A Mobile Augmented Reality Application for Automotive Spare-Part Installation

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ABSTRACT

Automotive exterior spare parts retailers frequently sell exterior spare parts for a range of cars via direct sales transactions and online media. A major issue has come up for consumers who purchase products online must install spare parts in-dependently, with limited instructions that make it difficult for customers to install the replacement components. This is demonstrated by nearly 50% of online consumers complaining to the seller about installation errors, indicating the need for a solution to these issues. Augmented reality was used as a solution to educate how to install automotive exterior spare parts. In this work, the Spatial Tracking technology is utilized to project objects from a viewpoint in order to send data digitally and show the 3D model to the object's surrounds in real time. This study included as samples rear-view mirrors, headlights, stop lamps, and fog lamps. According to the study's findings, The user acceptance test was carried out by online consumers who buy spare parts at the store, and the results of the average percentage score of the entire questionnaire by more than 53% agree and strongly agree that the use of augmented reality can ease the spare-part installation bought online, the results of testing the AVAR application by the user are successful and well accepted.

1. Introduction

Augmented Reality (AR) technology merges the computer-generated virtual and real worlds. Virtual items include text, animations, 3D models, and films that are blended with the actual environment such that the user experiences virtual things in their surroundings. Unlike virtual reality, augmented reality does not completely replace the real environment, but rather adds to or complements it. Virtual objects display data that the user cannot perceive directly with his or her senses. This makes Augmented Reality (AR) a helpful technology for supporting users in engaging with and viewing[1],[2] or interpreting information shown by virtual objects in the actual environment in order to accomplish real-world activities[3],[4]. Augmented Reality (AR) is rapidly increasing, enabling the development of educational applications in a range of fields [5], [6]. Up until now, direct sales have been impacted because spare part installation is performed directly by mechanics. While roughly fifty percent of customers who purchase replacement parts online from the store have difficulty installing them on their own, this company must include installation instructions for spare parts to ensure that things may be successfully installed by online customers. Therefore, we need a solution that utilizes Augmented Reality as a tool for learning how to install automobile exterior replacement parts in an application to handle these challenges. The Spatial Tracking technology is then utilized to project goods from a viewpoint to transfer digital information and introduce 3D models to the object's surroundings in real time, enabling internet shoppers to comprehend how to install vehicle replacement parts. Due to the enormous number of these transactions, there has been a great deal of consumer feedback regarding the correct installation procedure when purchasing things online. According to the findings of this study, internet users may link replacement parts purchased from the Dwi Mar Jaya shop with instructions from an Augmented Reality depiction, which is achieved using the spatial tracking approach.

2. Literature Review

Previous research discusses techniques involving hardware and software to implement a Spatial Augmented Reality installation, along with a number of illustrative display examples from various environments, including museums[7],[8], edutainment settings, research projects, and industrial settings [9]. The correlation between this research and the gathered research is the approach utilized, which is Spatial Augmented Reality (SAR). In contrast, the incorporation of Augmented Reality technology with Spatial User Interfaces enables users to freely interact with both 3D and conventional 2D workstation application data[10]. Another research conducted in spatial tracking [11] where this research explains the technical considerations that must be addressed. Future work will entail prototyping to improve the strengths and shortcomings highlighted for SAR. On contact with SAR, the next stage is to examine the strategies provided in action by constructing prototypes, as well as to investigate new interaction techniques and apply them to the same situation in SAR. Other research talks about a full natural feature-based tracking system that helps make Augmented Reality apps for the automotive industry[12],[13],[14]. Application system shows the location of 3D coordinates in a certain environment, which can be used in many different ways in cars. It also evaluates advanced tracking methods based on the needs of industrial settings.

In 2018, a study were conducted about a new way to use mobile Spatial Augmented Reality on real-world objects and was focused on mobile interactions with real-world objects in single or group settings[15], [16]. This system keeps track of the position and orientation of Real 3D objects and projects virtual content on top of them. Stereo optical tracking is based on features and gives you high accuracy and low latency. Mapping technique: This technique is used to project images onto real objects that have complicated 3D shapes. This research's prototype works well compared to current Augmented Reality (AR) systems, and it has been used for virtual prototyping and medical visualization. All of our results together suggest that the mobile spatial augmented technology approach lets people interact with real objects in a direct, mobile, and direct way.

3. Methodology

3.1 Problem Identification

During this phase, the objectives, benefits, and scope of the spare-part installation were documented. This phase's purpose was to employ new technologies in the automobile industry to educate online customers, particularly through the use of spatial tracking to detect and learn how to install replacement parts.

3.2 Planning Phase

In this stage, spare parts were selected to be modeled, designed, and planned based on the desired objectives and benefits.

3.3 Design Phase (Spatial Tracking)

This was a phase to design and develop spatial tracking to identify spare-part using in an augmented reality environment. The spatial tracking[17] method works by tracking points that are clearly identifiable or have the features of the item being tracked. These points will be presented during further monitoring. The line is the method of connecting 20 points to make a line that is the basis for creating 3D models. The system operates based on the received data, such as many points monitored in real-time objects, both sensor orientation and environmental structure owing to light and surrounds, so that tracking can be readily comprehended.

A. Preparation Stage

In this phase, the system will follow the image acquired by the camera and assign certain feature points depending on the unique characteristics of each item, such as its curves, edges, or colors. At this stage, two preparations are made: the cellphone camera, for which there is already an application to take points from the object to be visualized, and feature points, which are points that have been tracked by the system on objects captured by the camera to serve as an anchor and have a function similar to that of a special marker. In addition, the retrieved feature points may be employed during the recognize process to extend the map while exploring the tracking object's environment.

Figure 1. Feature Points Extraction

B. Read Stage

At this level, the aim is to read the items that have been tracked by camera in earlier phases, as well as the feature points that differentiate each object. From the perspective of the device, tracking utilizes Inertial Measurement Unit (IMU) sensor data that may be used to estimate postures[18],[19],

C Recognize & Track Stage

In the recognize and track stage, this is the picture acquired in the frame, thus image reference is processed just once while searching for anchor or focus points. If feature points are recognized when the object is tracked somewhat, the 3D model that appears subsequently may not be stable on the real-time object picture. Then, the process of feature extraction will be repeated in the same manner, and the new points will be added to the existing feature set. Figure 2 depicts the triangulation-completion point characteristics. Triangulation is the technique of connecting points to form a geometry of interconnected lines resembling a triangle, which serves as the basis for creating 3D models.

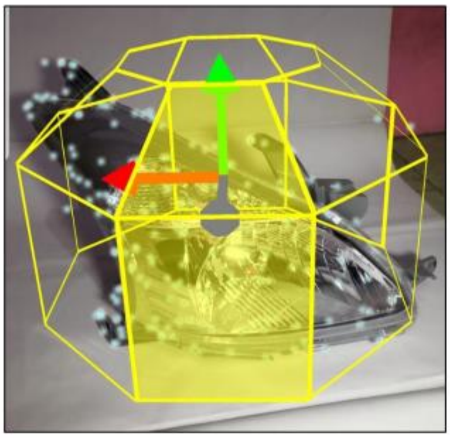

Figure 2. Spatial Tracking Triangulation

D. Display Stage

This display process is an update of identified feature points from the feature extraction process, based on a comparison of the map's features. The purpose of this presentation is to display a 3D model that has been tracked and identified in a prior phase. If the existence of a feature point changes and the 3D model object does not show, an update will be performed to correct the drift created during the reading process and add newly discovered feature points to the map. Next, proceed to the registration phase, which employs a tracking system to synchronize virtual content with the physical environment.

3.4 Test and Evaluation Phase

The user acceptance of this study was determined by 30 online consumers completing an online survey. The following steps are taken to determine the degree of user acceptance:

A. Questionnaire Development

The initial step is to generate a list of possible queries. Examining the results of the usage of location monitoring in online consumer applications using questionnaires. This questionnaire contains five points: the ease of operation of the application by users and consumers, the output quality of the application, the application's usefulness for consumers in the installation of spare parts, the application's influence on the difficulty faced by consumers, and consumer satisfaction with the application's use. The score for this research questionnaire is determined using a Likert scale. Scale Likert is a non-comparative, unidimensional scale with an inherent scoring scale greater than two.

B. Distribution of Questionnaires

The second stage entails sending questionnaires to 30 online users as a sample for evaluating the tested application.

C. Data Processing for Questionnaires

The questionnaire data will be analyzed to evaluate the average degree of online consumer acceptability of spatial tracking in tested applications for augmented reality (AR)-based information media used for the installation of automobile exterior replacement components.

4. Results And Discussion

4.1 Augmented Reality Application for Automotive Spare-part Installation

The following displays have been developed for the AVAR (Avanza Augmented Reality) application. Before the user utilizes this application by initiating the view from multiple menus consisting of Start AR 360, contacts, and guides, as seen in figure 4, the user must initiate the view from multiple menus comprising of Start AR 360, contacts, and guides.

Figure 3. AVAR Application Menu

The AVAR application's primary menu is depicted in Figure 3. There are three options available on the menu display. The three features begin with AR Camera 360° to access the AR Camera menu, which then takes users to real-world objects and provides them with information about them. The two contacts for which there is a menu to obtain information about the application and the item's purchasing contact. Third is the menu guide for users; if you do not understand how to use the application, you can access the menu guide.

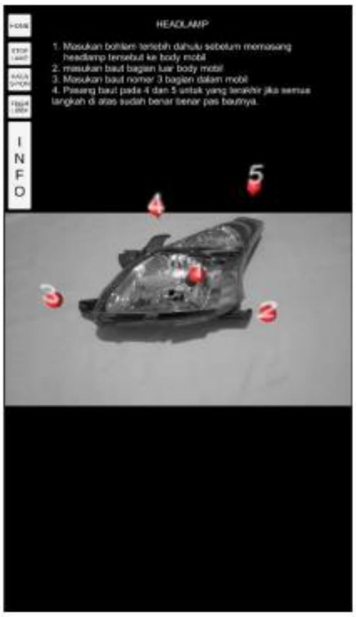

Figure 4. Headlamp AR Installation Tutorial

Figure 4 is an AR Camera display depiction of instructions for putting automotive spare parts on the headlamp of a commercial vehicle. If you wish to learn how to install it on other spare components, please click here.

Figure 5. Fog Lamp AR Installation Tutorial

Figure 5 is a representation of automotive fog lamp installation instructions using an augmented reality camera.

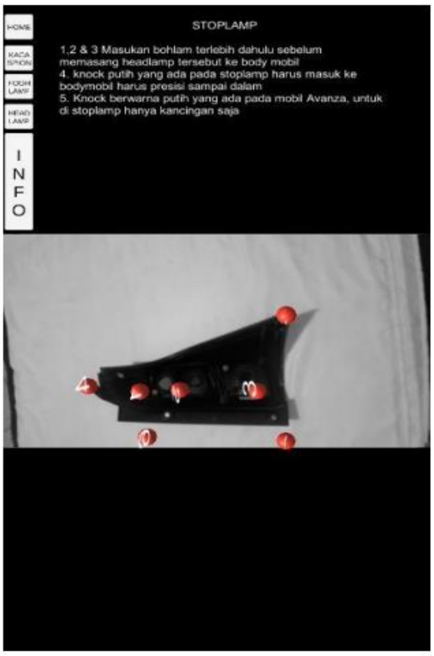

Figure 6. Stop Lamp AR Installation Tutorial

Figure 6 is an augmented reality (AR) camera display visualization of instructions on a car stop lamp. These instructions include direction points for installing automobile replacement parts.

Figure 7. Rearview AR Installation Tutorial

Figure 7 is a visualization of instructions on a car rearview lamp that was created with an augmented reality camera. These instructions provide direction pointers for installing automobile spare parts.

4.2 Users Testing and Evaluation

The results of the AVAR application assessment questionnaire (Avanza Augmented Reality) that was filled out by 30 online consumer respondents that buy car spare parts at the store using online questionnaire. The completed questionnaire is then processed by first computing the total score based on all of the responses and then comparing that score to the rating scale. The resulting score on average is used to calculate a percentage that indicates whether or not the percentage has reached 80%.

- Question 1: Does users have difficulty in installing auto parts independently?
- Question 2: Does the AVAR application is easy to understand and can be operated properly?
- Question 3: Does the AVAR application becomes the solution difficulties faced by consumers?
- Question 4: Does the AVAR application can help to ease the installation of spare parts?
- Question 5: Does the consumers are satisfied with the use AVAR application?

Table 1. Users Questionnaire Answers

Scale	Question 1	Question 2	Question 3	Question 4	Question 5
Strongly Disagree	0	0	0	0	0
Disagree	0	0	0	2	6
Neutral	4	1	1	0	2
Agree	9	19	6	12	9
Strongly Agree	17	10	11	16	19

The result of Question 1 indicated that 57% of the respondents (17 people) strongly agree, 30% of the respondents (9 people) agree, and 13% of the respondents (4 people) were neutral to the first point of the questionnaire, which was that the respondent experienced difficulty in installing car spare parts independently. The percentage result can be seen in figure 8 below.

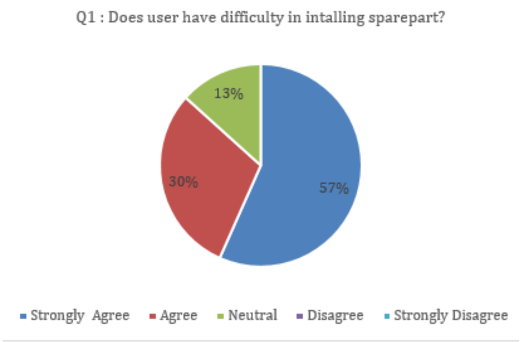

Figure 8. Question 1 Percentage Results

The result of Question 2 indicates that 34% of the respondents (10 people) agree, 63% of the respondents (19 people) agree, and 3% of the respondents (1 person) are neutral to the second point of the questionnaire, which is that the respondent is easy to understand and can operate the AVAR application properly. The percentage result can be seen in figure 9 below.

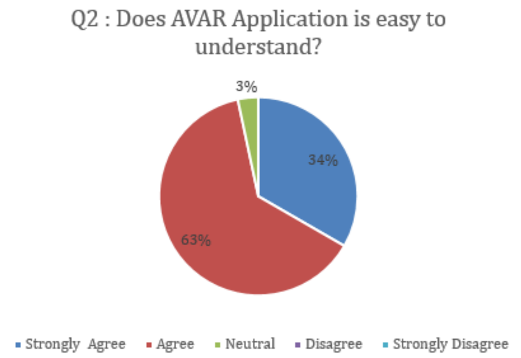

Figure 9. Question 2 Percentage Results

The result of Question 3 indicated that from 18 people answers that the application AVAR can be a solution to the challenges that are faced by consumers; 61% of respondents (11 people) strongly agree with the statement; 33% of respondents (6 people) agree with the statement and 6 % of respondents (1 person) are neutral regarding the statement. The percentage result can be seen in figure 10 below.

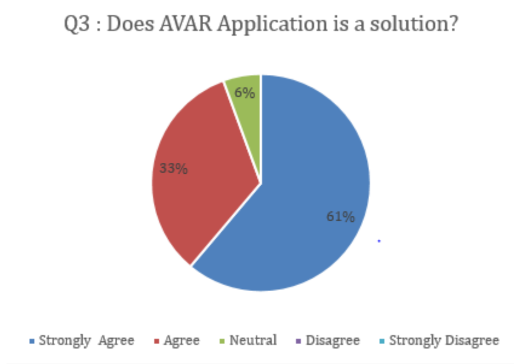

Figure10. Question 3 Percentage Results

According to the findings of Question 4, 53 % of the respondents (16 people) are extremely agree with the statement, 40% of the respondents (12 people) agree with the statement, and 7% of the respondents disagree with the statement (2 people) neutral to the fourth item of the questionnaire, which asks respondents how they feel about the possibility that the AVAR program may make it easier for customers to install replacement parts. The percentage result can be seen in figure 11 below.

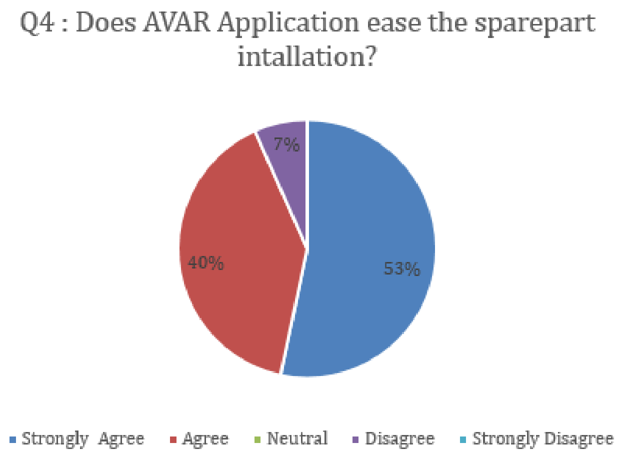

Figure 11. Question 4 Percentage Results

The results of Question 5 indicate that 53% of respondents (19 people) strongly agree with the statement, while 25% of respondents (9 people) agree with the statement, and 17% of respondents (6 people) disagree with the statement (2 people) neutral in regard to the fifth point of the questionnaire, which asks whether or not customers are satisfied with the utilization of the AVAR application. The percentage result can be seen in figure 12 below.

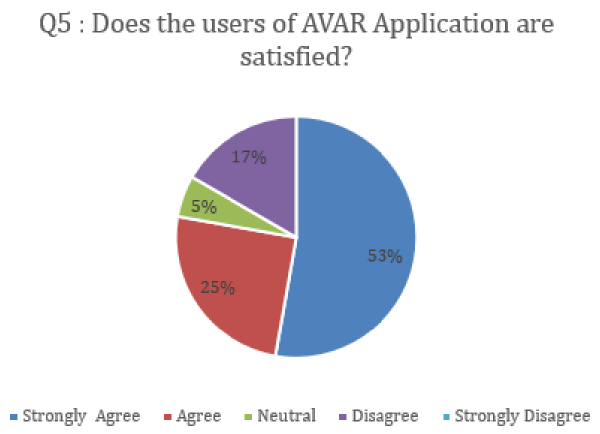

Figure 12. Question 5 Percentage Results

5. Conclusion

In accordance with the findings of the research, it is possible to draw the conclusion that spatial tracking is capable of detecting augmented objects. Furthermore, with online customer test results regarding the implementation of the spatial method tracking on the installation of car exterior spare parts yielding more than 53% agree and strongly agree that the use of augmented reality can ease the installation spare part that the users bought online, it is possible to assert that the test results AVAR application by the user is successful and is well received by the customers.

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