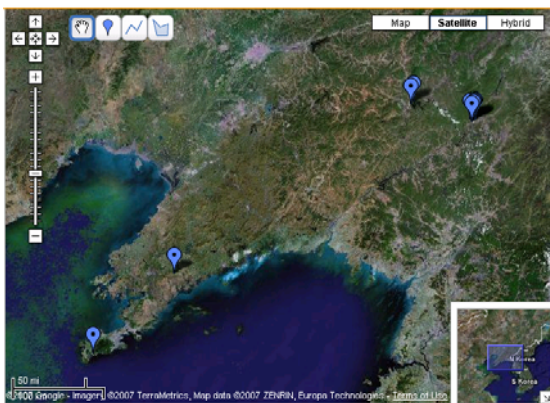
Manchuria, northeastern China, measuring their locations by GPS (Global Positioning System). Observed locations are listed in Table 2. These locations were identified using the Internet Google mapping system [http://maps.google.com] as shown in Figure 4.

Table 1. The list of smoke beacon signal sites around the northeastern border of North Korea [1]

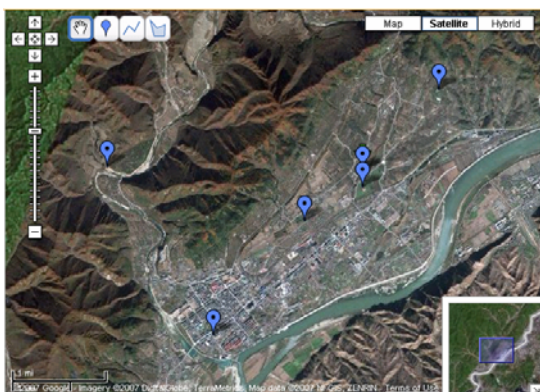
Site name		Latitude and longitude	
Gyungheung	Mangdug	42°244.08'N	130°3652.64'E
"	Pchanghyun	42°2622.58'N	130°3145.19'E
"	Seabong	42°3359.00'N	130°2946.06'E
"	Dangbong	42°3055.84'N	130°2757.69'E
Gyunwan	Baekarbo	42°3343.52'N	130°1133.97'E
"	GungalweAsarbo	42°3755.07'N	130°425.56'E
"	GunwanboSoajeong	42°4257.03'N	130°3202'E
"	DonginAnwanbo	42°4027.93'N	130°331.74'E
"	NamsanHooryongin	42°4655.37'N	130°925.63'E
"	Hochoon	42°4330.08'N	130°544.61'E
"	Sungsang	42°4437.89'N	130°513.00'E
"	Janghang	42°476.22'N	130°551.49'E
"	Mayoo	42°4927.41'N	130°523.99'E
"	Joangbong	42°5328.49'N	130°427.67'E
Onseong	Hwangjapabo.Jangseonghyun	42°5328.49'N	130°427.67'E
"	MjeonjinJeongang	42°575.13'N	130°559.83'E
"	MjeonjinSongbong	42°5747.66'N	130°710.22'E
"	MjeonjinMjeon	42°5837.69'N	130°543.68'E
"	Pohang	42°5732.00'N	130°434.81'E

Table 2. GPS observations of historical features over Manchuria

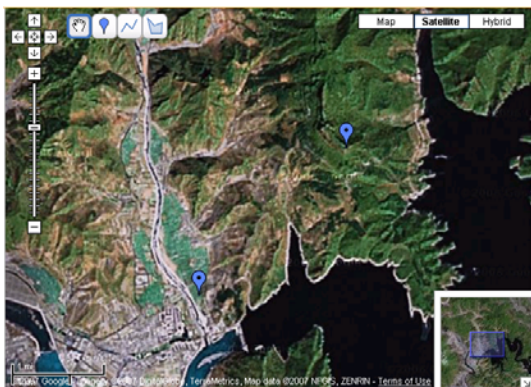
	Feature	Latitude	Longitude
1	Monument of Great King Gwangyeto	+41° 8' 41.28"	+126° 12' 37.44"
2	Grave of Great King Gwanggyeto	+41° 8' 32.64"	+126° 12' 37.44"
3	Grave of King Jangsoo	+41° 9' 27.36"	+126° 13' 34.68"
4	Ohomyo	+41° 8' 13.38"	+126° 11' 54.24"
5	Remains of South Gate of Hwando Mt Fortress	+41° 8' 44.16"	+126° 9' 27.36"
6	Entrance to Janggoonchong	+41° 7' 9.12"	+126° 10' 46.20"
7	Parking lot of Onyeo(Jolbon) Mt Fortress	+41° 17' 44.09"	+125° 23' 13.49"
8	Top observation point of Onyeo(Jolbon) Mt Fortress	+41° 19' 8.40"	+125° 25' 5.52"
9	Entrance to Wipae Mt Fortress	+39° 37' 9.01"	+122° 18' 57.60"
10	Entrance to Old Japanese Lushun Jail	+38° 49' 26.04"	+121° 15' 32.40"



(a)



(b)



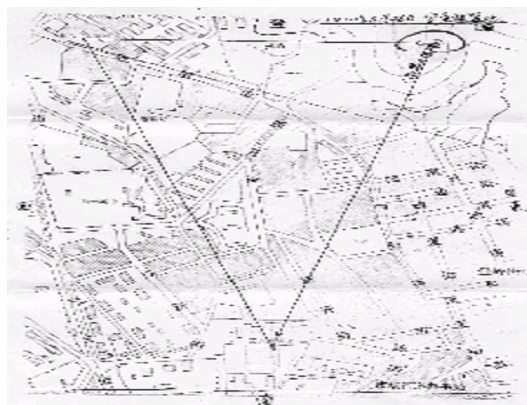
(c)

Figure 4. Google satellite maps showing surveyed sites of some Gogureyo Mountain Fortresses and historical features

There have been various reports [2] on the location about the burial site of General Ahn Joonggeun, patriotic martyr, as shown in Figures 5 and 6. These figures indicate that the burial site would be the right corner of this triangle consisted of 'Jail (left corner)', 'High Court (lower corner)' and 'Public Grave Yard (right corner)'. The distance between 'Jail' and 'Public Grave Yard' was estimated to be about 500m.



(a)



(b)

Figure 5. A suggested burial site of General Ahn shown in the right scormer of the dotted triangle



Figure 6. Same positions shown in a Google's satellite map.



Figure 8. A surveyor pulling a GPR system to generate underground soundings [2]

3. Survey by Ground Penetrating Radar

Electromagnetic waves penetrate more or less material. Especially, microwaves ranging wavelengths over 30cm, that is, less than 10^9 Hertz(Hz) of frequency, usually penetrate earth ground deeper than 1 meter. Ground Penetrating Radar (GPR) using frequency ranges of 100 M(10^6) Hz ~ several GHz have been used to survey objects under the ground . Figure 7 is a working scheme of Zond12c of Radar Systems, Inc. [7] Radar signals reflected from the ground may generate a depth profile along the distance moved and form a cross-section to be used for analyzing underground objects.

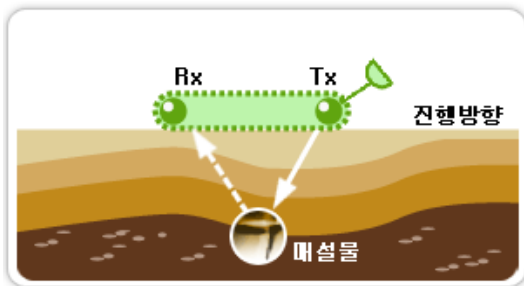


Figure 7. A working scheme of a GPR [2]

However, applications of portable GPR instruments would be limited in small areas[Figure 8]. Therefore we need to survey vast regions for exhuming any human remnants first by using satellite images and then narrow down into probable sites by GPR.

4. Conclusions

Various sites of historical mountain fortresses and king's graves were surveyed using GPS and surroundings of their locations were identified on satellite images over Manchuria, China. It was found that "Google Maps" were very convenient to pin out precise locations on satellite images. Many historical features of some sites seem to be disappearing due to recent land development programs and human activities. It needs to be taken care of historical sites under disturbance.

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