Digital map of zoo negara using geospatial information system (GIS) approach

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Abstract. National Zoo of Malaysia or Zoo Negara is one of popular tourist attraction places in Malaysia that receives many visitors every day. Providing the best service and tour information for large volume of visitors every day is the main objective of Zoo Negara. However, the current issue facing by Zoo Negara is its current information medium where they still use printed paper-based mapping system. This medium is not helpful enough for the visitors to navigate inside the zoo as the information is insufficient and troubles Zoo Negara management in updating their map as well. In this paper, we propose a GIS-mobile based application that provides visitors with digital map. The digital map includes information about animals and events inside the zoo. Visitor can also view their current location and visited track on the map using navigation module. Zoo Negara management can regularly update their map and recent information easily through database.

1. Introduction
Zoo Negara Malaysia (National Zoo of Malaysia) or also known as National Zoological Park was officiated by Y.T.M. Tunku Abdul Rahman Putra Al-Haj on 14 November 1963. It is an open concept zoo located on a 110-acre (45 ha) land in Ulu Klang. It is a popular tourist attraction in Malaysia, receiving an annual average of more than 1 million visitors. According to [1], Zoo Negara has a total of over 5137 specimens from 476 species of mammals, birds, reptiles, amphibians and fish. Basically, Zoo Negara has a wide range of facilities and services offered to fulfill the objectives and purpose of visitors visiting the zoo.

Currently, Zoo Negara uses a paper-based system to guide the visitor during their visit at the zoo. The guides that are prepared by the staff using two mediums. Firstly, they prepare pamphlet for the visitor to know information about the zoo. The information includes the map of the zoo, details about the zoo and the list of activities happening throughout the day. Secondly, a few of big information boards displaying the map and details of the zoo are also placed at a few points in the zoo. There are also several arrow signs in the zoo indicating which way should the visitor go to arrive in their desired destination within the zoo.

The current medium used to provide map and other information of the zoo are pamphlet and information boards. The size of pamphlet is not convenient for the visitor to hold it throughout their visit. If the user chooses to keep the pamphlet inside their bag and take it out when they need it, it become a nuisance for visitor to do so. There are also possibilities for the visitor to misplace their
pamphlet during their visit. Meanwhile, the information boards are only placed at certain point in the zoo which will only be useful if the visitor find the board while walking around the zoo. In the case where visitor does not have the zoo’s pamphlet with them, they will have to search for the board if they need to view the map of the zoo. The visitor will also have problem in keeping track of the ongoing activities around the zoo as the board is passive.

The current system used only allows one-way communication where the visitor need to make their own interpretation of what they see especially the map. It also does not provide a mean for the visitor to track their current location throughout their visit. Also, they are not fully aware of ongoing activities and might miss them. It is difficult to update the map and information of the zoo using the current system as the staff needs to print out new sets of pamphlets and change the boards around the zoo. The old pamphlets and boards can no longer be used. The process of updating will lead to wastage of money and time which can be spent for something else.

2. Literature Review

2.1. GIS versus GPS

In “Geospatial Information and Geographic Information System (GIS): Current Issues and Future Challenges” by Peter Folger [2] has stated Geospatial Information System (GIS) is a computer capable of capturing, storing, analysing and displaying geographical referenced information. In recent years, consumer demand has skyrocketed for geospatial information and for tools like GIS to manipulate and display geospatial information. Global Positioning System (GPS) data and their integration with digital maps has led to the popular handheld or dashboard navigation devices used daily by millions. In “Mobile Geographic Information Systems” by Yang Li and Allan J. Brimicombe [3] stated basic GIS software functionalities can be implemented on smart phones through Mobile GIS applications, which are often extended to include some location-based features, such as accessing maps and data relevant to user location, collecting location related data in real-time, real-time supporting of events with spatial tags.

In “Integrating GIS and Global Positioning System” by Karen Steede-Terry [4]. Jack Dangermond, president of Environmental Systems Research Institute (ESRI) stated that GPS is “uniquely suited to integration with GIS. Whether the object of concern is moving or not, whether concern is for a certain place at a certain time, a series of places over time, or a place with no regard to time, GPS can measure it, locate it, track it.”

2.2. Review on Existing Systems

Nike+ Run Club is a mobile app that gives the user a better running experience. It has many function that can be utilized by the user to track their progress, get personalized coaching, run together with their friend who has the app, stay motivated and share their run. This app includes GPS tracking of user’s run. The good side of the system is that it has the ability to keep track of the visited path when the user uses that app for their run. Even when the user pauses their run, the track is still being recorded until they stop the run. Also, user get to see visually their pace throughout the run by observing the colour of the recorded route.

In “Denver Zoo App” by Denver Zoo [5] is a mobile application where user can access the zoo map, daily activities and schedules, animal facts, and help them to experience the zoo in a whole new way. The application consists of complete map that uses GPS technology to track user’s location so they would not get lost. The animals are mapped out in sections which are represented by clickable icons. Different icon is used for each animal, where the icon used is the picture of animal. This makes it easier for the user to identify the location of each animal inside the zoo. The application includes zoo schedule features where user can plan their visit where they want to be when the events are taking place. User also can locate themselves inside the map by activating “my location” button.

Hersheypark [6] has developed their own mobile application named Hersheypark App where it comes with helpful tools for user to plan their visit and maximize their day in the amusement park. The application uses GPS-enabled map that helps users to explore the park inside Hersheypark and
ZooAmerica. They applied real-time tracking in their app through *Take Me There* feature that allows user to view the path they need to take starting from their current position to the desired point. The app also allows user to filter icons on the map according to their preferences. They can sort out the attractions and rides suitable for them physically through this app. Also, user get to create their to-do-list and find place to sleep at the official resorts of Hersheypark using this app.

The above existing system uses GIS technology in creating their digital map. They also use GPS-enabled map for user to be able to track their location inside the zoo/park. But the existing app does not include a feature where the user is able to keep track of which part of the zoo/park that they have visited. User can end up walking at the same place without them intending to do so due to the nature of zoo/park having many junctions.

3. Methodologies

3.1. Agile Model
Agile model includes iterative and incremental process within the model. It emphasizes customer satisfaction, rapid delivery of system and adaptability of process. The advantage of this model is that it supports rapid and continuous delivery of working software. It emphasizes in the interaction with the customer throughout the project by involving user in every phase. It also flexible to changes which makes it has minimal risk. It allows changes to happen even in the later stage of life cycle. Also, it emphasizes in business value, good design and technical excellence. The disadvantage of this system is when the user is not sure about the final result of the system. This can make the project goes off track. By allowing changes to happen, defined requirements are not really expected. Due to the absence of defined requirement, the costs and resources are difficult to be estimated. With all the changes that may happen, project may exceed expected time to be completed. This model is suitable when customer need changes to be implemented throughout the life cycle. Also, it is suitable when the presence of customer is expected and needed throughout the project. As this model does not require complete requirements in early stage, it is suitable for project that has minimal planning.

3.2. Data Gathering
We focus on Zoo Negara staff and visitors as respondents for data gathering. Semi-structured interviews are conducted with Zoo Negara staff and visitors. The phase is divided into two. The first phase is interview with Zoo Negara staff which focuses on the problem faced by them and the current solution related to mapping and information about events. In this phase a set of question were prepared to assist interviewer. The questions were about the current method Zoo Negara is using in mapping and updating the map, the difficulties they face in practicing the current method, and how they solve the difficulties that they face in terms of mapping. The second phase is interview with the visitors of Zoo Negara which focuses their thoughts and experience on the current mapping method. Visitors were asked about how the current mapping system helps them during their visit and what are the difficulties they face in navigating inside the zoo.

3.3. Analysis
According to Zoo Negara management staff they mainly use manual paper-based system for their map which includes pamphlet distributed to the visitors and 12 wooden boards inside the zoo. There is no computerized system used currently in handling the mapping system in Zoo Negara. This also includes updating process for the map. The current method used results in few problems which affects Zoo Negara management and visitors. For Zoo Negara management, the cost of updating map burdens them as it includes printing new set of pamphlets and buying 12 new wooden boards. The wooden boards are expensive as they need to be weather resistant. Due to the high cost, they only update their boards when there is a major change. For minor change, the will just paste laminated paper on the boards to indicate changes. In terms of information regarding events like animal shows, visitors are informed at the entrance and via Zoo Negara’s social media.
According to Zoo Negara visitors, even with the pamphlets and boards, they still encounter problem in navigating inside the zoo. This is due to the overwhelming number of junctions inside the zoo where each junction will lead them to a different path. Zoo Negara also has certain duplicated area where same animal may be displayed in 3 different sections. This can also confuse the visitors as they might think they have pass the same area more than one time. Another problem would be when foreigners lost their way inside the zoo. It takes more effort and time for Zoo Negara staff to help foreigners as there are language barrier between them. Adding to that, Zoo Negara stated that foreigners usually spend lesser time in the zoo compared to the locals. Thus, when they get lost, they will not experience much inside the zoo. In addition to pamphlets and boards inside the zoo. Zoo Negara provides customer service around the zoo ready answer the visitors’ inquiries. Other than that, they have moving trams around the zoo to commute inside the zoo. Zookeepers are also available in all sections and they can provide guidance to the visitors. But these services can still be insufficient to cater the overwhelming numbers of visitors. Also, not all visitors reach out to the services provided as the prefer to explore on their own.

4. Proposed Solution
The proposed method is to create a mobile application which will help user to visualize Zoo Negara in a form of digital map. The digital map will assist the user to navigate inside Zoo Negara and get information about Zoo Negara. The information includes information about the animals and events inside Zoo Negara. The information can be accessed from the digital map by clicking on the icon displayed on the digital map. To control the amount of information user can view at a time, certain icons can be hidden from view. Also, user can zoom in and out of the digital map. User will also be able to track their current position and visited track on the digital map. This mobile application also allows the Zoo Negara staff who have access to the database to update the information available inside the digital. Any intended changes can be made directly in the database.

4.1. Product Perspective
Figure 1 illustrates the user and system scopes of the system. It involves two actors/users: visitor and staff of Zoo Negara.

![Figure 1. Use Case Diagram of DMZONE](image-url)
4.2. User Interface Design

4.2.1. Home Screen. The main part of the system is the digital map of Zoo Negara (Figure 2). On the digital map, different types of icons are displayed where each icon is clickable and contains information about the place it represents. Information will appear in a popup box. The information inside digital can be updated from DMZONE database. New points can also be added to the digital map from DMZONE database. A zoom button is available at the bottom right corner of the digital map to enable user to adjust their view according to their preferences. A menu button is also available at the top right corner which will display a list of icons once clicked. The icons are also clickable where information associated with the icon will be displayed in a form of picture and text. The map also allows user to hide and unhide icons on the digital map.

![Figure 2. Home Screen](image)

The block of codes below set some of the attributes for the digital map, such as the boundary, maximum zoom, minimum zoom and the type of map used. For this digital map, Open Street Map is used.

```javascript
var southWest = L.latLng(3.2077469755150734, 101.7575104401247),
    northEast = L.latLng(3.215202518542764, 101.761314868927),
    bounds = L.latLngBounds(southWest, northEast);
this.map =
L.map("map").setView([3.2110034262913345,101.75848642181395], 16);
L.tileLayer('https://{s}.tile.openstreetmap.org/{z}/{x}/{y}.png', {
    attribution: 'Map data © <a href="https://openstreetmap.org">OpenStreetMap</a> contributors',
}).addTo(this.map);
```
4.2.2. Visited Path and Animal Section Module. Users can view their visited track and animal section by choosing the visited path option shown in the menu. The color of walking path in map that have been used by user will be automatically changed to red color (Figure 3). The application will continue tracking the current location of the visitor as they are moving around Zoo Negara. This information is used to get visitor’s visited path and display it on the digital map.

![Zoo Negara map](image-url)

**Figure 3. Visited Path**

The block of codes below retrieves the current location of the device used by the visitor.

```javascript
this.geolocation.getCurrentPosition().then((resp) => {
  this.lat = resp.coords.latitude;
  this.lng = resp.coords.longitude;
  L.marker([this.lat, this.lng]).addTo(this.map).bindPopup("You are here");
}).catch((error) => {
  console.log('Error getting location', error);
});
```
var options = {enableHighAccuracy: true,timeout: 500000,maximumAge: 0,delayedAccuracy: 0,desiredAccuracy: 0, frequency: 10000 }; 
let watch = this.geolocation.watchPosition(options); 
watch.subscribe((data) => { 
//data can be a set of coordinates, or an error (if an error occurred).
this.lat = data.coords.latitude;
this.lng = data.coords.longitude;

L.marker([this.lat,this.lng], {icon: L.icon({'iconUrl': 'assets/icon/dot.png', iconSize: [5, 5]})).addTo(this.map);

var trackLat = {};
trackLat['/users/coords/latitude'] = this.lat;
firebase.database().ref().update(trackLat);

var trackLng = {};
trackLng['/users/coords/longitude'] = this.lng;
firebase.database().ref().update(trackLng);
});

As mentioned in previous section, National Zoo of Malaysia consists of numerous animal sections for visitors that have been placed in different areas. By clicking the “Visited Section” button at the bottom of the digital map, user will be directed to a list of icon representing each section in Zoo Negara (Figure 4). All icons are clickable. Once icon in grey-colored state is clicked, it will turn into a multi-colored icon. User may use this to mark their visited section, where multi-colored icon will be considered as visited section.

4.2.3. Animal Information. This application allows users to preview specific animal information by clicking the animal icon shown in the map (Figure 5). This information includes the animal name, image and brief description. To get alert with all animal shows’ schedule, users can get the information by clicking the star icon (Figure 6).

5. Conclusion
The absence of computerized system in assisting the visitors in viewing the whole area of Zoo Negara results in few problems faced by the visitors. The problems are mainly about losing their way inside Zoo Negara because of the junctions inside the add. For the foreigners, adding up to the main problem, language barrier and less time spent in the zoo become obstacles for them to get full experience in the zoo. The current way Zoo Negara used to solve this problem is also done manually which mostly consists of verbal assistance inside the zoo by their available staff. Zoo Negara also updates the visitor verbally inside the zoo and they also update through their social media.

With all the findings gathered, it is proven that there is a need for proposed system to be conducted to help Zoo Negara in solving their problems. With our proposed system, it is provenly assist the visitors to maximise their day in Zoo Negara.
Figure 4. Visited animal section module

Figure 5. Animal Information
Figure 6. Animal Show

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