On the Positional Accuracy of the GoogleEarth® Imagery

Kazimierz BECEK and KHAIRUNNISA Ibrahim, Brunei Darussalam

Keywords: GoogleEarth®, positional accuracy, satellite imagery

SUMMARY

The ubiquitous GoogleEarth® service is arguably the most well-known and frequently used internet service that provides free-of-charge access to the global collection of georeferenced satellite imagery. Its popularity is thanks not only to its accessibility, but also the availability of tools that allow users to add their own content to the imagery, such as photographs and notes. As such, GoogleEarth® has undoubtedly become the ultimate source of spatial data and information for private and public decision-support systems and many types and forms of social interactions. However, it must be noted that GoogleEarth® provides this service with a disclaimer that warns users about the quality of the data. Despite this warning, many individuals still refer to GoogleEarth® as a reliable and accurate data source. While inaccuracies in the GoogleEarth® data are not expected to cause harm or damage in many cases, it can potentially cause problems further down the line, for instance when a lecturer encourages his or her students to use the service for navigation purposes, or when it is used in technical tasks requiring high accuracy. In this contribution, we report on discrepancies in coordinates of objects as captured in GoogleEarth® and their coordinates according to other data sources. In this project, the coordinates of the beginnings and ends of the centralines of runways well-visible in GoogleEarth® were compared with the coordinates of the corresponding runways extracted from the Global Elevation Data Testing Facility (GEDTF). The results demonstrate that there are inconsistencies in the position data provided by GoogleEarth®, and therefore caution must be exercised when using this service for certain purposes, such as navigation.

On the Positional Accuracy of the GoogleEarth® Imagery

Kazimierz BECEK and KHAIRUNNISA Ibrahim, Brunei Darussalam

1. INTRODUCTION

Since its launch in June 2005 (Google, Inc., 2007, cited in Potere, 2008), GoogleEarth® has enjoyed ever increasing popularity as the go-to application for map lovers, navigators and armchair explorers. Free for download and installation on every computer system – PC, Mac and Linux – Google has made GoogleEarth® a portable, within-grasp virtual globe one is free to explore at one's leisure (Google, 2011a).

Via satellite imagery, maps, terrain, 3D buildings and other locational data, Google aims to provide viewers with "a more realistic view of the world"; in fact, the application is not merely limited to planet Earth – it also offers the opportunity for moonwalking and visiting planet Mars (Google, 2011a).

More than simply providing locational information, GoogleEarth® allows users to add their own content such as photos or descriptions of areas or landmarks. They can also extrapolate information from the satellite imagery used by digitizing areas of interest and exporting them for use elsewhere. As such, the application has found a strong following not only in explorers and navigators but also in classrooms all over the world.

Its popularity however is not an indication of its accuracy. Errors abound in GoogleEarth®, some of them rather glaringly, particularly in terms of alignment of patches of images, a fact that Potere (2008) highlights in his paper using several images.

Our own search turned up two such errors within close proximity in the Mukim Pengkalan Batu area (mukim equivalent to a sub-district) of the Brunei-Muara district in Brunei Darussalam, as shown in Figure 1. It is very likely that a more thorough search could have uncovered more of such errors in other parts of the country.

While Google readily admits to blurriness, which it attributes to the use of different resolution images for a "seamless viewing experience", and the use of outdated imagery that provide a clearer view than more recent ones (Google, 2011b; Google, 2011c), it makes no mention of such discrepancies as above.

(a)  (b) 

Figure 1. Errors in GoogleEarth satellite images that have been patched together. (a) shows part of a cleared land with a large, circular man-made structure fading into forest, possibly due to the use of old imagery; (b) is an example of a georegistration error that breaks a linear structure and surrounding areas.

2. METHOD AND DATA

An assessment of the positional accuracy of GoogleEarth® imagery would require a comparison between known points and the corresponding points as displayed by the GoogleEarth® application. Potere (2008) for instance used four control points from 109 cities each where high-resolution Google Earth imagery is available and then compared these to their corresponding positions in the GeoCover data set, which he notes has the "positional accuracy of 50 meters root-mean-squared error (RMSE)".

In this study, the points to be compared are obtained from a previous study on the Global Elevation Data Testing Facility (GEDTF), which are then projected in the GoogleEarth® application. This database stores locational information on large and mostly flat manmade and natural features from all over the world which can be used to provide assessment on the calibration and accuracy of space-based remote sensing systems (GEDTF, 2010).

Currently, majority of the records in the GEDTF are of runways; all of the control points used in this research are therefore based on runways, each with their own, precise longitudinal and latitudinal coordinates. For each runway, the points at either end of the line running down the center of the runway are taken as the control points.

GEDTF records were previously used to estimate the accuracy of shuttle radar topography mission elevation data product; using 300 runway points, it was found that the standard deviation of the instrument-induced and other error sources of SRTM is ±1.55m (Becek, 2008).

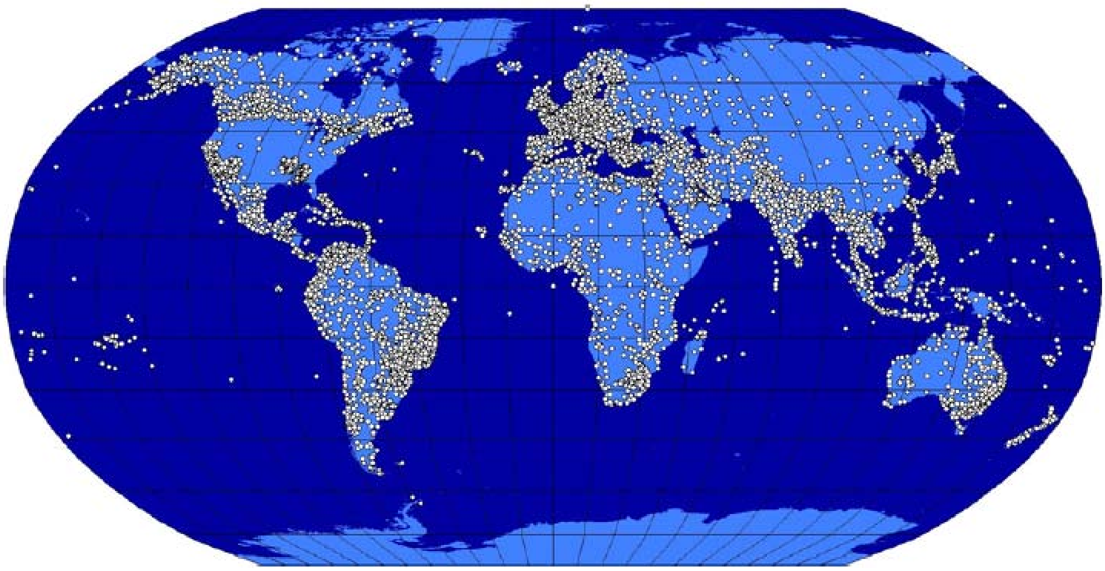

Figure 2. Approximately 8,235 runways worldwide are shown here. This is not a comprehensive map, as not all runways in the United States of America are included (Becek and Ibrahim, 2010).

Having proven the applicability of the GEDTF records for assessing accuracy of satellite imaging systems, the runways were utilized again for this study and are ideal as control points for GoogleEarth® accuracy. This time, points from more than 2000 runways were used.

The coordinates of these control points are used to create a set of point features within the ArchGIS 9.3 software package, which are subsequently exported to a file in the kmz format. This file is then opened in GoogleEarth®, with the point features spread out according to their respective coordinates.

In turn, each of the runway points were inspected closely. By clicking on each point, GoogleEarth® automatically zooms in to the immediate area, allowing better comparison of the control point and the location of the feature in the GoogleEarth® image.

Rarely do the points meet. In order to calculate the accuracy of GoogleEarth®, the distance between the point feature and the corresponding point on the threshold as identified by an operator in GoogleEarth® were estimated and recorded using the application's distance measurement tool.

After all the discrepancies were measured, the basics statistics were calculated for the discrepances which are considered as the measure of the accuracy of images in the GoogleEarth® facility. The results are discussed in the next section.

3. RESULTS AND DISCUSSION

In total, 2045 runways were inspected. There was a range of discrepancies ranged from less than 10m to more than 1,500m. For some 195 runways, less than 10% of the total, the disparity was less than 10m. The mean disparity was 113m, while the maximum disparity was 1676m and median disparity between the true and the GoogleEarth® runway positions was 51m.

Figure 3 shows an empirical Cumulative Distribution Function (CDF) of the disparities *x* in the runway positions. CDF is defined as a proportion of the *x* values less than or equal to a given x_o to all the *x* values. Figure 4 shows an enlargement of the left-hand section of CDF covering the first 200m of *x*. As it can be read from Figure 4, in 50% of the cases disparities are less than ~50m. However, at the same time, there is 50% of chance that a disparity will be larger than ~50m.

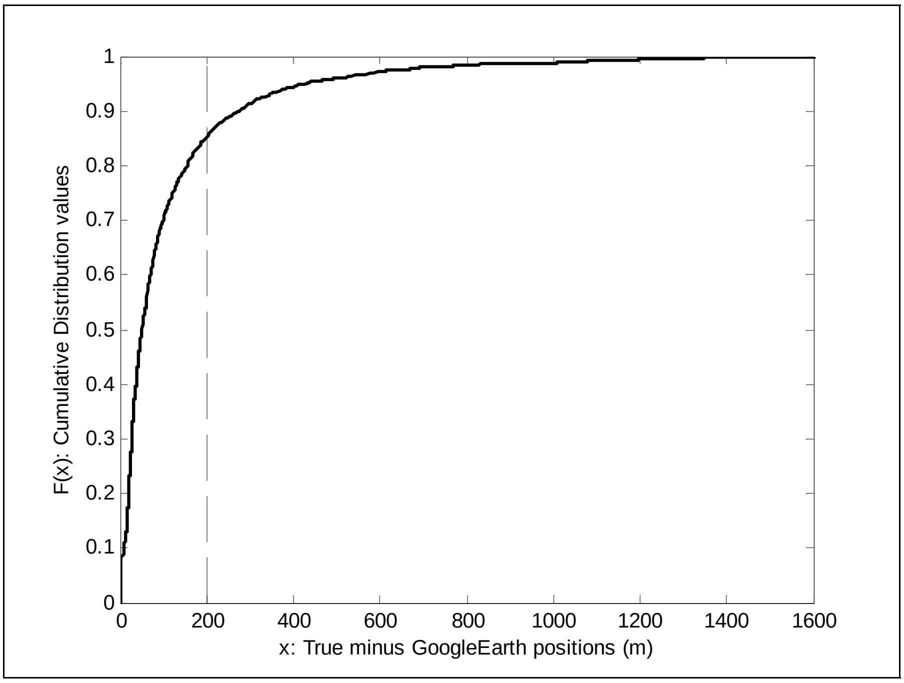

Figure 3. Cumulative Distribution Function of the disparities in runway positions. A region bordered by the *y*-axis and the dashed line is shown in Figure 3 in an enlarged form.

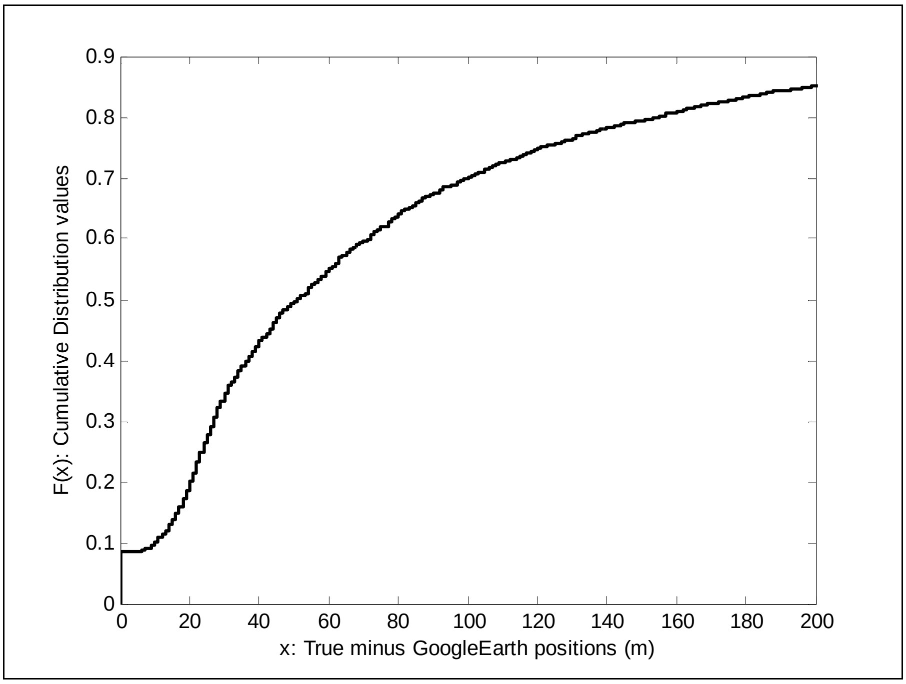

Figure 4. The first 200m portion of the Cumulative Distribution Function of the disparities in runway positions.

Because blurriness and cloud-cover are more likely in certain parts of the world than others, we also took the geographical location of runways as a factor for GoogleEarth® locational discrepancy. Table 1 shows the distribution of runway points used in the study from around the world. A subsequent analysis of the geographical spread of the disparities points out that the disparities are not spatially correlated.

Table 1. The geographical spread of the control points (runway features)

Location	Africa	Australia	Euroasia	North America	South America	Other
No. of runways	204	208	810	376	408	34

4. CONCLUSION

As Google acquires more updated, better-resolution and clearer satellite images it is hoped that the GoogleEarth® application will correspondingly connect and display these images accurately to offer viewers a truly "seamless" viewing experience.

As such, at the moment, it provides plenty of viewing pleasure and allows access to hard-to-reach places, even into space. However, as a navigation or education tool it is clearly flawed – with errors of more than 1.5km in some cases – unless its accuracy issues are not addressed.

REFERENCES

Becek, K., (2008). Investigating error structure of shuttle radar topography mission elevation data product. *Geophys. Res. Lett.*, 35, L15403, doi:10.1029/2008GL034592.

Becek, K., & Ibrahim, K. (2010, April 11-16). *Introducing the global elevation data testing facility*. Paper presented at the FIG Congress 2010 on Facing the Challenges – Building the Capacity.

GEDTF. (2010). *Global Elevation Data Testing Facility*. Retrieved June 2010 from www.gedtf.org.

Google (2011a). *About Google Earth: Understanding Google Earth imagery*. Retrieved March 2, 2011 from http://earth.google.com/support/bin/answer.py?&answer=176147.

Google (2011b). *Data and imagery: Blurry or outdated imagery*. Retrieved March 2, 2011 from http://earth.google.com/support/bin/answer.py?hl=en&answer=21417.

Google (2011c). *Google Earth (Free): Frequently Asked Questions*. Retrieved March 2, 2011 from http://earth.google.com/support/bin/answer.py?hl=en&answer=187961.

Potere, D. (2008). Horizontal positional accuracy of Google Earth's high-resolution imagery archive. *Sensors*, 8, 7973-7981.

BIOGRAPHICAL NOTES

Dr Kazimierz Becek obtained his PhD from the Technical University Dresden, Germany in 1987. He worked at the School of Surveying, UNSW, Sydney, Australia, from 1989 to 1994 before joining the Phone Directories Company, Gold Coast in 1995 as head of the company's cartography and data acquisition department. He also worked for the Queensland State government and the Gold Coast City local government from 1998. In 2003, he began working at the Geography Department, Universiti Brunei Darussalam, teaching surveying, photogrammetry, remote sensing, cartography and GIS. His research interests include modeling or environmental systems and applications of active remote sensing methods for environmental studies. He has published papers in numerous conference proceedings and in the Geophysical Research Letters.

Khairunnisa Ibrahim received her MSc in Environmental Informatics from University of Leicester, UK in January 2010. She is currently working as a lecturer in environmental studies at Universiti Brunei Darussalam, where she graduated with a BA degree (major in geography) in 2006. Between 2006 and 2008 she worked as a journalist at one of the English newspapers in Brunei, The Brunei Times, reporting on local news and issues. Her research interests include applications of GIS and remote sensing for environmental and development studies, conservation and sustainable development.

CONTACTS

Dr Kazimierz Becek and Khairunnisa Ibrahim
Universiti Brunei Darussalam
Jalan Tungku Link, Gadong, BE1410
BRUNEI DARUSSALAM
Tel. +673 2463001
Fax. +673 2461003
Email: kazimierz.becek@ubd.edu.bn; khairunnisa.ibrahim@ubd.edu.bn