

# BahaBa: A Route Generator System for Mobile Devices

**Ralph Vincent J. Regalado, Michael Benedict Y. Haw, Matthew Alexis P. Martinez,  
Lowie O. Santiago, Patrick Lawrence S. Tamayo**

Center for Language Technologies  
De La Salle University  
Manila, Philippines

ralph.regalado@delasalle.ph, {michael\_haw, matthew\_martinez,  
lowie\_santiago, patrick\_lawrence\_tamayo}@dlsu.ph,

## Abstract

The Philippines is considered to be one of the world's most disaster prone countries. Since the use of mobile devices continues to grow, many generated applications for mobile devices that will aid during disaster. While most of the people residing in the urban areas are mostly smartphone users, people who are living in the rural areas are still using low-cost phones. In order to equally provide information that will be needed on or during disaster, we created BahaBa a SMS-based route generation system targeted for mobile devices. The system accepts a SMS and generates a template-based response to the sender, containing instructions on the shortest path to the nearest safe place in a community.

## 1 Introduction

According to the Asia Pacific Disaster Report 2012, the average number of people in Asia-Pacific who are at risk from yearly flooding doubled from 29.5 million to 63.8 million (United Nations Economic and Social Commission for Asia and the Pacific and United Nations Office for Disaster Risk Reduction, 2012). Philippine is one of the region's hardest hit countries in the past decade which recorded 182 disasters that killed almost 11,000 people (United Nations Office for Disaster Risk Reduction, 2012).

Since the use of mobile devices continues to grow, several local applications for mobile devices have been developed, such as iTyphoon (Nueva Caceres Technology Solutions, Inc., 2013) and Project NOAH (Department of Science and Technology, 2013), to aid during disasters. Most of these applications require the use of smartphones and mobile internet to contribute and retrieve content.

According to a World Bank (2012) report, Philippines have a high access and usage statistics in mobile communication when compared to other countries. It is highlighted that mobile internet usage in the Philippines is low, 23.1% of Filipino mobile users have mobile broadband connection and only 9.8% use mobile internet. The data also showed that 97% of the users use Short Message Service (SMS). In order to provide information that will be needed on or during disaster we created BahaBa, route generation system targeted for mobile devices. It uses SMS to accept user request and generates a template-based response to the sender containing instructions on the shortest path to the nearest safe place in a community.

The remainder of this paper is organized as follow. Section 2 reviews existing works related to our approaches. Section 3 introduces the main processes of our approach. Section 4 describes our testing results. In Section 5, we conclude our efforts and discuss some future works.

## 2 Related Literature

The work of Dale, et al. (2003) was one of the early works who used Natural Language Generation (NLG) to provide navigational assistance. Their work, Coral, generate descriptions for routes from an area to another area. Routes generated consider the mode of navigation, means of communication and type of environment. The system represented the world as nodes, arcs and polygons. The nodes represent junctions or decision points, arcs represent travelable paths and polygons represent areas like parks, stations and the like. The system also has several options which allows user to customize their route, whether he wants the shortest or fastest path, avoid an area, or traverse a one way road. The NLG task in Coral involves text planning, micro

planning and linguistic realization. Text planning is about taking a path-based route plan that derives messages that are sent to the user. Micro planning makes a list of sentences and identifies what information to be used for the route to be undertaken. Linguistic realization maps the sentences. Same as Coral, our work focuses on using NLG to generate route to safe places. Our NLG task is focus on Text Planning, Discourse Planning and Linguistic Realization.

Fajardo & Oppus (2010) discussed MyDisasterDroid, an application that determines the optimum route to find different ge-graphical locations that the rescuers will take in order to serve effectively during a disaster. In determining the most optimum route along different geographical locations, it was solved as a travelling salesman problem wherein the objective is to go to a location and proceed to another in the shortest way possible in terms of length or cost. Since our work provides a path to a nearest safe place, we used A\* search algorithm. This algorithm ensures that a path can be found, and, if it exists, takes distance into consideration as the cost in order achieve the optimal route.

### 3 The BahaBa System

The BahaBa system is consists of 3 main modules: SMS Processing, Route Generation and Text Generation. Figure 1 shows the system architecture.

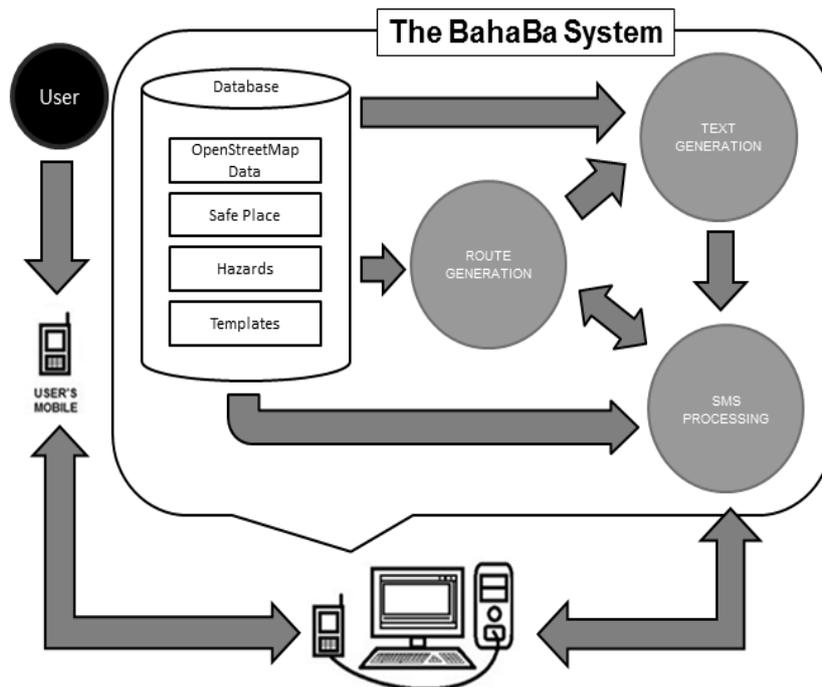


Figure 1. BahaBa System Architecture

### 3.1 SMS Processing Module

This module is responsible for sending and receiving SMS to and from the user. Once an SMS is received this module validates first the format. The format is:

BHB [Type] [Hazard] [User Location]

*BHB* is the system key variable. The *[type]* is the keyword for safe places being searched by the user. *[Hazard]* is the keyword if the user wants to consider the surrounding flood hazards. While the *[User Location]*, contains the user's current location. Table 1 and 2 shows the keywords used for *[type]* and *[hazard]*.

Keyword	Description
EC	Evacuation Center
P	Police Station
H	Hospital
O	Any nearest safe place

Table 1. Keywords for Safe Place

Keyword	Description
H	With hazards
NH	Without hazards

Table 2. Keywords for Hazard

Once the format is validated, it will perform location validation. The *[User Location]* will be compared to all the list of locations stored in the database. Once validated, it will transfer the SMS data, and the longitude and latitude of the *[User Location]* to the next module; else it will respond back to the user notifying that the SMS is invalid.

### 3.2 Route Generation Module

This module handles the actual generation of the route in the form of a list of nodes. It first creates a start node for the start location based on the *[User Location]*. It then searches the database for a list of safe places specified in the *[Type]* and creates goal nodes for them.

The task of this module is to look for the nearest safe place from the start location. We treated this route generation as a search problem where, from the initial node, or the start location, the search algorithm finds the fastest and lowest cost path to the goal node, or the target location. We used A\* search algorithm since it ensures that a solution or path can be found, and, if it exists, takes distance into consideration as the cost in order to achieve the optimal route.

For the evaluation function  $f(n)$  used in A\* search algorithm, the cost function  $g(n)$  will be the collective cost or distance from the start node to the node  $n$ , while the heuristic function  $h(n)$  will be the cost or straight line distance from the node  $n$  to the goal node. Distances are calculated with the Euclidean distance formula using latitude and longitude as the ordered pair for the nodes as seen in Figure 2.

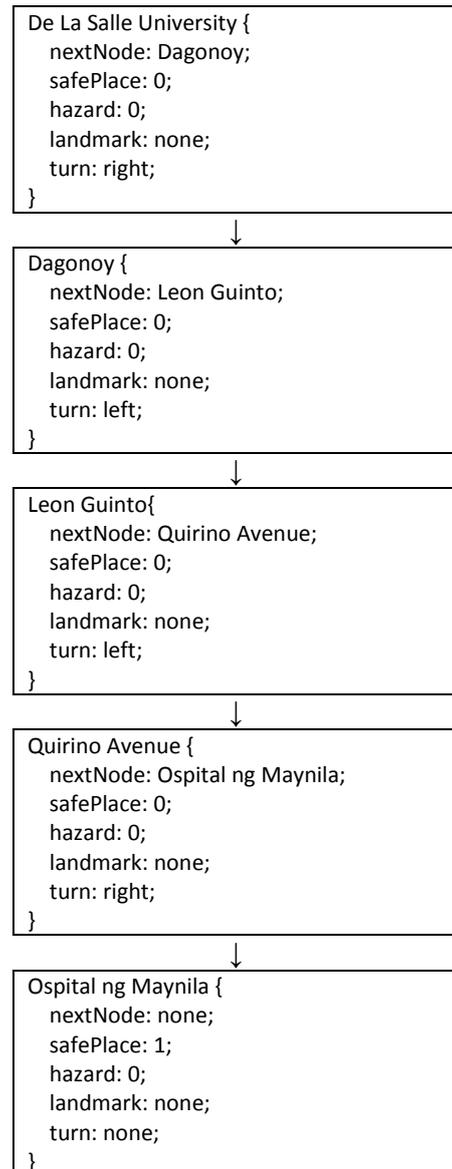
$$d = \sqrt{(latitude(n_1) - latitude(n_2))^2 + (longitude(n_1) - longitude(n_2))^2}$$

**Figure 2. Euclidian Distance Formula**

Since our system consider flood hazards, they are treated as expensive nodes depending on the hazard level. To be more specific, a hazard node can still be a viable node to pass through in a route. To emulate the added cost of a hazard node's flood level, the node's heuristic value can be increased by a value corresponding to the intensity of the flood level. A hazard node that currently has minimal flood levels would have its heuristic increased by a trivial amount, like an additional 10m, which would keep its overall cost lower, while a hazard node that currently has dangerous flood levels would have its heuris-

tic increased by a major amount, like an additional 500m, which would make the node extremely costly to traverse, effectively ruling it out as a possible node in the route. After the shortest path to the goal node is found the module then generates a Text Plan.

The Text Plan is constructed by traversing the route's nodes. Using the location's longitude and latitude found in each node, it identifies if it is traversing a single street and detects when the path turns to a new street or encounters a location landmark. Figure 3 shows an example of a generated Text Plan.



**Figure 3. Sample Text Plan**

If there is a route generated the Text Plan will be passed to the Text generation module; else it

will pass it to the SMS processing module to inform the sender that there are no routes available.

### 3.3 Text Generation Module

This module converts the route generated by the previous module into text form through the use of template-based NLG. This module has two sub-modules: Discourse Planning and Linguistic Realization. Figure 3 shows the process of the Text Generation Module

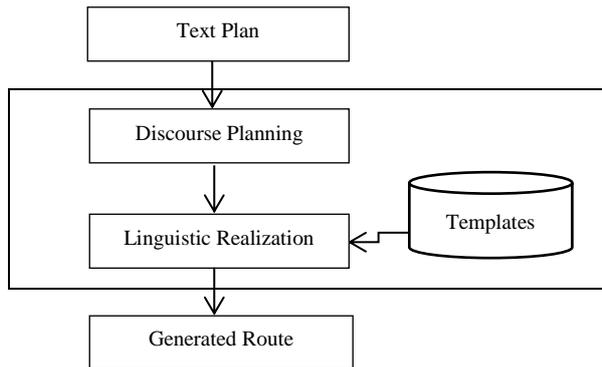


Figure 4. Text Generation Module

#### Discourse Planning

Each element in the Text Plan is analyzed and categorized according to the templates. Table 3 shows the list of template tag.

Template Tag	Description
<start no landmark>	First element in the Text Plan. No landmark near the area.
<start with landmark>	First element in the Text Plan. There is landmark near the area.
<body no landmark>	Elements between the first and the last element. No landmark near the area.
<body with landmark>	Elements between the first and the last element. There is landmark near the area.
<end no landmark>	Last element in the Text Plan. No landmark near the area.
<end with landmark>	First element in the Text Plan. There is landmark near the area.

Table 3. List of Template Tag

Once all the elements are analyzed, it will pass the Text Plan and the assigned templates to the next sub-module. Using the Text Plan in the previous module it will output the following:

<start no landmark><body no landmark>  
<body no landmark> <end no landmark>

#### Linguistic Realization

The template tags from the output of the discourse planning are the basis on what template number will be retrieved from the database. The database used in this sub-module contains all the templates with their corresponding tag. For every template randomly chosen, the values from the Text Plan are used to complete the template. Using the Text plan and the template tags it will output the following text:

- Simula sa De La Salle University, dumiretso pagkatapos kumanan sa Dagonoy.  
*Translation: 'Starting from De La Salle University, you walk straight ahead and then turn right to Dagonoy'*
- Pagkatapos lumiko, dumiretso lamang at kumaliwa sa Leon Guinto.  
*Translation: 'After you turn, you walk straight and then turn left to Leon Guinto.'*
- Ang susunod na gagawin ay hanapin ang Quirino at kumaliwa dito.  
*Translation: 'The next step is to look for Quirino and turn left.'*
- Dumiretso lamang at matatagpuan ang Ospital ng Maynila.  
*Translation: 'You walk straight ahead and you will see the Hospital on Manila.'*

Once the text form is generated it will then pass it to the SMS Processing Module to send back the message containing the route to the sender.

## 4 Evaluation

The quality of the routes generated was evaluated based on standards discussed by Lovelace, et al. (1999). According to Lovelace, et al. (1999), the quality of a route direction can be measured by the information present in the text. Examples of this information are the landmarks, turns and descriptive route information. To confirm the quality of the routed generated by our system two experiments were conducted.

### Experiment 1: Unfamiliar route and Map

The goal of the experiment is to determine if a SMS response generated from the system is clear enough to direct a user to a safe place.

The task performed was to ask evaluators to answer a survey which contains an unfamiliar map and a route generated by the system. Following the route found in the survey, the evaluators need to draw lines on the roads of the map starting from a specified starting location going to the destination.

The survey was answered by 30 respondents, 14 of which are male while the rest are female. Below is a summary of the evaluation:

- Errors made by some respondents were through following the route per sentence. They go through the whole street that was mentioned in the first instruction before they head to the next street indicated in the next instruction. This result to mistakes in turning and the respondents had to go back since they missed a corner.
- Errors were caused due to unfamiliarity of the area, based from their drawing there are some lines that went over the corners and passed through them. These errors were due to the problem with the generation of the route. Roads that are going to a curve are sometimes perceived as a turn in direction.

Based from the results of this survey, some roads are hard to simulate by only looking at the map and the given route. It is recommended that an actual simulation is needed to test the reliability of the generated instruction.

### Experiment 2: Validate Generated Route

The second experiment conducted is to evaluate the route generated whether it is effective in giving out directions.

Same as the previous experiment we ask evaluators to answer a survey. The survey was answered by 30 respondents, 14 of which are male while the rest are female. The survey contains an example route to be evaluated and a list of criteria made by Lovelace, et al. (1999). Evaluators were asked to check a criteria if it is present in the route generated by the system. Table 4 shows the result of the experiment.

Criteria	Votes	% *
A - Prepares the traveler for upcoming turning points to change location	21	70%

B - Mentions landmarks at turning points	21	70%
C - Gives 'you've gone too far if' statements in case a turning point is missed	18	60%
D - Gives landmarks rather than street names	14	47%
E - Provides a limited amount of redundant information	14	47%
F - Tells the traveler which way to proceed at a turning point to change location	23	77%
G - Provides information to allow recovery from errors	10	33%
H - Provides clearly linear information	20	67%
I - Gives distances between turning points	6	20%

\* no. of votes / no. of evaluators

**Table 4. Results of Experiment 2**

The results show that the generated route was able to direct a user when there is a turning point to change direction. It is also observed that the route was able to use landmarks, but this is dependent on the data stored in the database. Criteria G and I are expected to be low because the templates used for the routes does not cover giving directions to allow recovery of errors and does not give distances between turning points.

## 5 Conclusion

The BahaBa System was able receive a SMS request, process the request, generate a route and its corresponding route message, and send the SMS back to the user.

Currently, the routes generated by the system are in the Filipino Language. But since we are using template-based NLG, it can easily be adapted to other languages by simply translating the templates that are stored in the database.

While experiment 1 results shows confusion among evaluators when navigating on the paper map, experiment 2 showed that the generated routes are effective. Possible future work includes, doing experiment 1 again but instead of navigating on paper map, an actual navigation should be done. Another possible work is on resolving the criteria G and I by reviewing and expanding the templates and adding more information relevant to route generation.

## References

- Dale, R., Geldof, S., & Prost, J.-P. (2003). CORAL: Using Natural Language Generation for Navigational Assistance. *26th Australasian Computer Science Conference - Volume 16* (pp. 35-44). Australian Computer Society, Inc.
- Department of Science and Technology. (2013). *Project NOAH*. Retrieved January 2013, from Google Play:  
<https://play.google.com/store/apps/details?id=ph.ov.dost.noah.android>
- Fajardo, J., & Oppus, C. (2012). A mobile disaster management system using the android technology. *WSEAS Transaction on Communications*, 9(6), 343-353.
- Lovelace, K. L., Hegarty, M., & Montello, D. R. (1999). Elements of good route directions in familiar and unfamiliar environments. Spatial information theory. *Cognitive and computational foundations of geographic information science* (pp. 65-82). Berlin: Springer.
- Nueva Caceres Technology Solutions, Inc. (2013). *iTyphoon*. Retrieved January 2013, from Google Play:  
<https://play.google.com/store/apps/details?id=com.magnoconag.ITyphoon>
- The World Bank. (2012). *2012 Information and Communications and Development : Maximizing Mobile*. Washington DC: International Bank for Reconstruction and Development / The World Bank.
- United Nations Economic and Social Commission for Asia and the Pacific and United Nations Office for Disaster Risk Reduction. (2012). *Asia Pacific Disaster Report 2012*. Bangkok, Thailand: United Nations Economic and Social Commission for Asia and the Pacific and United Nations International Strategy for Disaster Reduction.
- United Nations Office for Disaster Risk Reduction. (2012). *Floods deaths down but economic losses significant*. Retrieved January 2013, from United Nations Office for Disaster Risk Reduction:  
<http://www.unisdr.org/archive/30026>