

Design and Implementation of Digital Tourism Village Virtual Tour

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Abstract

The purpose of this research is to develop a virtual tour application for tourist villages. The promotion carried out by tourist villages is still conventional, especially with the emergence of new tourist attraction spots that need to be informed quickly and interactively to visitors. Virtual tour technology and interactive maps are suitable solutions to promote tourist attractions in the tourist village. The research stage starts with collecting tourist location image assets, combining these images with stitching techniques, and applying the equirectangular model to produce panoramic images in the form of a spherical object, which will produce panoramic images that can be seen with a 360-degree. The results of testing the application show that the functional runs well and in accordance with the needs of the village administrator to manage its tourist objects. From visitors who use the application, it is concluded that the application can make it easier to find tourist attractions and images of these attractions more interactively. With this application, promoting tourist villages becomes easier and can reach a wider community.

Keywords: *Virtual Tour, Interactive Map, Panoramic Images, Spherical Object, Digital Tourism Village.*

1 Introduction

A tourism village is a community environment that strives for its potential and life from its tourist environment.[1]. It can be concluded that the development of tourism villages in the form of products is cultural tourism, ecotourism, marine tourism, adventure tourism, agro-tourism, gastronomy (culinary tourism), and spiritual tourism. [2]. The attraction of tourist objects in the countryside is deliberately created and developed by stakeholders so that tourists come in droves [3].

ICT technology can play a major role in the development of tourism villages. One technology that is widely used in promoting tourism is to use virtual tour technology [4]. This is because virtual tours are able to be part of a more attractive promotional media and are able to reach a wider segmentation [5],[6],[7]. In addition, other research results show

that 360° virtual tours can attract local or long-distance tourists and make it easier for users to see certain locations with their appearance [8].

Virtual Tour is a simulation of a real environment displayed online, consisting of a collection of panoramic images, a collection of images connected by hyperlink virtual models of the actual location. [9]. In designing the Virtual Tour there are many panoramic models, one of which is by using the equirectangular (spherical) model [10]. The equirectangular (spherical) model is a 360° panoramic model or the results of stitching images that are commonly used and supports many applications with various platforms and can be shifted according to the user's wishes, and can be zoomed out, zoomed in on the display image and allows users to see to the top and bottom of the image [11],[12]. One of the software to create a 360° virtual tour so that it can be dynamic using the Pannellum website tools [13]. Pannellum is a lightweight open source panorama viewer plug-in for the Web that includes a hotspot capable of displaying information, connecting multiple panoramas in a virtual tour, and video support. [14]. Interactive map supports the existence of many tourist sites in tourism villages, it requires an easy access media and is able to integrate the location and geographical area of the village. The use of interactive maps or web mapping allows to embed maps directly into web pages or mobile apps helps to keep users engaged and can show information relevant to the information on the map allows zoom in and zoom out, explore, identify certain features [15][16]. Interactive map helps to keep users engaged and can show information relevant to the information in the map allows zoom in and zoom out, explore, identify certain features[17],[18]. The development of interactive maps can use one of the open- source libraries, namely Leaflet. Leaflets are designed with simplicity, performance and usability in mind. In this case the leaflet works efficiently on all desktop and mobile platforms, can be extended with many plugins, has a reliable connection, is easy to use and well-documented, as well as simple easy-to-read source code that can contribute[19][20]. In its construction the Leaflet uses an Open Source map, namely OpenStreetMap [21]. OpenStreetMap is a web-based project to create a free and open world map, built entirely by volunteers by conducting surveys using GPS, digitizing satellite imagery, and collecting and releasing publicly available geographic data [22], [23].

The difference as well as novelty from previous studies is the development of a village virtual tour system combines elements of interactive maps and panoramic images of tourist attractions so that visitors can easily find routes and locations of tourist attractions and get a complete picture of the tourist attraction with panoramic images they see. Therefore, the contribution of this study is to develop a virtual tour system for tourism villages that is able to produce information in the form of 360° panoramic images and is integrated with interactive maps that show tourist locations in the tourism village.

2 Problem Formulations or Methodology

Figure 1 shows the flow and stages carried out in this research, which includes three stages of research starting from the collection of virtual tour assets, followed by image processing and locations on the virtual tour, and the last stage is to integrate the virtual tour system.

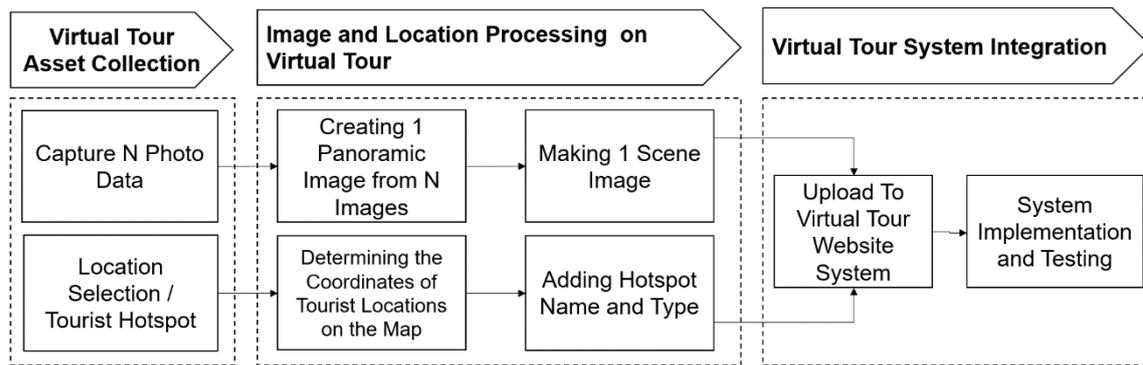


Fig 1. Flow and Stages of Research

The explanation of each stage of the research is as follows:

- Stage 1, is the stage where assets from the virtual tour are collected. Determination of the location of virtual assets is done by selecting 14 tourist location points that will be used as information on the tourist village. At each point of the tourist location, 53 images were taken which were used as image data to create a panoramic image.
- The second stage is the mechanism for processing image data into panoramic images using sewing techniques where 53 images obtained will be assembled into 1 panoramic image, where so that the viewing angle of the panoramic image becomes wider, the panoramic image is made in the form of a model of a spherical object. (Spherical) using the equirectangular method. After becoming a panoramic image, the image is equipped with other information that produces 1 image scene. The panoramic image processing was developed with the Pannellum open-source library. Meanwhile, to determine tourist locations that are far apart, the virtual tour system uses an interactive web-based mapping mechanism or web mapping. This is used to provide a marker of the coordinates of tourist locations that are far apart. Determination of the coordinates of tourist sites, using a base map derived from OpenStreetMap using the leafletJS library as a connector.
- The third stage is the activity of integrating panoramic image scenes and markers of tourist sites into a unified system for easy management and access to virtual tour data. This stage is also used to test the virtual tour system that was built.

3 The Proposed Method

The analysis steps for design and implementation of digital tourism village virtual tour are explained as follows

1. Describe a system architecture
2. Design of system structure
3. Perform a panorama image analysis
4. Perform interactive map analysis
5. Create system modelling
6. Conduct system testing
7. Draw conclusions and suggestions

4 Results, Analysis and Discussions

The system built is a virtual application using a website platform by integrating panoramic image processing capabilities and interactive maps. The website platform was chosen because it has advantages, namely that it can be accessed easily with a browser, making it easier for users to access applications with gadgets, smartphones, laptops or computer devices. Virtual Tour technology is used because it has several advantages, namely it can display better visual information compared to other information so that it can be applied to applications and can be a solution to existing problems. The purpose of this application is to be able to display information on tourist village locations interactively and easy to use by users.

4.1 System architecture

The system architecture built in Figure 2 involves interconnected components. From the user side, the virtual tour system that was built has two users, namely the admin who is in charge of managing virtual tour data and visitors who have access to visit the virtual tour system. The developed interface is divided into two parts, namely the interface used by the admin and the interface that is accessed by visitors. The tourist village virtual tour system is built on an internet-based server in which there is a database and data processing mechanism.

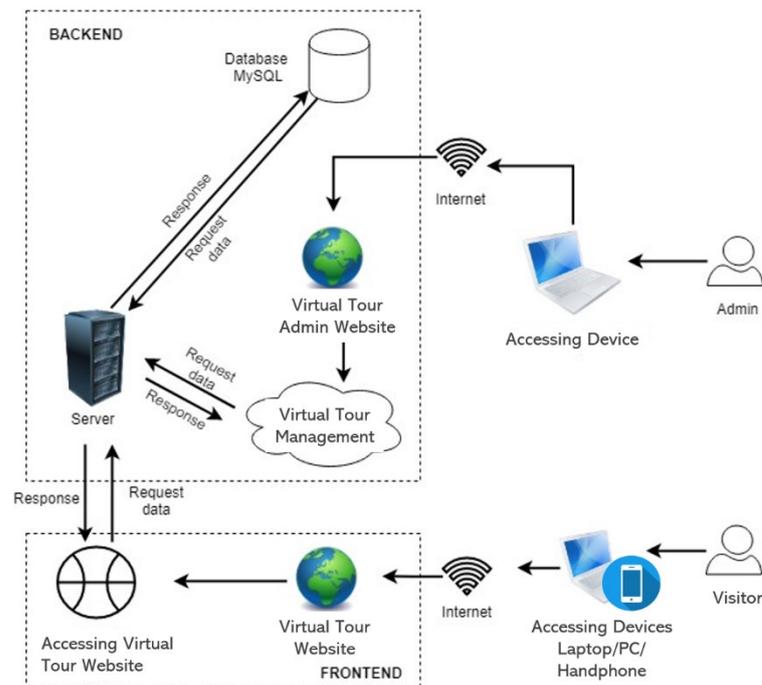


Fig 2. Tourism Village Virtual Tour System Architecture

4.2 System structure

The structure of the virtual tour system that is built consists of a panoramic image processing structure, an interactive web development structure, the structure of the database used, and the interface structure of the virtual tour system that is built. The structure of the virtual tour system can be seen in Figure 3.

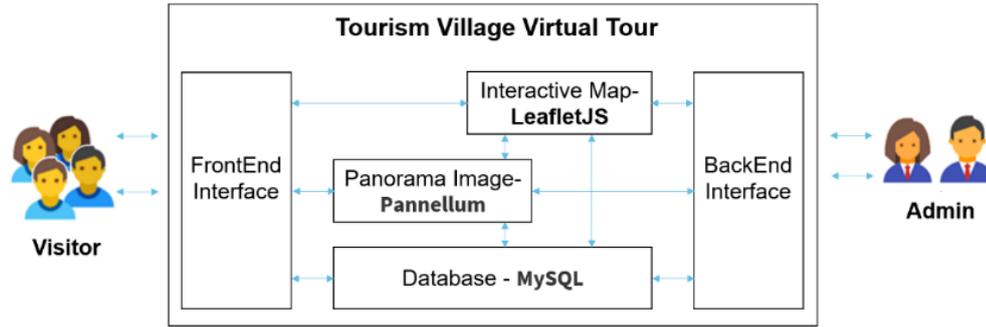


Fig 3. System Structure of Tourism Village Virtual Tour

4.2.1 Panorama image analysis

Panoramic images come from a collection of several images that are put together using a certain method. The technique of combining these images into one panoramic image is called the stitching technique. In this research, the images will be combined using a single row panorama mechanism where the allowable overlap of image similarities is 25%. Illustrations of stitching technique and single row stitching technique panorama mechanism can be seen in Figures 4(a) and 4(b).

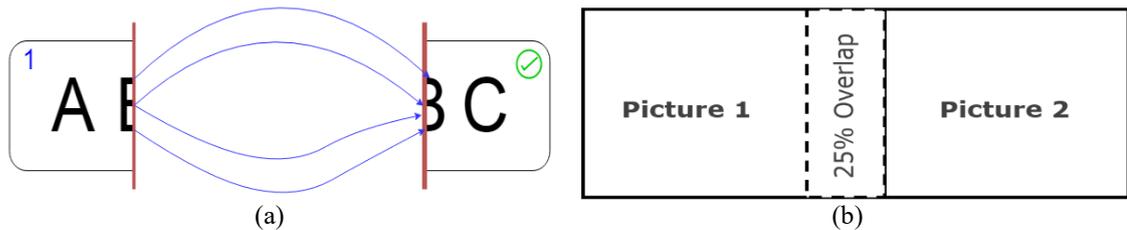


Fig 4. (a) The Stitching Technique Panoramic Images (b) Single Row Stitching Technique Panoramic Image Mechanism

Since the stitching technique is a merging of images by detecting color similarity. So that way the photo taken must get a connection object with the next object as shown in Figure 5.



Fig 5. Color Detection On The Image To Be Stitched

Figure 6 shows the stitching process of a panoramic image involving 4 photographic images taken at one of the region's spots and the images are arranged one after another sideways.

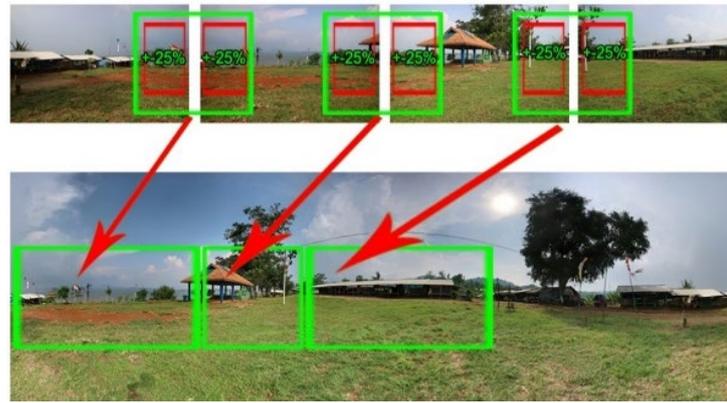


Fig 6. The Process of Stitching The Images to Panoramic Image

Figure 7 shows a flow chart of the creation of the panoramic image used in this study. With the formation of a 360° panorama, the combined image looks like it is curved and the user who is in the 360o virtual tour will feel like being in a tourist spot directly. The stitching of one image with another so that it becomes a 360° panoramic photo is by matching similar color codes to form a point-to-point. The equirectangular model is applied to a 360° panoramic image that has previously been stitched. This model performs the formation of a panoramic image with a circular projection that is 360°+180° so as to form a spherical object which can be seen in Figure 8.

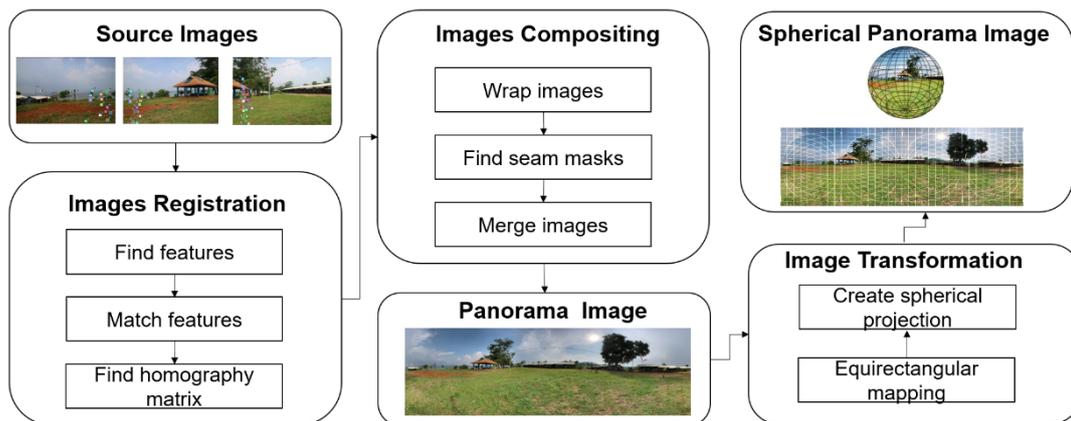


Fig 7. Flowchart of Creating Spherical 360° Panorama Images (Modified)

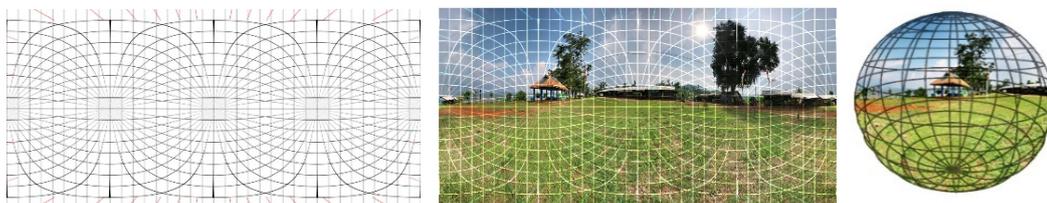


Fig 8. Transformation Of Panoramic Image Into Spherical Object Image

In this study, 14 panoramic images were produced which represent 14 locations on a virtual tour of tourist villages. The 14 panoramic images can be seen in Table 1.

Table 1: Panoramic image files in virtual tour system

No	File Name / Location	File Size
1	The monument 1.jpg	11.909 Kilobyte
2	The monument 2 KBB.jpg	3.741 Kilobyte

3	Front of the monument.jpg	5.571 Kilobyte
4	Love Sand - KBB.jpg	4.245 Kilobyte
5	Love Sand.jpg	2.545 Kilobyte
6	Village offices.jpg	550 Kilobyte
7	The Village Mosque.jpg	2.908 Kilobyte
8	Current Selfie Objects.jpg	2.799 Kilobyte
9	The peak of Damar.jpg	3.132 Kilobyte
10	Sand Tugaran (1).jpg	4.045 Kilobyte
11	Sand Tugaran (2).jpg	460 Kilobyte
12	Jati Gede Reservoir (1).jpg	3.993 Kilobyte
13	Jati Gede Reservoir (2).jpg	3.229 Kilobyte
14	Homestay.jpg	4.820 Kilobyte

In order to display a tourism area spot that combines the location name, location coordinates, images, display form, and application interaction, it is necessary to merge the interconnected scenes and hotspots in each scene in a JSON file format as shown in Figure 9.

```

"scenes": {
  "Waduk Jati Gede": {
    "title": "Waduk Jati Gede",
    "pitch": -3,
    "yaw": 117,
    "type": "equirectangular",
    "panorama": "foto-panorama-1.jpg",
    "hotSpots": [
      {
        "pitch": -2.1,
        "yaw": 132.9,
        "type": "scene",
        "text": "",
        "sceneId": "selfie"
      }
    ]
  },
  "selfie": {
    "title": "Foto Hotspot Selfie",
    "yaw": 5,
    "type": "equirectangular",
    "panorama": "foto-panorama-2.jpg",
    "hotSpots": [
      {
        "pitch": -0.6,
        "yaw": 37.1,
        "type": "scene",
        "text": "",
        "sceneId": "Waduk Jati Gede"
      }
    ]
  }
}

```

Fig 9. JSON Format on The Virtual Tour

4.2.2 Interactive map analysis

In the development of a virtual tour of a tourism village, the transfer of one scene point to another scene uses a map. This is because the related scene points are far from each other and the application of the scene is in an outdoor location. In taking the location of the tourist village map points using the Openstreetmap service by typing "Paku Alam Sumedang Village" then a page with a map location display appears as shown in Figure 10.

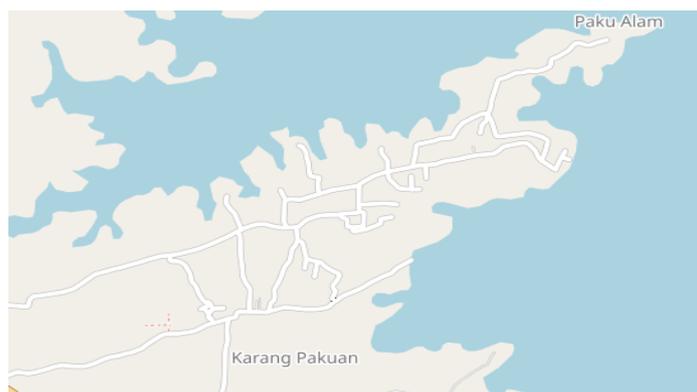


Fig 10. Tourist Village Location Map

To enter marker data for tourist locations in the virtual tour village system, we need a library that can interact with maps in the system. Implementation of the LeafletJS library is used to facilitate maps with the coordinates of tourist locations that have been determined in the tourist village virtual tour system. The coordinates of tourist sites stored in the virtual tour system can be seen in Table 2.

Table 2: Coordinates of tourist location points

No	Tourist Location Points	Latitude	Longitude
1	Buricak Burinong village	-6.88738	108.07329
2	Jati Gede Reservoir	-6.88246	108.07945
3	The monument	-6.88487	108.07497
4	Permata peak	-6.8835	108.07758
5	Love sand	-6.88906	108.07319
6	The peak of Damar	-6.88766	108.07252
7	The Village Mosque	-6.88779	108.07153
8	Front of the monument	-6.88868	108.06874
9	Village offices	-6.88374	108.07668
10	Sand Tugaran	-6.88736	108.07389
11	Jati Gede Reservoir (2)	-6.88248	108.07846
12	Panenjoan Tourism	-6.88781	108.07437
13	Mas waterfall	-6.8871	108.07559
14	Homestay	-6.88374	108.07604

The flow chart of the process of mapping the coordinates of tourist sites starting from the map initiation stage, the process of inputting coordinate data and viewing tourist location markers that have been stored on the map can be seen in Figure 11(a) and the results of inserting tourist site markers can be seen in Figure 11(b).

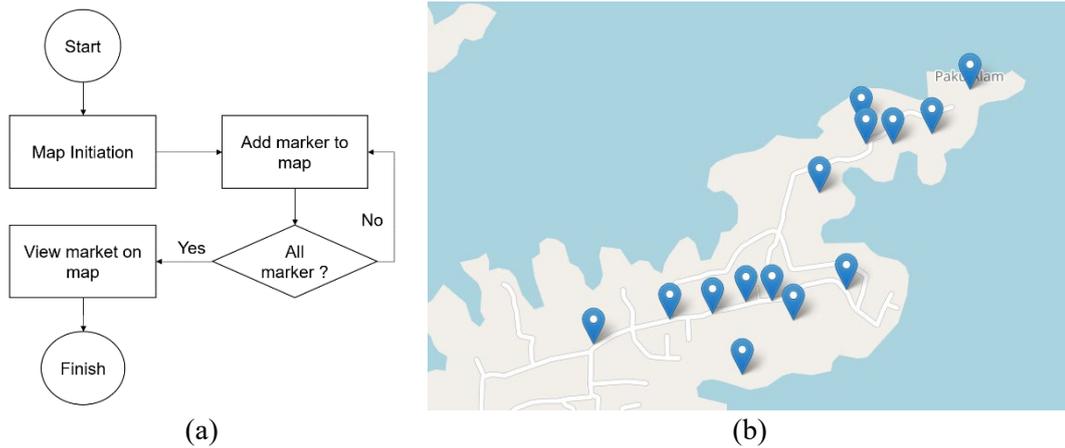


Fig 11. (a) Flowchart Of Insertion of Tourist Site Markers (b) Markers of Tourist Locations Map

4.3 System modelling

The modeling of the tourist village virtual tour system uses an object-based approach using use case diagrams dan class diagrams. Use case diagrams are used to show the functionality and interactions of the system with its users [24]. Figure 12 shows that the admin user can manage panoramic image data, including hotspots / information contained in it, manage maps and update the virtual tour system profile. Meanwhile, visitors are only given access to view information from the virtual tour system by accessing maps and 360° panoramic images. The next modeling process is to create a class diagram which is a structural description of the relationship between each object that runs on the system.

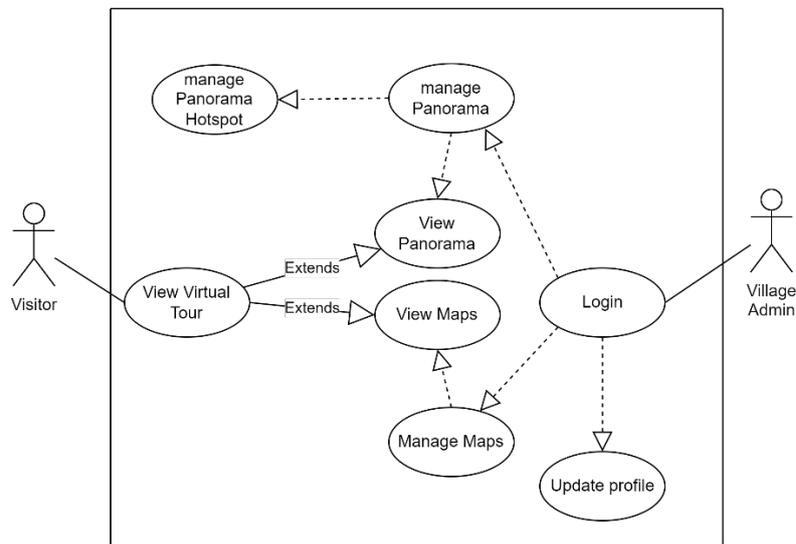


Fig 12. Use Case Diagram of Tourism Village Virtual Tour

Class is a specification that if instantiated will produce an object and is the core of object-oriented development and design. And class diagrams can describe and provide a broad view of a system by showing its classes and object relationships. Class diagram modeling on the virtual tour system can be seen in Figure 13.

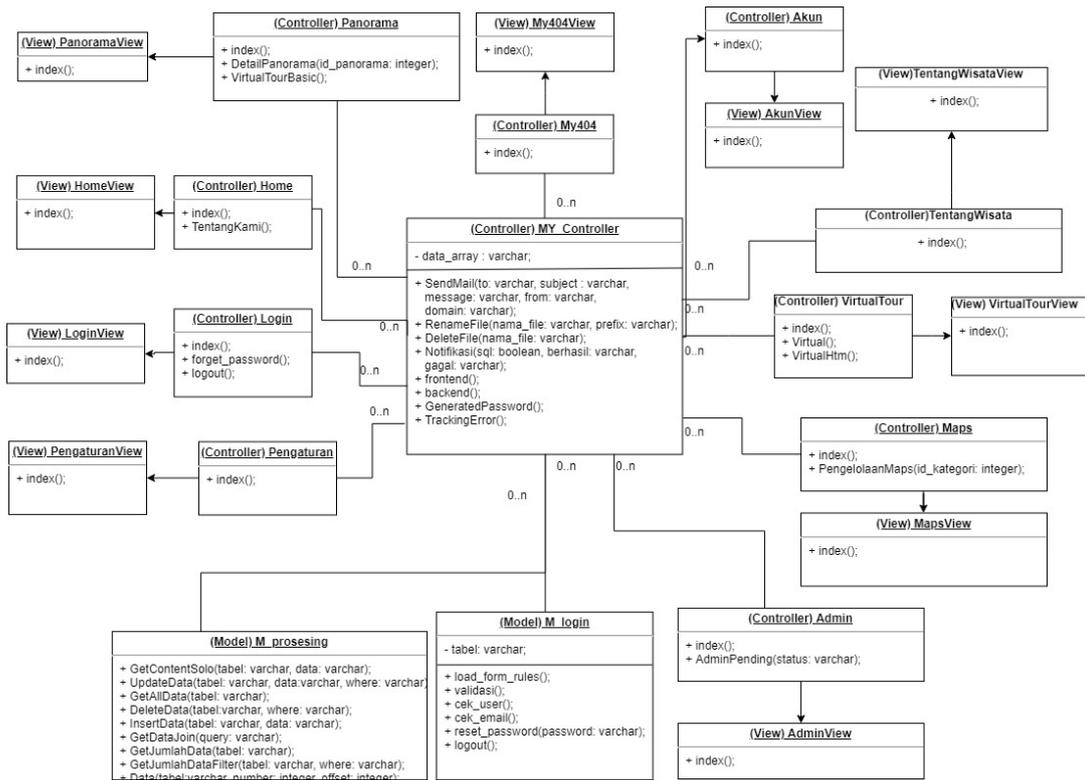


Fig 13. Class Diagrams of Tourism Village Virtual Tour

The database model developed in the tourist village virtual tour system consists of 5 interrelated tables. These tables serve to store administrator data, panoramic images and their hotspots, store location data and coordinates of tourist sites, as well as store profiles from the tourist village virtual tour system. The schema of the relationship between tables in the virtual tourism village tour system can be seen in Figure 14.

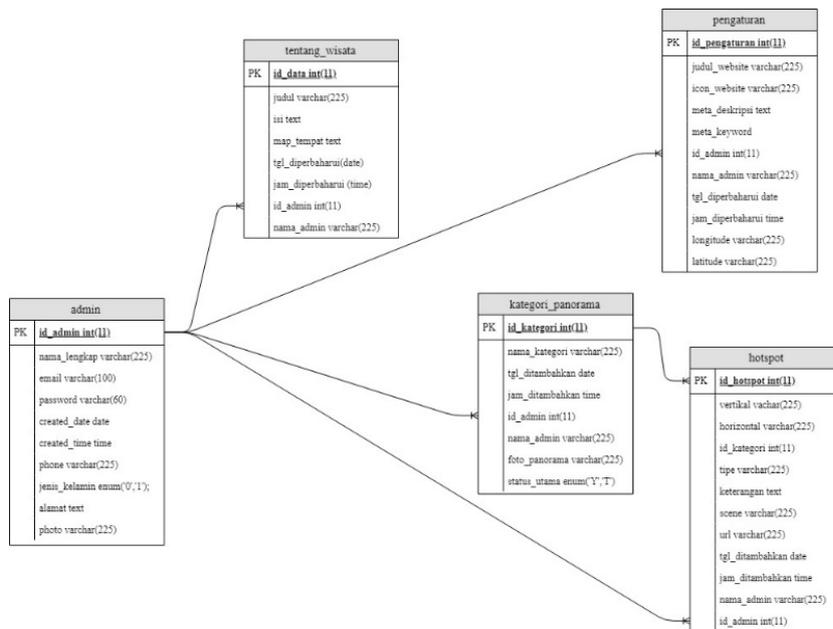


Fig 14. Database Model of Tourism Village Virtual Tour

4.4 System testing

The test is carried out using the black-box method by testing all the functionalities contained in the virtual tour village system, both by the village admin and visitors. Scenarios and results of testing the digital village virtual tour system can be seen in Table 3.

Table 3: Scenarios and test results of the tourism village virtual tour system

No	Testing menu	Detail testing	Method	Conclusion
1	Login	Entering email and password, if successful, you will be directed to the administrator page (dashboard)	<i>Black box</i>	Accepted
2	Manage Profile	Manage virtual tour profile data. If successful, it will display the message "Success, the profile on the visual tour has been successfully updated"	<i>Black box</i>	Accepted
3	View Dashboard	After the admin has successfully logged in, the dashboard page will display information data for the admin who is currently logged in.	<i>Black box</i>	Accepted
4	Manage Panorama	Manage panorama data in the form of creation, deletion, search and view data (CRUD data).	<i>Black box</i>	Accepted
5	Manage Hotspot panorama	Manage hotspot panorama data in the form of creation, deletion, search and view data (CRUD data).	<i>Black box</i>	Accepted
6	Maps	Manage all data coordinate data maps (CRUD data).	<i>Black box</i>	Accepted
7	Manage admin	Displaying admin data, admins can be added via a password that will be sent via email to prospective admins.	<i>Black box</i>	Accepted
8	Manage website	Displays website information data that was last updated on website information data.	<i>Black box</i>	Accepted

After functional testing is performed, beta testing is conducted to see user acceptance of the system being developed. Testing is done by tourists (users) by giving questionnaires and testing the application. The sample respondents used were 72 visitors who visited tourist sites. The conclusion of the user's assessment of the application, calculated using the formulation:

$$Y = P / Q \times 100\% \quad (1)$$

Notes:

Y = Percentage value

P = Total number of scores obtained from all respondents

Q = Total ideal score (criterion), assumed to be the highest weight/score.

The total number of scores (P) is obtained from the sum of the scores/weights * frequency in each answer. The weight/score on the answer criteria can be seen in Table 4.

Table 4: Questionnaire weighting criteria

No	Answer criteria	Weight
1	Strongly Agree (SA)	5
2	Agree (A)	4
3	Undecided (UD)	3
4	Disagree (DA)	2
5	Strongly Disagree (SDA)	1

The questionnaire statements that will be given to users are as follows:

1. Has the virtual tour website described the village Tourism experience?
2. Does the village virtual tour website provide sufficient information for potential visitors?
3. With the virtual tour website, are you interested in visiting this village?

The percentage results of each answer value of Questionnaire 1 were tested on respondents and have been calculated in Table 5.

Table 5: The results of the answers to question 1

Criteria	Number of Totals	Weights	Totals
Total score for strongly agree (SA)	37	5	185
Total score for agree (A)	35	4	140
Total score for undecided (UD)	0	3	0
Total score for disagree (DA)	0	2	0
Total score for strongly disagree (SDA)	0	1	0
Total number	72		325
Total percentage			90%

Total ideal score (criterion) of all criteria = $5 \times 72 = 360$ (if all answered Strongly Agree (SA)). The total score obtained from the research = 325. So based on question 1, obtained $(325/360) \times 100\% = 90\%$ of the expected (100%). The continuum can be seen in Figure 15.

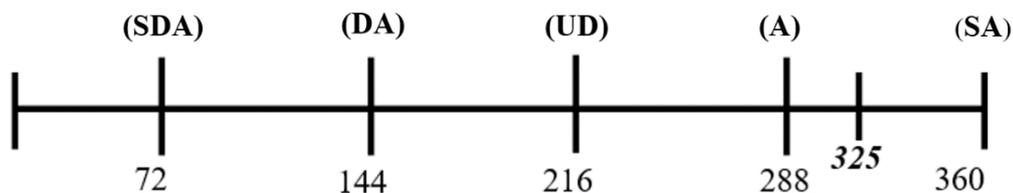


Fig 15. User Assessment Results for Question 1

Meanwhile, the answer to questionnaire no.2 given to the respondents obtained results shown in Table 6. Total ideal score (criterion) of all criteria = 5 x 72 = 360 (if all answered Strongly Agree (SA)). The total score obtained from research = 319. So based on this data, the level of agreement with statement 2 is $(319/360) \times 100\% = 88\%$ of the expected (100%). The continuum of the answer results is in the Figure 16.

Table 6: The results of the answers to question 2

Criteria	Number of Totals	Weights	Totals
Total score for strongly agree (SA)	41	5	205
Total score for agree (A)	22	4	88
Total score for undecided (UD)	8	3	24
Total score for disagree (DA)	1	2	2
Total score for strongly disagree (SDA)	0	1	0
Total number	72		319
Total percentage			88%

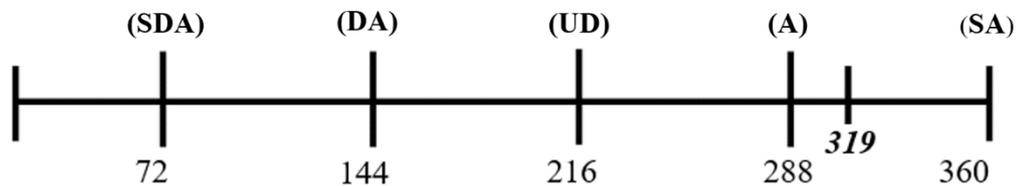


Fig 16. User Assessment Results for Question 2

For questionnaire 3 results, the results are shown in the Table 7. The ideal score (criterion) of all criteria = 5 x 72 = 360 (if all answered Strongly Agree (SA)). The number of scores obtained from research = 313. So based on this data, the level of agreement with statement 3 is $(313: 360) \times 100\% = 86\%$ of the expected (100%), and the continuum can be seen in Figure 17.

Table 7: The results of the answers to question 3

Criteria	Number of Totals	Weights	Totals
Total score for strongly agree (SA)	29	5	145
Total score for agree (A)	39	4	156
Total score for undecided (UD)	4	3	12
Total score for disagree (DA)	0	2	0
Total score for strongly disagree (SDA)	0	1	0
Total number	72		313
Total percentage			86%



Fig 17. User Assessment Results for Question 3

This research has been in accordance with previous studies where by using virtual tours, visitors will get a better picture of the tourist objects they will visit [25], while with the interactive map the ease of moving tourist objects can be done so that it makes it easier for visitors to be able to know the location and type of tourism that exists in a short time [26],[27]. However, this research needs to be developed towards a more complex direction such as booking homestays and purchasing souvenirs that can be done online [28],[29].

5 Conclusion

This research has produced a virtual tour application for tourist villages by utilizing a panoramic image mechanism that has the ability to view 360 degrees to see tourist spots contained in tourism villages. The web-based system makes it easy for visitors to see these tourist locations. The application of virtual tours in the application makes it easy for visitors to see tourist objects in 360o so that it is as if they are at the actual tourist attraction. The interactive map used makes it easier for visitors to move from one tourist attraction to another, as well as knowing the distance and location. The tests carried out show that the virtual tour application that is made can run well, is free from errors and produces functionalities that meet the needs. Tests on users show that the applications built are easy to use, provide more attractiveness to the sights seen, and have interactive capabilities and more interactive navigation. As future work, we plan to develop a virtual tour village system with more features such as an e-commerce mechanism for products in the tourist village, online ticket ordering to hotel reservations that are integrated in the virtual tour village environment as part of rural development in the era of digital.

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