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Merging Augmented Reality & Geographical Information System

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ABSTRACT

Geographic Information System (GIS) and Augmented Reality (AR) have numerous uses in a wide range of area. It provides useful information that can help us get useful information about our environment. As there are no courses available that offers GIS and AR certification, this paper provides an important study of the framework. Framework where students can teach GIS, AR, Database and mobile application development by merging all of the above. For this we need to know how Geo-location can be utilized , making way for a dynamic interface which users can interact with. This independent study is made keeping in mind open sourced technologies. The purpose is to illustrate the advantages of GIS and AR.

Terms— Database-software, (programming language, any open sourced preferred) angular-js , Google maps , geo-location , mobile application.

1. INTRODUCTION

Geographic Information System (GIS) is entrenched in intellectual practices, clustered by data and empowered by mathematical analysis. In a survey conducted by Schuurman suggested that currently, the main use of GIS is for spatial analysis, predictive modelling, cartography and visualization. The SI Industry, also known as the GIS industry, is a rapidly growing industry. GIS maps the exact location and survey coordinates of an object in space to provide answer to queries using a computer system.

Many of this geo-based apps have made a social impact with their users as they need to go out and move around to get the most out of the app. It has also allowed the users to be more active physically which is a great initiative to be more connected with the world.Many popular applications like PokemonGO and Uber come in to play and have great success with their brand as they have geographical based products. Users experience more engagement with the product when their location depends on it. This new trend has exposed the possibilities of geo-based apps and services as they have the most active users.

As these geo-based apps gain popularity among users, lawmakers are eyeing geolocation apps as there are many privacy concerns have arisen regarding user tracking. Now, GPS location-aware phones and other devices collect huge amounts of data about where people go and what they do. This information can be aggregated with other information to determine 'who they are' with precision and accuracy [2].

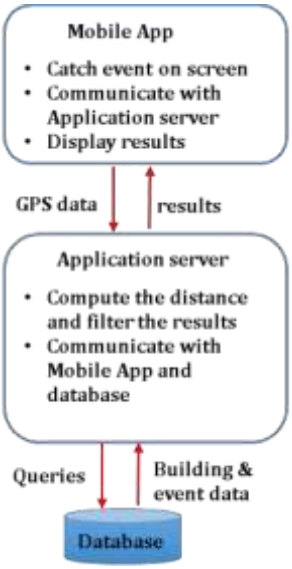

Fig.1. System architecture

As it is becoming an important component of daily lives (Ex. Navigation devices), GIS will face new regulations that are more on the privacy and intrinsic to safe guard user policy. To stop leaking user data and protecting their privacy, greater protection of the data should be accounted for this study will help the understanding of why geography based systems are so popular nowadays and their usefulness for consumers. With the end product being a location based system which may be used for building navigation or even open house navigation/information for colleges, hospitals, the use is immeasurable, this system would massively help communities that need geography based systems to help people learn its advantages.

2. RELATED WORK

Generally, geolocation apps do two things: They send your location to consumers, and they relate real-world locations (such as events and restaurants) to your location. Geolocation apps that run on mobile devices provide a richer experience than those that run on desktop PCs because the relevant data you send and receive changes as your location changes [3].

To become used to the topic of AR and GIS, some resources that have greatly improved the skills needed for this project are the Google Maps API [4]. To store objects like places, buildings, points, etc., Google Maps greatly helps with understanding how these objects are made and stored in the database schema.

Some products that are related to this specific study is Foursquare. With this geolocation service, users are able to check in to cafés, bars, restaurants, and pretty much anyplace. Aside from the social impact of checking in to a place when you're actually there, it empowers users to collect stamps/badges to track progress of places visited, and overall keeping the consumer engaged with the application

3. SYSTEM ARCHITECTURE

For visualization the location and other information, a front-end Graphic User Interface (GUI) is required for the system. Since the system is designed for portable device such as smartphone, a mobile app is necessary. The database is the back-end to keep the building coordinates event information, images and other information. The middle-end is to handle the data upload from front-end and transferring between front-end and back-end.

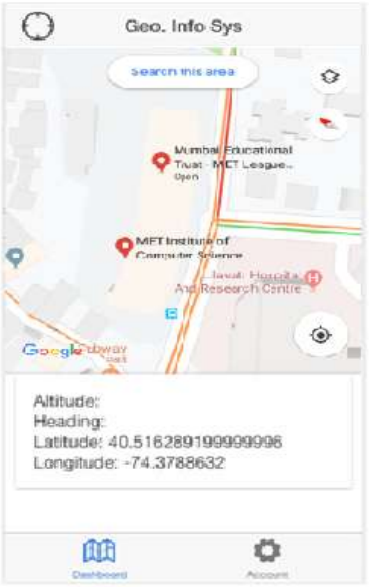

Fig. 2 Automatically check user's location

3.1 Frontend: Mobile App

The Graphical user interface for this application will contain the location of the user and will display current information about the place they are in (building, classroom, etc.). As a user moves from a building to another or to another classroom, the main view will update with current information about their location, with interactive links and videos that will show the users more information about their location, as shown in Fig. 2.

The mobile app will read the GPS location from the smartphone device and pass the altitude, orientation, latitude, longitude and time information to the application at the middle-end. The Latitude 40.516289 and Longitude 74.378863 indicate the GPS location of the red marker shown on Fig. 2. Since the

mobile app uses Google Map API, user can switch to Street View by clicking on the "people icon" at left, or switch to Satellite View by clicking on the "Satellite" at the right top.

To insert these objects to our database, a portal will be built to submit records. A seamless UI will be designed for easy interaction and administrators will be able to submit buildings information alongside with specifics like classroom schedules, special events, and videos about the department. The Google Maps API is used to get the actual coordinates of buildings for submission, as shown in Fig. 3.

It is important to understand that the GPS information might be not accurate in general inside the building [5], [6]. Therefore, it is difficult to precisely identify the location inside a building and display correct event information for each floor and room. Especially, each floor might have different heights, for example the ground floor of MET building is much taller than other floors, in addition to the GPS altitude values inside the building could be not very accurate. Since the GPS coordinates of the NAAB building boundary are not available, we have to manually mark and read the GPS coordinates on Google map [7] as shown in Fig. 5, and store the information into the database.

Fig. 3. Drawing a polygon on the google maps for MET league of colleges.

3.2 Middle-End: Application Server

The application server is written in Javascript and is used in par with AngularJS and Ionic Framework. These are new, open-sourced technologies that will help build a robust app front-end and server to handle the amount of computations that will be made.

Fig. 4. The MET building

Fig. 5. The MET building displayed on a browser based on www.googlemap.com.

The application requires a lot of computations in order for the user to get updated geographic information and interacting with the app. Understanding these computations and how to decrease the amount of computations enhanced math knowledge and overall computer science foundation.

Some crucial fields like the GPS coordinates will be stored on the database, these coordinates come as points or paired up points (Polygon). These points are a combination of latitude and longitude pairs, as shown similar to a picture EXIF information extraction, shown in Fig. 6.

GPS information:	
GPSLatitudeRef	N
GPSLatitude	40 40 45.36 (40.679267)
GPSLongitudeRef	W
GPSLongitude	74 14 6.14 (74.235039)
GPSAltitudeRef	Sea level
GPSAltitude	31.09 m
GPSTimeStamp	15 17 19.14
GPSImgDirectionRef	Magnetic direction
GPSImgDirection	115.65
GPSDateStamp	2015:01:29

Fig. 6. GPS EXIF information retrieved from an image.

3.3 Backend: Database Server

```
{ "type": "FeatureCollection",
  "features": [
    { "type": "Feature",
      "geometry": {"type": "Point", "coordinates": [102.0, 0.5]},
      "properties": {"prop0": "value0"}
    },
    { "type": "Feature",
      "geometry": {
        "type": "LineString",
        "coordinates": [
          [102.0, 0.0], [103.0, 1.0], [104.0, 0.0], [105.0, 1.0]
          ]
      },
      "properties": {
        "prop0": "value0",
        "prop1": 0.0
        }
    },
    { "type": "Feature",
      "geometry": {
        "type": "Polygon",
        "coordinates": [
          [ [100.0, 0.0], [101.0, 0.0], [101.0, 1.0],
            [100.0, 1.0], [100.0, 0.0] ]
          ]
      },
      "properties": {
        "prop0": "value0",
        "prop1": {"this": "that"}
        }
      }
    ]
  }
```

Fig. 7. JSON document with richer and more flexible data structures.

For For this application, instead of using a relational database, MongoDB [8] will be used. Since performance between MongoDB and RDBMS is marginally in favor of MongoDB . The database server will receive a lot of requests when it is used in a large scale, and being able to do query faster will help with showing information on the application quickly.

MongoDB structures data into collections of JavaScript Object Notation (JSON) [9] documents. JSON is a self- describing, human readable data format. Originally designed for lightweight exchanges between browser and server, it has become widely accepted for many types of applications. JSON is also a natural data format for use in the application layer [10]. Supporting JSON will enable to make more flexible data structures, as shown in Fig. 7.

4. FRAMEWORK

This study has several components that are necessary to develop the system. Some of them are not offered in regular courses. The framework includes the computer programming languages for designing the front-end and back-end, database knowledge for storing and retrieving the data, AR and GIS knowledge to work on the location and Google Map API, and the mobile app development skills to implement the system on mobile device.

Component 1: Programming Language

As the application is built using web technologies such as Html, JavaScript and CSS classes such as web development greatly help understand how to build a front- end interface and how to effectively use frameworks to build more responsive and modern applications. As this application uses JavaScript in the client and server side, a flexible strong programming language is needed.

Component 2: Database

Many students only have experience with relational databases with languages like MySQL, but as this study is using MongoDB, it is recommended to at least have some general database knowledge. Classes such as Database Management Systems have helped understanding how to manage a database and access rights for different users.

Component 3: Augmented Reality

To integrate the Augmented Reality element to the system, a combination between Google Maps and Unity engine will be implemented to show users directions to their desired location with their back-facing camera. Background using Unity engine is preferable, but Google Maps API knowledge is more desired.

Component 4: Geographic Information System

To get familiar and proficient with building a geographical information system, tools like ArcGIS were used to grasp the concept. Hackathon experience trying out these new concepts has improved the proficiency of building this system and overall understanding of the study.

Component 5: Mobile Application Development

Previous internship experience has expanded mobile app development knowledge. As many successful products has been implemented in mobile applications, the best way to make this application accessible to the general public is to make it available in an app.

5. CONCLUSIONS

As geo-based applications are becoming popular and getting more exposure, a study like this shows how geo-location can be used to make systems that allow more immersive experiences with the surroundings around a person. This study has helped understand how geo-location works and how we can use places like buildings and build entities on top on them. As a student, this study greatly helps the understanding of how to build a geo-location service for consumers. As this is a current work in progress, the expectations for Spring semester is to fully bring this project to life and test a pilot with the Open House events to provide prospective students with an immersive experience of the campus.

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