Augmented Reality and Global Positioning System (GPS) for Indoor and Outdoor Navigation using Features from Accelerated Segment Test (FAST) Corner Detection Algorithm and A-Star Algorithm

Epafraditus Memoriano [1*]

[1]Department of Computer Science, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Semarang, Indonesia
*Corresponding author: epamemo@students.unnes.ac.id

ARTICLE INFO

Article history
Received 18 August 2020
Revised 18 September 2020
Accepted 13 October 2020

Keywords
Augmented Reality
GPS
FAST
Corner Detection Algorithm
A-Star Algorithm

ABSTRACT

Digital technology is currently being developed for mobile devices. The widespread use of gadgets is one aspect that has led to a lot of research on device technology. In the last few years, the technology that is embedded in developing information delivery is augmented reality. Augmented reality technology is a technology that combines real-world space with virtual objects created using computer graphics. The augmented reality technology embedded in the device to find a location is Global Positioning System (GPS). GPS is a system of directions with the help of satellites that are interconnected and are in orbit. Universitas Negeri Semarang will accept new students every new academic year. Many new students and parents were confused about the building they would visit during the new student admission period. This problem refers to the lack of complete plans and location directions for buildings at Semarang State University. With these problems, the researcher proposes a solution in the form of augmented reality technology to make it easier for someone to find the location of a building or room that is combined with a GPS. The application of augmented reality can increase user interaction in finding locations. Location search using augmented reality will be supported with GPS to determine the location of buildings and the user's location so that the application can show directions to the desired location from where the user is. With augmented reality, the direction can be shown in digital form on the user's device screen. This application will be collaborated with the existing Universitas Negeri Semarang floor plan as a marker to indicate the location option to be directed then the application will show the direction. This system will support the delivery of existing information, namely the building location plan at Universitas Negeri Semarang.

1 Introduction

Information is the result of a data processing that goes through a set of processes on a system, which is processed so that it is feasible to be presented to the public (Nataniel & Hatta, 2009). In the submission of information to show, a location conventionally is conveyed using a location plan or map depicted on a book or paper. With the rapid development of technology, the current location plan or map is delivered in digital form.

Digital technology is currently widely developed for gadgets. The increasing use of devices is one of the aspects that led to a lot of research on technology that can be applied to devices (Rumiński, 2015). Gadgets became so popular because it offered ease and speed in accessing information. Gadgets are commonly used by the public today with the Android operating system (Tarng, Ou, Yu, Liou, & Liou, 2015). The use of gadgets with this android operating system can be made easy by daily activities such as no longer needing to bring a paper map into a location or sharing an address using an image plan.

In recent years, technology embedded in the gadget is increase. A technology that can be applied to develop information delivery namely augmented reality (Tholabi, Ferdiana, & Hartanto, 2018). Augmented reality technology is a technology that combines real-world space with virtual objects created using computer graphics (Pramudita, 2015).

In addition to augmented reality technology embedded in the gadget to search for a location, the Global Positioning System (GPS) is used. GPS is a directional system with the help of interconnected satellites in orbit (Putra, 2019). In determining its location, another device called receiver GPS is necessary to receive data sent from satellites (Riera, Redondo, & Fonseca, 2015). The submitted data is converted into a position in latitude and longitude coordinate points displayed on the gadget screen (Cheng, Chen, & Chen, 2017). GPS is a system that is useful in accurately determining location, speed, and direction.

Every year, Universitas Negeri Semarang opens registration for new students. Most first-year students and their parents find difficulties looking for a building on campus due to insufficent information on maps and signs informing directions to certain faculty or buildings. Technological advances are currently running rapidly and can be implemented in conventional ways to simplify and streamline work (Taqyuddin, 2018). One of them is the augmented reality technology currently being used to facilitate the delivery of information (Tarng *et al*., 2015). This technology can be applied to give information about the location plan of a building or area at Universitas Negeri Semarang so that new students can more easily find a building location.

2 Methods

2.1 Research procedure

The current study used Research and Development (R&D) methods. According to Rusiñol, Chazalon, and Diaz-Chito (2018), research and development methods are used to produce certain products and test such products' effectiveness. Another opinion on research and development was expressed by Rusiñol *et al.* (2018), that development research is a process to develop a new product or perfect an existing and accountable product.

2.2 Data Collection

This research uses data collection tools in the form of instruments. The instrument used for data collection in this study is a questionnaire (Hidayat & Muttaqin, 2018). Data collection tools in the form of instruments for testing is BlackBox testing Tables (Putra, 2019).

2.3 Processing data

2.3.1 Feature Form Accelerated Segment (FAST) Corner Algorithm

FAST is an algorithm developed by Edward Rosten, Reid Porter, and Tom Drummond (Calonder *et al*., 2012). FAST Corner Detection is built to accelerate computing time in real-time with the consequence of lowering the accuracy of angular detection. FAST corner detection begins by specifying a p point at the coordinates (xp, yp) of the image and comparing the p point's intensity with the surrounding 4 dots *(*Münzer, Schoeffmann, & Böszörmenyi, 2018). The first point is located at the coordinates (x, yp-3), the second point is located at the coordinates (xp+3, y), the third point is located at the coordinates (x, yp+3), and the fourth point is located at the coordinates (xp-3, y). If the intensity value at point p is greater or smaller than the intensity of at least three dots around it plus a threshold intensity, then it can be said that point p is an angle. After that, the p point will be shifted to the position (xp+1,yp) and perform the intensity of all four points around it again. This

iteration continues until all points on the imagery have been compared (Antoni, Krajci, & Kridlo, 2013).

2.3.2 Augmented Reality Work System

Augmented reality work systems use image manipulation on electronic camera devices and data processing results to form images in the user's path of view on real physical objects combined. The process of image formation can also start from shooting a marker with the camera, then a mark that has the feature processed into the object reader provided by the Software Development Kit (SDK). The marker must also be registered and stored in the database in order to display the object data that matches the intended marker (Putra, 2019).

3 Results and Discussion

A 3D-object is created to display information in the form of text or a faculty location to be visited. Figure 1 is one of the 3D-object forms that show faculty name information.

(a) 

(b) 

Figure 1. 3D model text for information media: (a) without materials and (b) with materials

The 3D models depicted in Figure 1 appeared on the screen when the user gets close to the location on GPS or maps. If the user went to the mathematics and natural science faculty, the 3D model showed in front of the building.

The users are required to scan the marker at Universitas Negeri Semarang to open the menu for faculty navigation. The marker used for these purposes is illustration maps at Universitas Negeri Semarang, and the FAST algorithm finding the corner point at this image to create a marker database. As shown in Figure 2, the yellow lines show the points recorded into the database as a marker.

Figure 2. The marker of Universitas Negeri Semarang illustration map, readed using FAST Corner detection algorithm.

In indoor navigation, the shortest route search is done with the A* algorithm. The route is displayed on augmented reality in the form of an arrow to the desired location. This arrow appears by detecting the environment, in this case, the use of augmented reality reading technology without markers. When detecting a flat field, the arrow to the location can be displayed, and the user can follow the arrow up to the room you want, as illustrated in Figure 3.

Figure 3. The indoor navigation scene, yellow arrow shown as a navigation for user to get to the destination.

According to Figure 2 and Figure 3, the function of this app was working well. The app was also tested through the BlackBox testing method, as shown in Table 1.

Cases and Test Results			
Input	Expected Output	Results	Description
Read the map of Universitas Negeri Semarang as a augmented reality marker	The drop-down page appears to go to one of the options	The drop-down page appears to go to one of the options, and user could select the faculty	[✔]Success [ ]Failed

Table 1. In the indoor navigation scene, a yellow arrow is shown as navigation for the user to get to the destination.

When the marker is well-read, exactly like Table 1, this application can show the location to look for faculty at Universitas Negeri Semarang.

4 Conclusion

Augmented reality technology is developing rapidly. It can be utilized for navigation systems, and in this study, it is proven that augmented reality can be used for navigation systems with GPS support. The FAST Corner detection algorithm can also be applied to augmented reality to read markers well. In addition, it can also be concluded that the application can run smoothly to navigate outdoors indoors. Using the GPS, outdoor navigation can be run accurately and adequately.

Augmented reality can be developed more as a part of marketing, creative industries, advertising, and exhibition of a product.

References

Antoni, L., Krajci, S., & Kridlo, O. (2013). Fusing Points and Lines for High Performance Tracking. In *8th Conference of the European Society for Fuzzy Logic and Technology, EUSFLAT 2013 - Advances in Intelligent Systems Research*, 32, 302-309. doi:10.2991/eusflat.2013.49

Calonder M, Lepetit V, Ozuysal M, Trzcinski T, Strecha C, Fua P. (2012). BRIEF: Computing a Local Binary Descriptor Very Fast. *IEEE Transactions on Software Engineering*, 34(7), 1281-1298. doi:10.1109/TPAMI.2011.222

Cheng, J. C. P., Chen, K., & Chen, W. (2017, July). Comparison of Marker-Based and Markerless AR: A Case Study of An Indoor Decoration System. *Lean & Computing in Construction Congress (LC3) Conference*, 483–490. doi:10.24928/jc3-2017/0231

Hidayat, T., & Muttaqin, M. (2018). Pengujian Sistem Informasi Pendaftaran dan Pembayaran Wisuda Online menggunakan Black Box Testing dengan Metode Equivalence Partitioning dan Boundary Value Analysis [Online Graduation Registration Testing and Information Systems Payment using Black Box Testing with Equivalence Partitioning Methods and Boundary Value Analysis]. *Jurnal Teknik Informatika UNIS (JUTIS)*, 6(1), 2252–5351. doi:10.33592/jutis.Vol6.Iss1.38

Lutfiyati, T. A. (2016). Aplikasi Augmented Reality Pembelajaran Pengenalan Hardware Komputer untuk Sekolah Menengah Pertama dengan Metode Transformasi Geometri [Augmented Reality Application Learning Introduction to Computer Hardware for Junior High Schools using the Geometry Transformation Method]. *E-Theses UIN Malang*, 3(1). Retrieved from http://etheses.uin-malang.ac.id/3419/

Muhammad Taqyuddin. (2018). Pengembangan Media Pembelajaran Ipa Berbasis Augmented Reality Pada Pokok Bahasan Sistem Organ Tubuh Manusia untuk Kelas Vii Smpn 41 Semarang [Development of Science Learning Media Based on Augmented Reality on the Subject of Human Organ Systems for Class Vii Smpn 41 Semarang]. Undergraduate Thesis. Retrieved from https://lib.unnes.ac.id/32557/

Münzer, B., Schoeffmann, K., & Böszörmenyi, L. (2018). Content-based Processing and Analysis of Endoscopic Images and Videos: A Survey. *Multimedia Tools and Applications*, 77(1), 1323–1362. doi:10.1007/s11042-016-4219-z

Nataniel, D., & Hatta, H. R. (2009). Perancangan Sistem Informasi Terpadu Pemerintah Daerah Kabupaten Paser [The Design of Integrated Information System for the Regional Government of Paser Regency]. *Jurnal Ilmiah Ilmu Komputer*, 4(1), 47–54. doi:10.30872/jim.v4i1.27

Pramudita, D. A. (2015). Pengembangan Aplikasi Artopeng sebagai Media Pengenalan Topeng Adat di Museum Sonobudoyo dengan Teknologi Augmented Reality Berbasis Desktop [Artopeng Application Development as a Media for the Introduction of Traditional Masks at the Sonobudoyo Museum with Desktop-based Augmented Reality Technology]. *Lumbung Pustaka Universitas Negeri Yogyakarta*, 151. Retrieved from https://eprints.uny.ac.id/33052/

Pucihar, K. Č., & Coulton, P. (2014). Exploring the Evolution of Mobile Augmented Reality for Future Entertainment Systems. *Computers in Entertainment*, 11(2). doi:10.1145/2582179.2633427

Putra, S. I. W. (2019). Implementasi Teknologi Markerless Augmented Reality menggunakan Metode Algoritma Fast Corner Detection Berbasis Android (Studi Kasus Multimedia Buku Interaktif Kebudayaan Lokal Kalimantan Barat) [Implementation of Markerless Augmented Reality Technology using the Android-based Fast Corner Detection Algorithm

Method (Case Study of Multimedia Interactive Book of Local Culture in West Kalimantan)]. *Coding: Jurnal Komputer Dan Aplikasi*, 07(1), 1–10. doi:10.26418/coding.v7i01.30807

Rumiński, D. (2015). An Experimental Study of Spatial Sound Usefulness in Searching and Navigating through AR Environments. *Virtual Reality*, 19(3–4), 223–233. doi:10.1007/s10055-015-0274-4

Rusiñol, M., Chazalon, J., & Diaz-Chito, K. (2018). Augmented Songbook: An Augmented Reality Educational Application for Raising Music Awareness. *Multimedia Tools and Applications*, 77(11), 13773–13798. doi:10.1007/s11042-017-4991-4

Sánchez Riera, A., Redondo, E., & Fonseca, D. (2015). Geo-located Teaching using Handheld Augmented Reality: Good Practices to Improve the Motivation and Qualifications of Architecture Students. *Universal Access in the Information Society*, 14(3), 363–374. doi:10.1007/s10209-014-0362-3

Sudaryono, Guritno, S., & Rahardja, U. (2011). Theory and Application of IT Research: Metodologi Penelitian Teknologi Informasi [Theory and Application of IT Research: Information Technology Research Methodology]. Yogyakarta: Andi.

Tarng, W., Ou, K. L., Yu, C. S., Liou, F. L., & Liou, H. H. (2015). Development of A Virtual Butterfly Ecological System Based on Augmented Reality and Mobile Learning Technologies. *Virtual Reality*, 19(3-4), 253-266. doi:10.1007/s10055-015-0265-5

Tholabi, M. R., Ferdiana, R., & Hartanto, R. (2018). Augmented Reality Application Development for Sales and Promotion in Shopping Mall. Universitas Gadjah Mada. Retrieved from http://etd.repository.ugm.ac.id/penelitian/detail/160256