Korean Journal of Geomatics
Vol. 2, No. 2 / December 2002
pp. 107~113

The Coastline Extraction Using RTK GPS/GLONASS

Ho-Sik JANG*, Tae-Ho ROH and Jong-Chool LEE*****

Abstract

SOn this study, it was applied that the method of Coastline extracting by aerial photogrammetry so as to extract the coastline using the method of RTK GPS/GLONASS.

The observed area is Gwanganri beach that is located in Pusan and it was observed according to high wave of scar when the approximate highest high water and it was surveyed according to that the boundary line connecting to sea water surface at random time-zone.

Observation analysis was used digital map of 1:1,000 and compared coastline that was converted tide with coastline of high tide. So this conclusions was agreed with converted coastline and high tide coastline.

Keywords : *Coastline Extraction, RTK GPS/GLONASS, High Wave of Scar, Tide*

1. Introduction

The efficient management and use of coasts are an important issue for the use of national lands, and to protect sea resources which are drying up nowadays. The main issues in managing or using coasts are safety and recovery of coastal areas, environment, managing resources, national plans for using lands, industrial development, traffic and governmental policies. But, coastal areas have strong localities, and each coastal area has its own special issues.[1]

The functions of precise and consistent information are outlined below. Firstly, it provides public data. Secondly, it improves digital coastal chart for navigation. Thirdly, it provides exact boundary data for simulation of storm surge and overflow near the shore. Fourthly, it provides detail numbers for managing resources near the shore. Fifthly, improves management of shores using an improved land-sea geographic information system. Sixthly, it provides exact analysis of environmental problems. For these purposes, it is necessary to provide quantitative data of coastlines with their longitudes and latitudes. However, there is large difference between Real-Time GPS/GLO-NASS, and recent digital maps.

The digital maps need so much time produce. This makes it difficult to reflect ever changing coastline data. But, the GPS/GLONASS method can complement this shortcoming.

In this research, coastlines were surveyed during approx. higher high water(high wave of scar) using RTK GPS/GLONASS and during other randomly selected points of time, and then the changed amount of coastlines in the two data were compared. Coastline extraction using RTK GPS/GLONASS was suggested to be better than other method such as extracting amount changed using height of the tide.

2. The Theories of Surveying Coastline

Surveying coastlines is a process to make a map by checking shapes and kinds of coastlines. Surveyed items included are land terrain near coastlines, rock which covers and uncovers and low water lines etc. normally, coastlines and near terrains are surveyed using photogrammetry, and some times using actual measurement if inevitable.[2)-4)]

In this research coastlines were surveyed using RTK

*Ph. D. Candidate, Dept. of Civil Engineering, Pukyong National University, Busan, Korea (Email : gpsjhs@mail1.pknu.ac.kr)
**Ph. D. Candidate, Dept. of Civil Engineering, Pukyong National University, Busan, Korea (Email : rth1348@hanmail.net)
***Professor, Division of Construction Engineering, Pukyong National University, Busan, Korea (Email : jclee@pknu.ac.kr)

The manuscript for this paper was submitted for review on November 15, 2002.

GPS/GLONASS, extracting coastline using aerial photogrammetry. If a riverside line obtained by photogrammetry is proper to its definition, there are no problems at all. However, a riverside line is always changing due to changing sea levels by tides, so the relationship between a riverside line from photogrammetry and that to be drawn on the map.

The smaller the slope of a riverside line is, the larger its change. If pictures are taken during a full tide, the a riverside line pictures can be used with modification. But, pictures taken during other tides, the slope of coast terrain should be compensated by considering the time when the pictures were taken, and the tides.

Furthermore, if a coast is mostly composed of rocks, its terrain is not largely changing. But, in the cases of sands, it is changing dramatically due to waves and winds.

Therefore, when analyzing aerial pictures to decide coastlines, articles below should be considered as well as described above.

1. Artificial coast facilities such as harbors and breakwaters are included in coastlines without modification.
2. When pictures are taken during Approx. H. H. W, the boundary between sea and land becomes a coastline.
3. When coastlines are composed of rocks or sands in gentle slope, the high wave of scar becomes coastlines.
4. When there is no high wave of scar, height of tide during Figure 1 taking, and differences of tide(ℓ) of approx. Higher high water are obtained form the tide table of the coasts, then vertical average slope vertical average slope(θ) and complement(s) are obtained from the formula below.

$$s = \ell \times \cot\theta$$
$$\theta = \tan^{-1}(h/d) \qquad (1)$$

5. In the case of aerial (1/1,000～1/5,000), in put the height of Approx. H. H. W based on control points in pictures, and then decides the height of coastlines by the same manner as a contour line drawing.
6. Natural colors or infrared pictures are helpful in analyzing pictures.
7. If pictures are taken during low tides, it is easy to

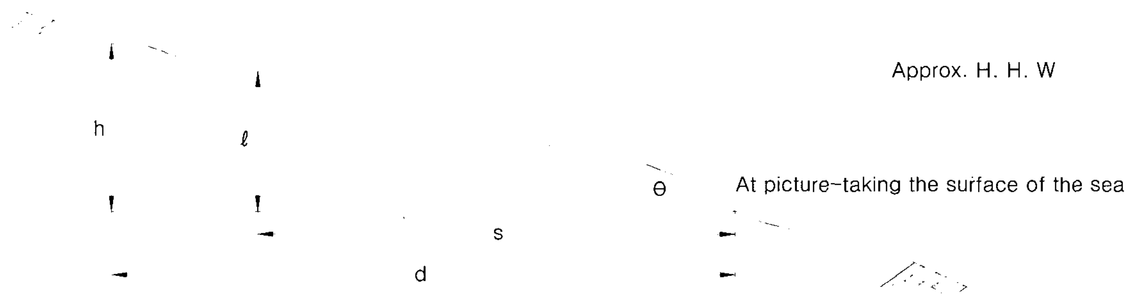

Fig. 1. Deciding coastline by calibration differences of tide[2].

Table 1. Analysis of surveying standard of each law[4]

Law		Law of Surveying No.5	Law of Hydrographic Work No.4
The Size of Earth		Bessel	Bessel(and for WGS-84)
Position		Longitude and Latitude (with right angle and polar coordinates)	Longitude and Latitude (with right angle and polar coordinates)
Base Point for Surveying		The starting point of Korea for Longitude and Latitude	The starting point of Korea for Longitude and Latitude
Height Depth	Altitude	The starting point of Korea Depth from the mean sea level	The starting point of Korea Depth from the mean sea level
	Depth	NA	Depth from the datum level
	Coastline	Line or riverside line with mean sea level 0m	The boundary between sea land during approximate highest high water
	Hehght of Artificial Facility such as bridges	Mean sea level	Approximate highest high water
Usage		Making land map	Making sea map

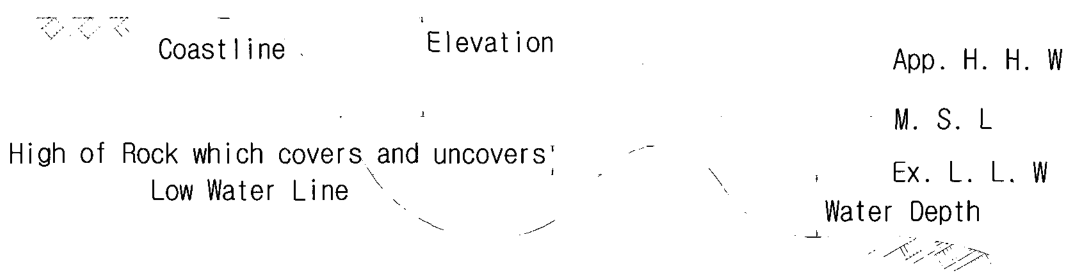

Fig. 2. Coastline and water depth[2),3)].

discover the low water line, deadlocks, rock which covers and uncovers, and sandbanks.

Altitudes of lands are average height from the sea level. However, coastlines and the bottom of the sea are measured by the average sea level, which is higher or lower than the sea level. According to the coastline regulations applied to Korea. Law of Surveying decided a riverside line, and Law of Hydrographic Work decides coastlines as approx. Higher high water.

As shown in Figure 2, because coastlines from aerial pictures are based on approx. higher high water, the coastline in this research is the boundary between land and sea during approx. higher high water.

3. The Method of Observation

3.1 The Observation Area

The observation area, in this research, a bathing resort at Gwanganri beach in Pusan, Korea, which is located at the west side of Haeundae beach, and it is composed of 82,000㎡ of total area, length of 1.4km,

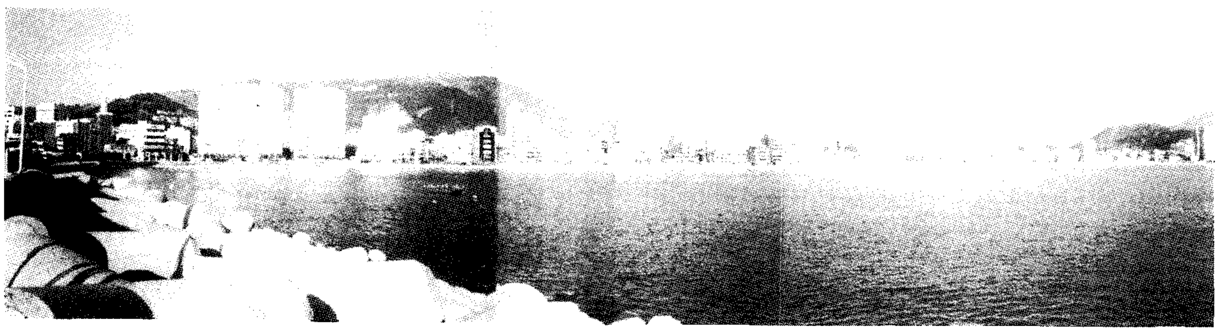

Fig. 3. The Observation Area.

Table 2. GPS/GLONASS Control Point[6)]

Point	X Coordinate(m)	Y Coordinate(m)	Hight(m)
1	182320.447	210657.837	4.7643
2	182993.645	210669.659	4.7896
3	183756.310	211281.373	4.1737

Table 3. Tide data from the tide station of Pusan[7)]

Tide Station	Latitude : 35° 06′ Longitude : 129° 02′	App.H.H.W	361.6cm
Sp.Rise	123.8cm	Np.Rise	86.0cm
M.S.L	64.9cm	M.H.W.I	8h 2m
Ex.H.H.W	168cm(1960.8.22)	Ex.L.L.W	-41cm(1967.2.26～1968.2.16)

Fig. 4. Beach Cusp Terrain.

Fig. 5. GPS/GLONASS Receiver installed at control points.

width of 64m, and high-quality sands.[5]

However, as shown in Figure 4, the beach cusp terrain, beach and coastline of it is diminishing due to the construction of the Kwangan Grand Bridge.

The control points used in this research are those used in the construction of the Kwangan Grand Bridge as shown in Table 2.

To show the boundary of the coastline by using real time GPS/GLONASS, the coastline was surveyed along high wave of scar during approx. higher high water using the digital map, and coastlines during randomly selected times were also surveyed. The coastline determined by using approx. higher high water and the randomly surveyed coastlines were compared after being converted by using the tide table.

The tide survey used in this research came from the tide station located at latitude 35° 06′ and longitude 129° 02′ . Table 3 shows the contents.

3.2 The Specification of Survey Devices and Survey Methods

The receiver used was L1/L2, C/A-code, P-code and JAVAD with 20 channels, and A Legant was used as an antenna. Table 4 shows the specifications of the survey devices.

Firstly, the target area was initialized by using 3 points Table 2, which were used as control points near the coastline, and surveyed along high wave of scar in regular steps. Lastly, the coastline was surveyed for randomly selected height of the tide.

Table 4. The specification of surveying devices

Tracking Specification			Performance Specification	
Tracking	Signals Tracked	Measure Mode	RTK Mode	
			H	V
40 L1 channels, 20 L1+L2 channels GPS/GLO (optional)	L1/L2 (L1-C/A &L1/L2 Full Cycle Carrier, P1/P2)	Static Kinematic RTK DGPS	10mm+1.5ppm (×Base) for 2 freq.	20mm+1.5ppm (×Base) for 2 freq.

Table 5. Positioning tolerance error for reduced scale (NGI, 1988)[8]

Reduced Scale	Positioning error of plane	Positioning error of elevation
1 : 500	within ± 0.25m	within ± 0.25m
1 : 1,000	within ± 0.70m	within ± 0.33m
1 : 2,500	within ± 1.75m	within ± 0.66m
1 : 5,000	within ± 3.50m	within ± 1.66m
1 : 10,000	within ± 7.00m	within ± 3.33m

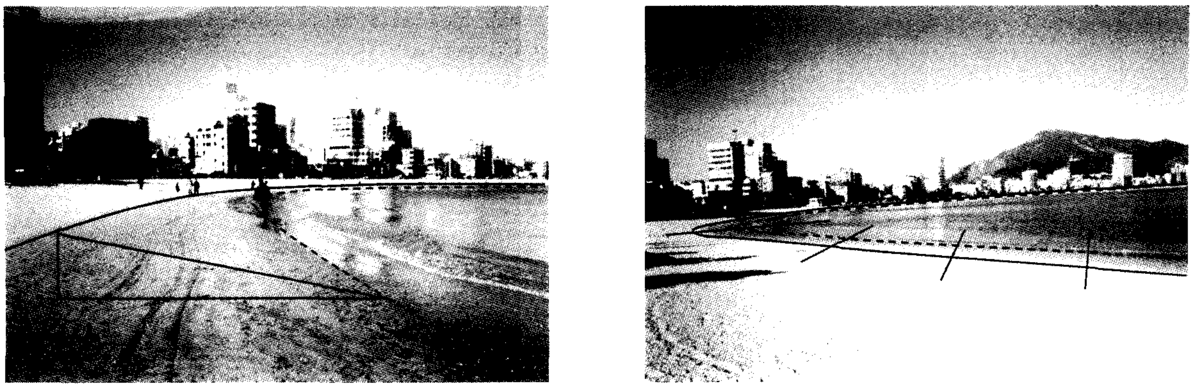

Fig. 6. The boundary and form of the coastline profile.

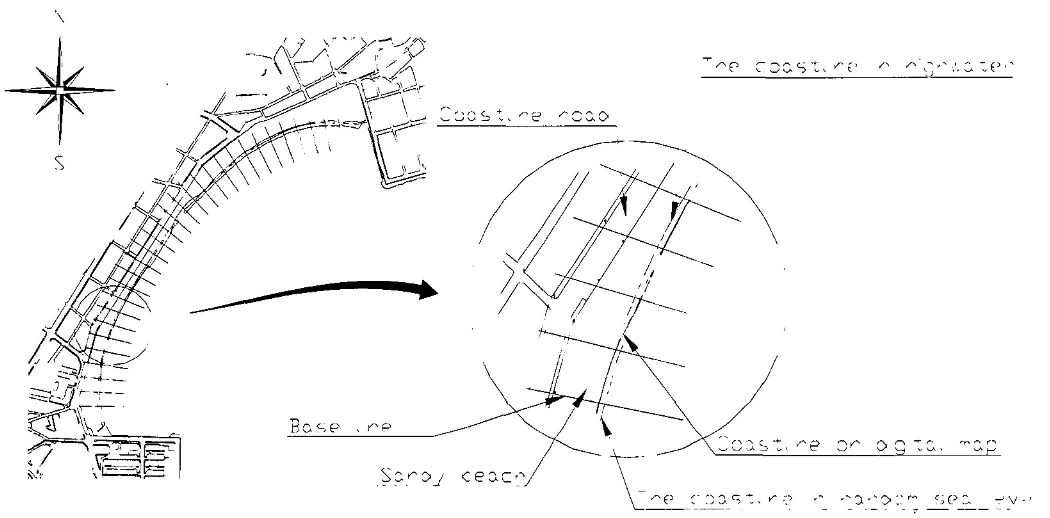

Fig. 7. Digital map of the coastline.

4. The Results and Analysis of the Surveying

The coastline was surveyed during approximate highest high water using RTK GPS/GLONASS as shown by Figure 6, and then the horizontal length was shown in vertical to the coastline. From the horizontal length, and the difference between these two heights of the tides, the slope of coast was calculated. Table 6 shows the data about changes in the length of the coastline due to tides.

The horizontal length randomly surveyed based on the coastline during a full tide was compared to the changed coastline. The tolerance was based on a positioning error for each reduced scale published by the National Geography Institute as shown in Table 5. As shown in Figure 7, 30 reference lines, the sample data, were set in a regular length, based on roads and commercial buildings near the coast.

As shown in Table 6, the coastal slope was gentle between 2° 03′ and 8° 39′ to the reference lines, and the difference between the complemented length by height of the tide and the surveyed length was 0.15m ~ 0.53m, and its average was 0.34m. It satisfied ±0.70m, which comes from the positioning errors for each reduced scale published by the National Geography Institute.

Table 7 shows the distances between the coastlines in the digital map(1995), and average sea level. For height of the tide 1.28m, there has been erosion from -0.08m to -12.16m, and accumulation from +1.86m to 8.16m. Distances between the coastlines in the digital map and average sea level said that there has been erosion from -0.41m to -6.63m, and accumulation from +0.76m to +14.04m. This means that there has been accumulation in the east and north side, and erosion in the south and west side.

Table 6. The observation data

Station	Coastline length(d)	Height of the tide (Survey tide:h)	tide range	Coast slope(θ)	Randomle selected height of the tide(tide range)	The complemented length with tide range(m)	Survey length(m)	Difference
1	5.58	1.28(0.77)	0.51	5° 13′ 20″	1.07(0.21)	2.30	2.75	0.45
2	4.65	1.28(0.77)	0.51	6° 15′ 33″	1.06(0.22)	2.01	2.33	0.32
3	5.47	1.27(0.76)	0.51	5° 19′ 36″	1.06(0.21)	2.25	2.67	0.42
4	5.88	1.27(0.76)	0.51	4° 57′ 26″	1.05(0.22)	2.54	2.95	0.41
5	4.93	1.27(0.75)	0.52	6° 01′ 16″	1.04(0.23)	2.18	2.56	0.38
6	3.42	1.27(0.75)	0.52	8° 38′ 44″	1.04(0.23)	1.51	1.72	0.21
7	4.89	1.26(0.74)	0.52	6° 04′ 12″	1.03(0.23)	2.16	2.41	0.25
8	4.93	1.26(0.74)	0.52	6° 01′ 16″	1.03(0.23)	2.18	2.40	0.22
9	5.10	1.26(0.73)	0.53	5° 55′ 59″	1.02(0.24)	2.31	2.69	0.38
10	5.02	1.26(0.73)	0.53	6° 01′ 37″	1.02(0.24)	2.27	2.60	0.33
11	5.69	1.26(0.72)	0.54	5° 25′ 17″	1.01(0.25)	2.63	3.01	0.38
12	5.42	1.26(0.72)	0.54	5° 41′ 23″	1.01(0.25)	2.51	2.86	0.35
13	5.23	1.25(0.71)	0.54	5° 53′ 42″	1.00(0.25)	2.42	2.73	0.31
14	4.56	1.25(0.71)	0.54	6° 45′ 13″	1.00(0.25)	2.11	2.30	0.19
15	5.84	1.24(0.70)	0.54	5° 16′ 58″	0.99(0.25)	2.70	3.09	0.39
16	5.32	1.24(0.70)	0.54	5° 47′ 45″	0.99(0.25)	2.46	2.71	0.25
17	5.62	1.24(0.69)	0.55	5° 35′ 22″	0.98(0.26)	2.66	2.88	0.22
18	4.37	1.23(0.69)	0.54	7° 02′ 40″	0.98(0.25)	2.02	2.21	0.19
19	7.88	1.23(0.68)	0.55	3° 59′ 33″	0.97(0.26)	3.73	4.18	0.45
20	6.23	1.23(0.68)	0.55	5° 02′ 42″	0.97(0.26)	2.95	3.33	0.38
21	7.56	1.22(0.68)	0.54	4° 05′ 08″	0.96(0.26)	3.64	4.16	0.52
22	6.51	1.22(0.68)	0.54	4° 44′ 30″	0.96(0.26)	3.13	3.59	0.46
23	5.76	1.21(0.67)	0.54	5° 21′ 21″	0.96(0.26)	2.67	2.91	0.24
24	7.09	1.21(0.67)	0.54	4° 21′ 20″	0.95(0.26)	3.41	3.79	0.38
25	7.51	1.21(0.66)	0.55	4° 11′ 19″	0.95(0.26)	3.55	4.08	0.53
26	10.56	1.20(0.66)	0.54	2° 55′ 38″	0.95(0.26)	4.89	5.29	0.40
27	10.28	1.20(0.65)	0.55	3° 03′ 45″	0.94(0.26)	4.86	5.29	0.43
28	13.47	1.20(0.65)	0.55	2° 20′ 17″	0.94(0.26)	6.37	6.59	0.22
29	15.36	1.19(0.64)	0.55	2° 03′ 03″	0.93(0.26)	7.26	7.72	0.46
30	12.75	1.19(0.64)	0.55	2° 28′ 12″	0.93(0.26)	6.03	6.18	0.15
Average								0.34

Table 7. The differences of length between coastline on a digital map and the m. a. s. l.(−:erosion, +:accumulation)

Station	The differences between coastline in a digital map of height of the tide 1.28m and the m.a.s.l(m)	Coast slope(θ)	at mean sea level of 0.649m, coastline distance(0.571m)(m)	The differences between coastline in a digital map and the m.a.s.l(m)
1	-10.22	5° 13′ 20″	6.25	-3.97
2	-7.89	6° 15′ 33″	5.21	-2.68
3	-6.53	5° 19′ 36″	6.12	-0.41
4	-3.26	4° 57′ 26″	6.58	+3.32
5	-0.27	6° 01′ 16″	5.41	+5.14
6	-0.08	8° 38′ 44″	3.76	+3.68
7	-4.61	6° 04′ 12″	5.37	+0.76
8	-4.13	6° 01′ 16″	5.41	+1.28
9	-4.09	5° 55′ 59″	5.49	+1.40
10	-2.86	6° 01′ 37″	5.41	+2.55
11	-3.25	5° 25′ 17″	6.02	+2.77
12	-8.41	5° 41′ 23″	5.73	-2.68
13	-12.16	5° 53′ 42″	5.53	-6.63
14	-10.46	6° 45′ 13″	4.82	-5.64
15	-9.19	5° 16′ 58″	6.18	-3.01
16	+5.27	5° 47′ 45″	5.63	+10.9
17	+6.25	5° 35′ 22″	5.83	+12.08
18	+8.16	7° 02′ 40″	4.62	+12.78
19	-0.99	3° 59′ 33″	8.18	+7.19
20	+3.47	5° 02′ 42″	6.47	+9.94
21	+3.63	4° 05′ 08″	7.99	+11.62
22	+3.45	4° 44′ 30″	6.88	+10.33
23	+5.64	5° 21′ 21″	6.09	+11.73
24	+4.22	4° 21′ 20″	7.50	+11.72
25	+4.86	4° 11′ 19″	7.80	+12.66
26	+2.87	2° 55′ 38″	11.17	+14.04
27	+1.86	3° 03′ 45″	10.67	+12.53
28	-1.01	2° 20′ 17″	13.99	+12.98
29	-4.55	2° 03′ 03″	15.95	+11.4
30	-3.86	2° 28′ 12″	13.24	+9.38

5. Conclusion

In the aerial photogrammetry, it was applied that how to extract of coastline which was based of RTK GPS/GLONASS for high wave of scar and conclusions are as follows about the length - difference of converted coastline for tide of surveyed at random time-zone ; the change of coastline was expressed more conveniently in realtime than existing method for digital terrain model correction or global warming, and it was thought that the decrease of beach because of lost sand can be expressed by realtime for maintenance management of coastline.

References

1. Intae Yang, A Study on the Shoreline Changes by the Geodetic Characteristics of the East Sea and on the Numerical Model for the predicting, Korea Science and Engineering Foundation, 1990, pp. 17-32.
2. Bock Mo Yeu, The Principles of Surveying (II), 1995, pp. 284-291.
3. Seok-woo Lee, Gun-sik Kum, Ocean Surveying, 1996. pp. 149-158.
4. Kyeong Won Park, A Study on Changing Coastlines of Kwanganri using Aero photogrammetry, Proceedings of the 2001 KSRS Spring Meeting, 2001, pp. 122-127.
5. Hydrographic Work Guides, Ministry of Transportation & Hydrographic Office, 1980.
6. The Total Report for Designing Kangan Road, Busan MetroCity, 1994. 8, pp.38-39.
7. http://www.knto.or.kr/Korean/index.html
8. Ge-hyun Kim, General GIS (2nd edition), Deyoungsa, 2000. p. 81
9. IPCC(Intergovernmental Panel on Climate Change), 1990: Climate Change: the IPCC Scientific Assessment, J. T. Houghton, G. J. Jenkins and J. J Ephraums (eds.), Cambridge University Press, Cambridge, UK.