Automatic geotagging using GPS EXIF metadata of smartphone digital photos in tree planting location mapping

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Abstract. Tree planting is one of the programs that are currently being promoted. The location of tree planting is important to be monitored in the future. Tree planting activities carried out on the UNNES campus always carry out online documentation and reporting. However, the problem is the difficulty in obtaining the coordinates of the location of the plants because what is currently done is clicking on maps manually. In this research, we designed automated geotagging tree planting photos. Digital photos from smartphones are read, then extracted EXIF information to get GPS coordinates. Then the coordinates are obtained automatically, then stored in the database. The coordinates can be reversed to display on maps. In our experiment, we study in two cases. Case 1 the original photo near the building, Case 2 the photo near the forest. We can show that the result of mapping represents the actual state of the photo. So, the use of GPS information on photo smartphones can be an alternative solution in terms of documenting planting photos to get an accurate location.

1. Introduction

Tree planting is an effort to reforest and restore climatic conditions [1]. Through tree planting, it is hoped that it can make the air fresh and balance the ecosystem. UNNES, as a conservation campus, also organizes a tree-planting program for every student. In tree planting programs, the location of planting is very important. Students do the planting, then input data through the system and choose an address. However, the current problem is that students click the coordinates manually. As a result, many actual locations with locations documented in the database are inaccurate. So, a solution is needed, how to get coordinates automatically and more accurately.

Along with the development of technology, nowadays, GPS has developed as a technique for determining the location of coordinates. GPS has been widely used, for example, to find friends or family [2], in terms of transportation [3], vehicle tracking [4, 5], vehicle security [6], autonomous [7], and in determining the location of wheels [8]. We can see many uses of GPS, but not many have implemented it in environmental terms. So in our study, we will discuss the automation of GPS coordinate locations in tree planting. Currently, cellphone cameras are equipped with location information stored in EXIF (Exchangeable image file format) metadata [8]. The study regarding the level of GPS accuracy on smartphones is also interesting to study, including [9] as well as the use of smartphone GPS in a campus environment [10] and tourism [11]. Currently, almost every smartphone
is equipped with GPS, so when taking pictures using the camera, location information is stored in EXIF metadata. EXIF can store information such as time, camera settings, make, model, location, and other information. Information in images can be widely used, both in terms of copyright and in terms of security, for example, steganography [12].

There are many activities that can be done with EXIF metadata. Previous studies examining EXIF include image classification with EXIF [13], for copyright [14], and image enhancement [15]. Information in EXIF can be extracted, one of which is through ExifTool [16]. Research on errors in EXIF data has also been reviewed by Orozco [17]. In this paper, we discuss the use of EXIF generated from digital cameras on smartphones. GPS coordinate information is then extracted and stored in a database for documentation at the time of tree planting input.

2. Methods
In this study, we used photo data obtained in the UNNES tree planting database (Siomon). The information inputted by students is as in Table 1.

| Variable          | Description                                                                 |
|-------------------|-----------------------------------------------------------------------------|
| Tree information  | Tree information such as Plant height, stem diameter,                       |
| Address location  | User input address location                                                  |
| Coordinate location | The user clicked manually on the maps provides                              |
| Time              | User input the time of planting                                             |
| Photo             | The photographic of tree planting                                           |

We used a random sample of photos contained in the database. Then detect photos that already contain EXIF GPS or not. Next, we extracted the information contained in the EXIF. The extraction results are then stored in the database; then the coordinates are returned in the form of maps as shown in Figure 1. The Exchangeable Image File Format (EXIF) is a specification for image formats like JPEG and TIFF. The information includes the camera setting, the information of the picture itself as well as the copyright information, the shooting environment, and the geographic information. Our proposed method is shown in Figure 1.

![Flowchart of automatic geotagging method](image)

**Figure 1.** The automatic geotagging method our experiment.

3. Results and Discussion
We have developed automatic geotagging using GPS EXIF data for Seed location mapping using PHP programming language. We use function in PHP "exif_read_data ()" [18] to read the image then extract the metadata information. In this study, we compare in two cases. We select a sample image that taken a photo in a forest area and in a near building area. Case 1 an image in a forest area, case 2 an image near a building area, so we can visually see the results on the photos and the results on maps. Metadata extraction can be carried out using ExifTool [16]. While in this study, extracted EXIF data on the https://www.exifdata.com/exif.php [19] site as a comparison to the program we developed. The image used is shown in Figure 2. We sensor the face due to the privation of the photo.
Table 2. EXIF data information of sample images

| Information           | Figure 2 (a) Value | Information           | Figure 2 (b) Value |
|-----------------------|--------------------|-----------------------|--------------------|
| Camera                | Xiaomi Redmi 4X    | Camera                | OPPO A1601         |
| GPS Position          | 7.051230 degrees S, 110.402835 E | GPS Position          | 7.060587 degrees S, 110.343811 E |
| Date of Creation      | 2019/11/15 06:12:03 | Date of Creation      | 2019/11/25 08:48:42 |
| Resolution            | 2340x4160          | Resolution            | 1717x3052          |
| Make                  | Xiaomi             | Make                  | OPPO               |
| Model                 | Redmi 4X           | Model                 | A1601              |
| Aperture              | 2                  | Aperture              | 2.2                |
| Exposure Time         | 1/224 (0.004464257142857 sec) | Exposure Time         | 1/101 (0.0099009900990099 sec) |
| Flash                 | Off, Did not fire  | Flash                 | No Flash           |
| File Size             | 1128 kB            | File Size             | 1511 kB            |
| File Type             | JPEG               | File Type             | JPEG               |
| MIME Type             | image/jpeg         | MIME Type             | image/jpeg         |
| Image Width           | 2340               | Image Width           | 1717               |
| Image Height          | 4160               | Image Height          | 3052               |
| Encoding Process      | Baseline DCT, Huffman coding | Encoding Process      | Baseline DCT, Huffman coding |
| Bits Per Sample       | 8                  | Bits Per Sample       | 8                  |
| Color Components      | 3                  | Color Components      | 3                  |
| X Resolution          | 72                 | X Resolution          | 72                 |
| Y Resolution          | 72                 | Y Resolution          | 72                 |
| YCbCr Sub Sampling    | YCbCr4:2:0 (2:2)   | YCbCr Sub Sampling    | YCbCr4:2:0 (2:2)   |
| YCbCr Positioning     | Centered           | YCbCr Positioning     | Centered           |
| Exposure Program      | Not Defined        | Exposure Program      | Not Defined        |
| Date and Time (Original) | 2019/11/15 08:12:03 | Date and Time (Original) | 2019/11/25 08:48:42 |
| Date and Time (Original) | 2019/11/15 08:12:03 | Date and Time (Original) | 2019/11/25 08:48:42 |
| Color Space           | sRGB               | Color Space           | sRGB               |
| Sensing Method        | Center-weighted average | Sensing Method        | Center-weighted average |
| Exposure Mode         | Auto               | Exposure Mode         | Auto               |
| White Balance         | Auto               | White Balance         | Auto               |
| Focal Length In 35 mm | 0 mm               | Focal Length In 35 mm | 0 mm               |
| ISO                   | 100                | ISO                   | 80                 |
| Compression           | JPEG (old-style)   | Compression           | JPEG (old-style)   |

Table 2 provides the metadata according to Figure 2. We can see that the metadata contains model, GPS, and other information. In this study, we focused on GPS Position information. This information contains latitude and longitude information. For example, the GPS information in Figure 2 (a) is 7.051230 S, 110.402835 E, and in Figure 2 (b) is 7.060587 S, 110.343811 E, see dashed red line square. With this coordinated information, we can automatically save it to the database. This information automatically captures from the photo, so this coordinates more accurately than clicked manual by the user. On the other hand, this information can be extracted further, such as time and other information. Furthermore, the coordinates that can be extracted are displayed on the map, using the help of Google Maps as shown in Figure 3.
Figure 3. The result of mapping the original photo coordinate in the maps. (a) The photo was taken from near the building area, (b) the Photo was taken near the forest area.

Let's we can see in Figure 3, the Figure 3 (a) (i) is the original photo images after we extract GPS coordinates then locate in MAP by google maps on satellite view - Figure 3 (a) (ii) and street view-Figure 3 (a) (iii). The first image indicates the photo was taken near the building (see dashed red line), so the result of the map, we can see the building near the thick red maps. While in Case 2, see Figure 3 (b) that the original photos place in the forest area, then we can see that the result of the map is shown in the map area too (Figure 3 (b) (ii) and Figure34 (b) (iii). Based on our experiment, we can use the EXIF of GPS information to automatically save the coordinate of the planting location. So we can monitor the plant in the future by this location.

4. Conclusion
Our study is to solve how to automatically detect the geolocation of tree planting programs. In our proposed method, we have done by extracting the EXIF data of image photographic. We get information of GPS coordinate, then save it to the database. The coordinate can is displayed on maps Kembali, one of which is using the google maps service. The results of our experiment, with two case examples, show the results of the coordinate mapping in accordance with the environmental condition data. We conclude that the use of GPS data in photos can be used as a technique for the automatic extraction of coordinates so that the planting location can be tracked accurately.

References
[1] Bernatzky A 1982 Energy build.5 1
[2] Al-Suwaide G B and Zemerly M J 2009 IEEE/ACS Int. Conf. Comput. Syst. Appl. p 555
[3] Zhao Q, Zuo C, Pellegrino G and Zhiqiang L 2019 Netw. Distrib. Syst. Secur. symp. Febr 2019 (NDSS 2019)
[4] Adaramola B A, Salau A O, Adetunji F O, Fadodun O G and Ogundipe A T 2020 Proc. Int. Conf.
[5] Maurya K, Singh M and Jain N 2012 *Int. J. Electron. Comput. Sci. Eng.* 1 1103
[6] Espinosa P, Pilataxi J, Morales L and Benavides V 2019 *Proc. - 2019 Int. Conf. Inf. Syst. Comput. Sci. INCISCOS* p 222
[7] Zein Y, Darwiche M and Mokhiamar O 2018 *Alex. Eng. J.* 57 3127
[8] Gangwar D P and Pathania A 2018 *J. Sci. Res. Comput. Sci. Eng. Inf. Technol* 3 335
[9] Merry K and Bettinger P 2019 *PloS one* 14 219890
[10] Sottilio E, Giacchetti T, Tuveri G, Piras F, Calli D, Concas V, Zamberlan L, Meloni I and Carrese S 2021 *Res. Transp. Econ.* 85 100926
[11] Santoso K I and Rais M N 2015 *Sci. J. Inform.* 2 29
[12] Alamsyah, Muslim M A, and Prasetiyob B 2015 *J. theor. appl. inf. technol.* 82 106
[13] Ghazali J M, Khan S M N and Zakaria L Q 2020 *Int. J. Eng. Trends Technol.* 1 69
[14] Huang H, Chen Y and Chen S 2009 *Int. J. Innov. Comput. Inf. Control* 5 1903
[15] Safonov I V, Kurilin I V, Rychagov M N and Tolstaya E V 2018 *Adaptive Image Processing Algorithms for Printing* (Singapore: Singapore) p 65
[16] Toevs B 2016 *Proc. - 2015 Annu. Glob. Online Conf. Inf. Comput. Technol (GOCICT)* p 26
[17] Orozco S A L, González A D M, Villalba G L J and Hernández-Castro J 2015 *Multimed. Tools Appl.* 74 4735
[18] PHP Group 2021 https://www.php.net/manual/en/function.exif-read-data.php
[19] EXIF Data Viewer 2021 https://www.exifdata.com/exif.php