TIP EXPRESS: An Android School Navigation Application

Reynaldo E. Castillo*, Paula Jean M. Castro, Maria Christina R. Aragon, Henry C. Macugay
938 Aurora Boulevard, Cubao, Quezon City, Metro Manila, Philippines.

* Corresponding author. Tel.: 09150095020; email: rcastillo.cs@tip.edu.ph
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Abstract: Unfamiliarity about the school campus grounds results common problems for new students or visitors. They tend to get lost inside the campus, arrive late in classes or meetings. They navigate by themselves and ask security personnel, still they tend to take time to reach their destination or most often they get lost. This study is for new students and visitors. It helps them to explore and navigate the campus grounds thru a mobile application. The mobile application provides a user-friendly interface which considers user experience. The mobile application serves as a guiding tool in navigating around the school campus grounds. In the study, the mobile application used Google Map to track the current location of the user and plot the route from the origin to the destination inside the Technological Institute of the Philippines Quezon City campus using fuzzy logic algorithm to get the shortest route and channel selection algorithm to get the nearby user within a perimeter. The study used the Rapid Application Development model in order to deliver expected outputs. Surveys using a questioner drafted from ISO 25010 were conducted to determine the effectiveness of the developed mobile application in terms of its functionality, reliability and efficiency. It was concluded that the mobile application is an effective tool in giving navigation and campus information for its users. For the result, the average mean of all the criteria yields 4.12 interpreted as very effective using the 5 point Likert's Scale. Thus, the mobile application is useful reliable, functional, and efficient to serve its purpose.

Key words: Algorithms, mobile, path finder, static and dynamic maps, turn-by-turn navigation.

1. Introduction

Routing application is becoming very popular in the modern era. It offers innovative applications in the market for mobile users. Innovation has been one of the trendiest topics in this generation. With the rapid growth of technology, most of the simple things in daily the lives are being innovated [1]. With the help of the mobile phones and internet connectivity, innovative applications online are accessible to everyone. It helps mostly because users can access their wants and needs by using smartphones that are available with them. It is always in use because of its features that provide users the convenience of texting, calling, playing games or surfing in social media, to name a few. All these things are done with the help of smartphones. Likewise, technology is very helpful for the people who want to be aware of their location [2]. Most often, mobile users do not know the exact place they are in. Thru the use of mobile application, it helps the user to generate the shortest route to travel from the users' current location to its current location to its destination [3], [4]. Routing application is recently getting more powerful in path finding [5], [6] as a solution for difficulties in navigation. Collecting information on the geographical structure of the earth using Google Map makes the application more accurate [7]. It can seamlessly collect comprehensive information and enables users to

provide mobile resources with real-time updates. As the users gain more information for manipulation on finding the path, many companies want to achieve the most accurate and efficient route finding application. Since mobile applications use Google Map to aid the routing is rather inconvenient and does not necessary lead to shortest route [4], [8]. Most people will have had the experience of giving or receiving directions for navigating through an unfamiliar geographic environment. For example, visiting a foreign city for the first time, a tourist might ask a passer-by for directions to a hotel or visitor attraction [9]. In such situations, often what is required is not the shortest route to a destination but the simplest route in terms of how easy it is to explain, understand, memorize, or execute the navigation instructions. Most automated navigation systems rely on computing the solution to the shortest path problem, and not the problem of finding the "simplest" path [10].Many applications and tools were developed tried to determine short routes in order to achieve a reduction of travel distance and time [11]. With this kind of application, it can help people having difficulty in selecting [12] the shortest route by providing them the shortest distance and the shortest traveling time[13], [14].

This study aims to develop a mobile application that generates the path transfer from one building to another inside T.I.P. Quezon City Campus. Specifically to: (1) Develop a user-friendly mobile application that will be used as a guide in navigating around the T.I.P, Quezon City campus grounds; (2) Provide the path with interactive navigation using fuzzy logic algorithm; (3) Display nearby users using channel selection algorithm; (4) Test algorithms implemented in the created mobile application in terms of response time and throughputs; and (5) Evaluate the application using ISO 25010 measuring the quality standard in terms of functionality, reliability and efficiency.

The study is focused on the development and implementation of a mobile application. It is intended to be used by students, professors and or professors. The study includes: (1) Plotting the waypoints of the destinations with route navigation; (2) Global Positioning System (GPS) route tracking that can trace users and route direction; (3) Used fuzzy logic algorithm to plot the short path between two points; and (4) Implementation of channel selection algorithm to locate nearby users within the perimeter. The study is limited to (1) Indoor layout of the GPS map; (2) Tracking of the user in indoor layout view; (3)Provides the shortest route with routing mode (walking); (4) Focuses on the destination that is in the Technological Institute of the Philippines Quezon City campus; and (5) Limited to android devices only.

2. Theoretical Framework

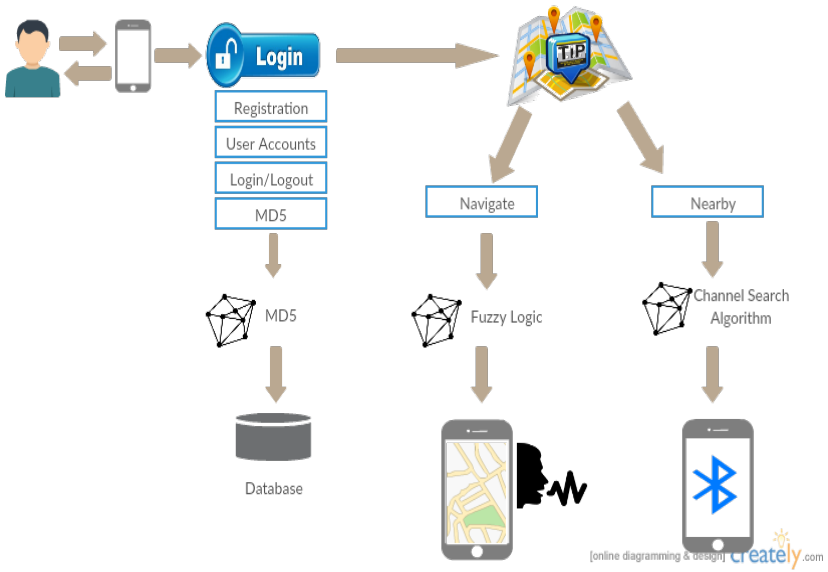


Fig. 1. System flow and organization.

The application needs the user's credentials for authentication. The process starts when the user login or register to the system. In registration, the user input his/her name, address, age and birthday to have an account. That account which will be saved on the database. After successful registration, the user can login and enjoy the benefits of the mobile application register; he/she can use the account in logging in the application.

The features of the application includes implementation of the Bluetooth technology, Text-to-speech, notification and location-based services. For navigation the mobile application automatically identifies origin and users main plot multiple destinations. The mobile application gives routing direction, implementing fuzzy logic algorithm, to the users through text to speech. The mobile application also provides information about active users using channel selection algorithm via Bluetooth technology. The mobile application also secure all information given by the user during the creation of the account thru the implementation of the MD5. (See Fig. 1).

3. Algorithms

Message Digest algorithm 5 (MD5) is a widely used cryptographic hash function that was invented by Ronald Rivest in 1991[15]. The idea behind this algorithm is to take up a random data (text or binary) as an input and generate a fixed size "hash value" as the output [15]. The input data can be of any size or length, but the output "hash value" size is always fixed. Here is an example of MD5 Hash function at work (See Fig. 2):

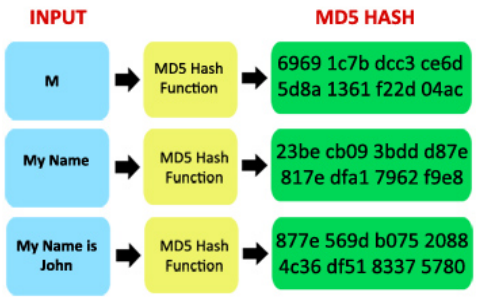


Fig. 2. MD5 process flow[16].

The main MD5 algorithm operates on a 128-bit state, divided into four 32-bit words, denoted A, B, C, and D. These are initialized to certain fixed constants. The main algorithm then uses each 512-bit message block in turn to modify the state. The processing of a message block consists of four similar stages, termed rounds; each round is composed of 16 similar operations based on a non-linear function F, modular addition, and left rotation [17] (see Fig. 3). Thus, all information saved in the mobile phone's database will be encrypted for security purposes.

$$F(B,C,D) = (B \wedge C) \vee (\neg B \wedge D)$$
$$G(B,C,D) = (B \wedge D) \vee (C \wedge \neg D)$$
$$H(B,C,D) = B \oplus C \oplus D$$
$$I(B,C,D) = C \oplus (B \vee \neg D)$$

$\oplus, \wedge, \vee, \neg$ denote the XOR, AND, OR and NOT operations respectively.

Fig. 3. MD5 mathematical formula[18].

Fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) Boolean logic on which the modern computer is based [19]. Fuzzy logic seems closer to the way our

brains work. The developers implemented the algorithm to generate the path to the destination. This type is called decisional algorithms [20] in which it approximately describes a strategy for performing some task. The algorithm first created the variables from the user and create a rule base and evaluate it to produce the result (See Fig. 4a).

Channel Selection algorithm is use to enable interfaces to automatically figure out [21] which channel configuration (See Fig. 4b) to use for initiating communication [22][23]. The algorithm first scan for the number of user then performed the summation to the number of user and the number of subcarriers to determine users within certain radius.

Initialize:
- a. Define the Linguistic Variables and Terms
- b. Construct Membership Functions
- c. Construct Rule Base

Fuzzification:
- a. Convert Input Data to Fuzzy Values using Membership Functions

Inference
- b. Evaluate Rules in the Rule Base
- c. Combine Results of each Rule

Defuzzification:
- a. Convert the Output Data to Non-Fuzzy Value

Algorithm 1: ChannalSelection(node i)
Input
S_i : Set of nodes in i's interference range.
c_j : The channel of each node $j \in S_i$
c_i : i's current channel
begin procedure
for all $k = 1, \cdots, K$,
$F(k) \leftarrow \sum_{j \in S_i} f(k, c_j)$.
if $F(c_i) > F(k)$ for any $k = 1, \cdots, K$, **then**
$c_i \leftarrow k_{min}$ where $k_{min} = k : F(k) \leq F(k') \; \forall k' = 1, \cdots, K$
end if
end procedure

Fig. 4. a) Fuzzy logic algorithm b) channel selection algorithm.

4. Project Methodology

Rapid Application Development (RAD) model distributes the analysis, design, build and test phases into a series of short, iterative development cycles [24]. The researchers started gathering information and planned on how the application will be created to satisfy the needed requirements. What language will be use, what are the scopes of the project, and also what is the content of the application. Then the designing of the interface of the mobile app was done. Also, on the development the design was given very much consideration to ensure best user experience. By the use of Adobe Photoshop, the developers designs the login, registration and the logo. The next phase is focused on programming and application development. The developer used Android Studio for developing the TIP Express. Lastly, the mobile application was evaluated to determine acceptability in terms of its functionality and reliability. During the testing, the researchers together with the respondents tested the mobile application while traversing the school grounds (See Fig. 5).

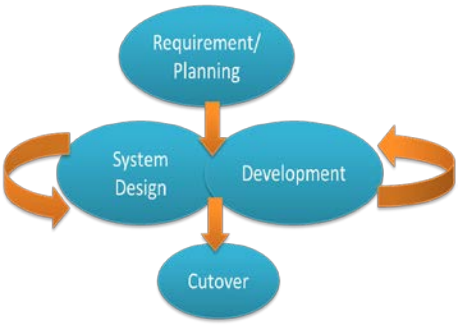


Fig. 5. Rapid application development model.

5. Results and Discussion

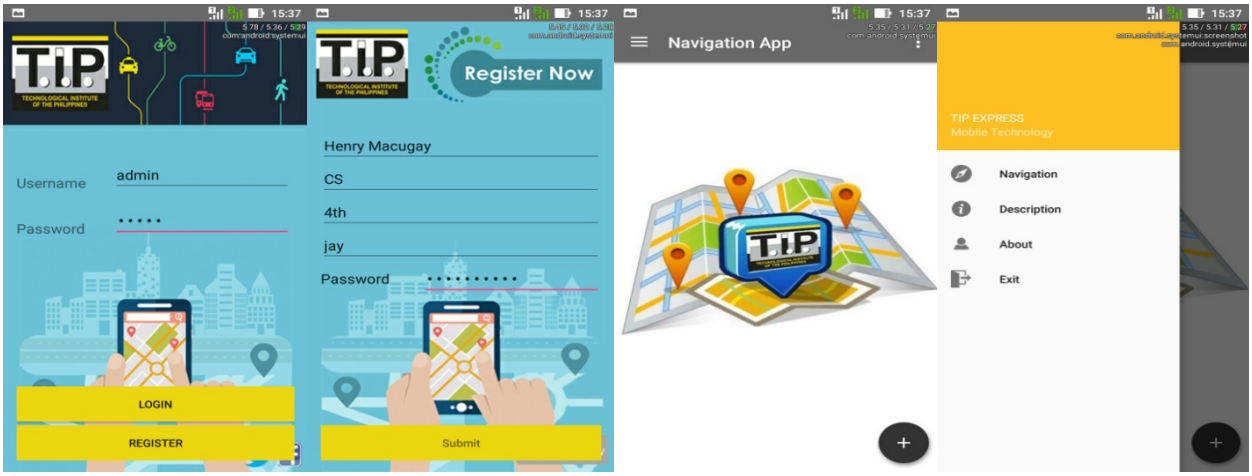
Fig. 6a shows the login and the register of mobile application. In the Registration, the user enters information to have an account and the sense that all information will be encrypted using MD5 algorithm. This is to ensure data confidentiality in all times. After the account is successfully created, the user now

proceeds to logging in of his/her account.

Fig. 6b shows the home screen and other components of the mobile application such as navigation and description modules.

A piconet is a network of devices connected using Bluetooth technology. The network ranges from two to eight connected devices. When a network is established, one device takes the role of the master while all the other devices act as slaves. Piconet gets its name from the word "pico", which means very small [25].

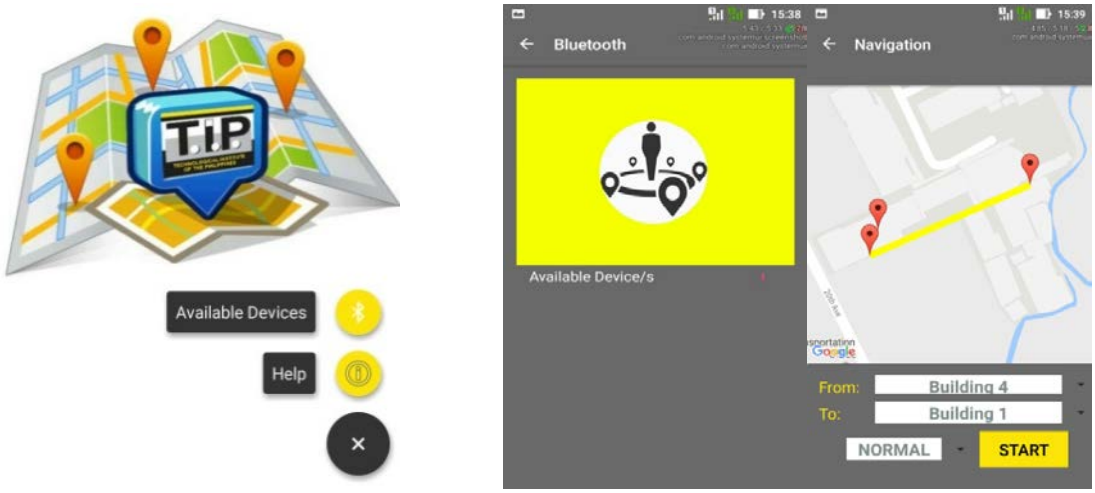
Bluetooth is a short range communication technology in which devices communicate in a master-slave fashion within a piconet. Several piconets interconnect via gateway devices to form a scatternet. This algorithm is a greedy approach to scatternet tree and mesh formation which tries to minimize the number of piconets at each iterative step [25]. The protocol is distributed, rapidly converging and incurs minimum control packet overhead. The scatternet formed is optimized in terms of number of piconets formed and average shortest path between any two devices. In the TIP Express scatternet formation algorithm was used to find nearby Bluetooth devices around the user and find shortest path between the two devices.



a) b)

Fig. 6. a) Login & register screens b) splash screen & home screen.

Fig. 7a shows “the around me” feature of the mobile application. Nearby enabled Bluetooth devices may be visible to the user to see people within certain range (Bluetooth).



a) b)

Fig. 7. a) Bluetooth implementation b) available device & navigation screen.

Fig. 7b shows the screen for displaying the available devices of the person around the user. And second screen is the navigation part which is the plotting route and guiding tool for navigating in the T.I.P. Quezon City campus.

Surveys using questioners drafted from ISO 25010 [26] were utilized to determine the effectiveness of the application in terms of its functionality, reliability and efficiency. It was concluded that the mobile application is an effective tool in giving information navigations for the users. For the result, the average mean of all the criteria yields 4.12 or very effective using the 5 point Likert Scale [27]. The interpretation is that the mobile application is effectively usable.

Table 1 displays the result of survey gathered from the Non-Technical or Non ITE (Information Technology Education) (150 students) students as to the acceptability of the TIP EXPRESS considering all criteria. On a scale of five (5) as the highest and one (1) is the lowest, the respondents rated the system according to its functionality, efficiency and reliability. Functionality covers the application's correctness, appropriateness and completeness. Reliability refers to the availability of the desired output, fault tolerance and recoverability, Efficiency refers to the time behavior, resource utilization and capacity of the application to function effectively. The average mean are 3.93, 4.17, 3.80 respectively and an overall evaluation of 3.97 which can be interpreted as very acceptable. Thus, in the point of view of the non-technical users, the mobile application caters desirable outcomes which the mobile application intends to do.

Table 1. Non-technical Evaluation Results

Characteristics	Average	Interpretation
Functionality	3.98	Very Acceptable
Efficiency	4.17	Very Acceptable
Reliability	3.80	Very Acceptable
TOTAL	3.97	Very Acceptable

The result implies that the mobile application, TIP Express, conforms to its goal of providing a mobile application that user-friendly, simple to use and well-design application and complied with the ISO 25010 standard of functionality, reliability and efficiency.

Table 2 shows the result of survey gathered from the Technical or ITE students (150 Computer Science, Information Systems and Information Technology students) and ITE faculty members (17 teachers) as to the acceptability of the TIP EXPRESS considering all criteria. On a scale of five (5) as the highest and one (1) is the lowest, the respondents rated the system according to its Functionality: applications correctness, appropriateness and completeness; (b) Reliability: availability, fault tolerance and recoverability; and (c) Efficiency it consists of applications: time behavior, resource utilization and capacity. The average mean are 4.06, 4.12 and 4.19 with an average score of 4.12, interpreted as very acceptable. The overall result for the evaluation of the mobile application on the technical aspect is interpreted as Very Acceptable. The result implies that the mobile application, TIP Express, conforms to its goal of providing a mobile application that will use as guiding tool in navigating around the T.I.P campus and complied with the ISO 25010 standard of functionality, reliability and efficiency.

Table 2. Technical Evaluation Results

Characteristics	Average	Interpretation
Functionality	4.06	Very Acceptable
Efficiency	4.12	Very Acceptable
Reliability	4.19	Very Acceptable
TOTAL	4.12	Very Acceptable

The response time of the mobile application varies depending on the number of plotted destination given that the mobile phone has stable internet connectivity. The generation of the path and identifying other users around with in a range also varies with the number of parameters (number of destination and enabled Bluetooth device) involved in the path formulation and device searching.

6. Summary, Conclusion and Recommendation

The TIPEXPRESS Application is a mobile application that used Google Map to track the current location of the user and plot a route from origin to the destination inside the Technological Institute of the Philippines Quezon City campus using fuzzy logic algorithm to get the shortest path and channel selection algorithm to get the nearby user within a perimeter. Implementation of MD5 algorithm was considered to ensure non-disclosure of any input information.

This mobile application is for TIP students/staff and visitor who have a hard time locating building structure. With this application the user will be able to go to the desire destination inside the T.I.P. Quezon City campus. Overall, TIP Express mobile app is very suitable for the students and visitors. TIP express provides enhanced user experience with a user-friendly environment and a responsive guiding tool in navigating around the T.I.P. Quezon City campus.

After the testing and evaluation phase, the researcher were able to conclude that the application conforms its project objectives. Based on the findings of the study, the following can be concluded: (1) The mobile application, "TIP Express", was able to simulate and visualize route/path for T.I.P. Quezon City Campus; (2) The mobile application gives the current location of the user and a list of college buildings where he/she may want to go by the use of fuzzy logic algorithm; and (3) TIP Express is acceptable in terms of functional suitability, reliability and efficiency which are software quality factors based on ISO-25010.

To further improve TIPEXPRESS, the developers recommend the implementation of secured chatting to gain more power in communication around T.I.P. Quezon City campus using a single mobile application. The developers also recommend for TIPEXPRESS to identify someone's location with user's consent present on the area upon request.

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Reynaldo E. Castillo is a computer science faculty member at the Technological Institute of the Philippines Quezon City (T.I.P. Quezon City) from 2012 up to present. He finished his BS in computer science in 2012 and master of information technology in 2015 at T.I.P. Quezon City. His was inloved in the instruction, research, and sectoral engagement grants of the commission on higher education in partnership with the Knowlegde Chanel Inc. as the team leader for game development. His research interest lies in the fields of mobile and web application development, multimedia technologies, information security, modeling and simulation.

Paula Jean M. Castro graduated with a BS Information Technology degree from Technological Institute of the Philippines-Quezon City (TIP-QC) in 2012 and a Master of Information Technology in 2015 from the same institution. She became a full-time faculty member of TIP-QC College of Information Technology Education in April 2012. As faculty member she is handling database administration, PL/SQL programming, project planning and management and data mining courses. Moreover, she is also a member of Philippine Society of IT Educators (PSITE) since year 2012 up to present. She was involved in the Instruction, Research, and Sectoral Engagement (IRSE) Grants of the Commission on Higher Education in partnership with the Knowledge Channel Inc. Her research interests lies in the field of applications of data mining in the computing, business and educational disciplines and mobile application development.

Maria Christina Aragon received her BS and MS in computer science degrees at AMA Computer University-Makati. She finished her doctorate degree at Technological University of the Philippines in 2011 and her research interests are image processing and natural language processing. She is currently the chair of the CS program at Technological Institute of the Philippines, Quezon City. Dr. Aragon is a member of ACM, IEEE, Philippine Society of IT Educators and Computing Society of the Philippines.

Henry Macugay is a graduate of BS computer science from the Technological Institute of the Philippines Quezon City in 2017. Henry is currently working in the industry. His specializations are in sowaftare development, website design and development, project management and I.T. infrustructure. His research interest lies in the fields of web application and software development.