Real Time Public Transportation Navigator System in Jakarta by Using Greedy Best First Search Algorithm

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***Abstract*—According to Castrol's Magnetec Stop-Start index 2015, Jakarta was determined as the most traffic jam city in the world. This condition is getting worse in 2016 with significant increase of private vehicle number in Jakarta. In order to tackle this problem, current Jakarta's governor stated that the only working theory to dissolve the congestion in Jakarta is to make people willing to commute using public transportation. However, there is no integrated system to facilitate and navigate the usage of public transportation in Jakarta. In order to help the government to encourage people to use the public transportation, an integrated public transportation system is developed. On the first development phase, this system will integrate two main public transportations in Jakarta: train KRL and bus TransJa-karta. Greedy best first search algorithm is implemented to calculate fastest route information. Routes, direction, current location and others real time information is provided by using Google Map service. Some alternative routes based on cost, distance and time will be shown to facilitate user preferable. The system is developed for three main platforms: website, android, and iOS to cover user's usage diversity in Jakarta. Based on survey conducted on the last phase on development cycle, 90 percent of respondent says that the navigation information is accurate.**

***Index Terms*—Greedy Best First Search; Google Maps API; Shortest Route; Navigation System; Public Transportation.**

I. INTRODUCTION

Traffic congestion is one of big problem that need to be solved in Jakarta. The main cause of traffic congestion is number of vehicle that is greater than available road-way capacity. In 2015, Jakarta was determined as the most traffic jam city in the world based on Castrol's Magnetec Stop-Start index [1]. Number of private vehicles purchasing in 2016 increased significantly according to Jakarta transportation statistical report with little number of roadway construction. Thus, the congestion problem is getting worse in this year. In order to tackle this problem, current Jakarta's governor stated that the only working theory to dissolve the congestion in Jakarta is to make people willing to commute using public transportation [2]. Government enhances public transportation service by creating new route and adding transportation fleet. Moreover, a Mass Rapid Transportation is under construction and planned to be operated in 2018. However, there is no integrated and real time system to facilitate the usage of public transportation in Jakarta. This condition leads Jakarta people to keep using private vehicle rather than public transportation.

In order to help the government to encourage people using public transportation, an integrated and real time public transportation system is developed as the main re-search in this paper. On the first phase development, system will integrate two main public transportations in Jakarta metropolitan area: commuter line or KRL (Kereta Rel Listrik) and Bus Rapid System named TransJakarta. Other public transportation such as public buses, metromini, angkot, or MRT will be considered to be integrated on the next phase development. The system will provide main information needed such as schedule, station/corridor location, and available routes for each public transportation. Real time information is retrieved by using Google map service. Current location of user detected automatically to check public transportation station/corridor around user. Feature direction searching and real time traffic information will be used to calculate estimation time and distance. Implementation of Greedy best first search algorithm is used to recommend possible fastest route.

Two top mobile operating system used in Indonesia is Android and iOS [3], therefore this system will be developed on both mobile operating system. To cover other mobile operating system user, we develop as well a web version of this system. The rest of this paper is organized as follows. The second section will discuss about related works regarding this research. Subsequent section describes proposed solution system. The 4th section presents the implementation result in three platforms. Conclusions are given in the last section.

II. RELATED WORKS

Google Map is a web mapping service developed by Google Inc. As quoted from Hu & Dai [4], "Google Maps launched in 2015 has revolutionized online mapping service application on the World Wide Web". With over a billion monthly active users and dozens of function it is no doubt one of the most used and most famous mapping service as well as one of the most state-of-the art. The journey of Google Map start of as a C++ program designed by two Danish brothers, whose company, Where 2 Technologies, later on propose the idea of a purely web based mapping service to Google. In 2004 they said company is acquired by Google Inc along with Keyhole, a geospatial data visualization company, and ZipDash, a traffic analysis provider company, later on.

The main Google Map functions are; direction searching, earth imagery view, real time traffic coloring, transit point, bicycle route, private map making tool, real time accident information, place recommendation, place name information,

real imagery street view, travel direction, cost and time calculation, terrain view and level information, borders and even the earth and its surrounding universe imagery.

Similar application such as web based bus tracking system developed by Kumbha [5] provides real time location of bus by using Google Maps. Chandukar et al [6] develop Real Time Bus Monitoring and Passenger Information System to track the current location of all the buses and estimated their arrival time at different stops in their respective routes. Omar et al [7] introduces an application for android mobile, which is implemented to provide the android mobile user to add, remove and review specific locations on the online map. The proposed applications also presents the basics navigation operations like showing directions with the optimal path between source and destination and calculating the distance and expected driving time by using Google Maps API.

III. SOLUTION SYSTEM

A. *Analysis and Design*

Based on user requirement analysis and comparison of similar applications, several points need to be addressed to give user excellent service. Main features of this navigator system are determined below:

- Navigator, with suggestions of best route based on the duration and distance, and the calculation of total cost.
- Schedule of Commuter Line and Transjakarta Buses that will show all information about schedule.
- Nearby places that surrounds transportation stops
- Problem report regarding public transportation facilities.
- Live update of event reported based on location of public transportation stops that is shared from other users.

Use case diagram to summarized main functionality of this real time public transportation navigator system is shown on Figure 1. User will need to enroll before using the application.

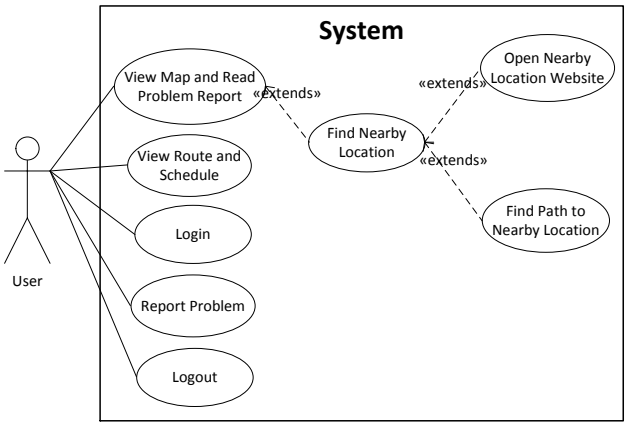

Figure 1: Use Case Diagram

B. *Geolocation to get current location*

Main functionality to navigate user from current location to the destination is implemented by using Google Maps API services. The figure below (Figure 2) is the code to add Get Current Location feature. The green lines are new codes that are added for the feature. Geolocation function is added to get users location based on their IP address.

part-map2.php

Hunk 1 : Lines 53-59

```
 53  53  <script>
 54  54  //Global variable
 55  55  var marker_array = [];
     56 + var myMarker_array = [];
 56  57  var poly_array = [];
 57  58  var map = "";
 58  59  function initMap() {
```

Hunk 2 : Lines 204-217

```
203 204    map.controls[google.maps.ControlPosition.RIGHT_BOTTOM].push(controlDiv);
204 205
205 206    firstChild.addEventListener('click', function() {
     207 +    for (var i = 0; i < myMarker_array.length; i++) {
     208 +      myMarker_array[i].setMap(null);
     209 +    }
206 210      var myMarker = new google.maps.Marker({
207 211        map: map,
208 212        animation: google.maps.Animation.DROP
209 213      });
     214 +  myMarker_array.push(myMarker);
210 215      var imgX = '0';
211 216      var animationInterval = setInterval(function(){
212 217        if(imgX == '-18') imgX = '0';
```

Hunk 3 : Lines 223-230

```
218 223          var latlng = new google.maps.LatLng(position.coords.latitude, position.coords.longitude);
219 224          myMarker.setPosition(latlng);
220 225          map.setCenter(latlng);
     226 +        $("#origin-input").val("Lokasi Anda");
     227 +        $("#destination-input").focus();
221 228          clearInterval(animationInterval);
222 229          //$('#you_location_img').css('background-position', '-144px 0px');
223 230        });
```

Figure 2: Snippet to get current location

C. *Greedy best first search algorithm*

Greedy best first search (GBFS) is an algorithm that is quite popular to be used as path-finding method. The way that GBFS works is, as explained by Richter & West-phal [8], "the greedy best first search always expands a state with minimal heuristic value h among all open states and never expands a state more than once", meaning that at a node, GBFS will take the current best next node and that decision is irreversible. Wilt, et al [9] presented comprehensive comparison across greedy search algorithm families for solving shortest path problem. Three major algorithms families compared are best first, hill climbing, and beam search. This comparison showed us that the Greedy Best First Search is preferable in domains where the goal cannot be reached from all states. Thus, this algorithm is implemented in this system to find possible routes and suggest shortest route from user's current location to the destination. Both pseudocode of finding route and getting fastest route algorithms are provide below:

i) *Pseudocode for find route*

```
classPathNode
construct(StationId, StationTransportId, station_lat, sta-
tion_lng, StationTransportCode, line_id, line_name,
line_type, line_color, line_icon, station_name, elt, toEnd)
       set this class' StationId to StationId
       set this class' StationTransportId to
                StationTransportId
       set this class' StationTransportCode to Station-
                TransportCode
       set this class' station_lat to station_lat
       set this class' station_lng to station_lng
       set this class' station_name to station_name
       set this class' line_id to line_id
       set this class' line_name to line_name
       set this class' line_color to line_color
       set this class' line_icon to line_icon
       set this class' line_type to line_type
       set this class' elt to elt
       set this class' toEnd to toEnd
getElt() return elt
getToEnd()return toEnd
getMDI()return StationId
getMI()return StationTransportId
getMCode()return StationTransportCode
getMLat()return station_lat
getMLang()return station_lng
getLID()return line_id
getLName()return line_name
getLColor()return line_color
getLType()return line_type

getLIcon()return line_icon
getSName()return station_name
```

ii) Pseudocode for get fastest route

```
set max to number of item in finalBigArray[0]
set iteration to 0
FOREACH finalBigArray[0] as smallArray
       set each["station_id"] to smallArray-> getMDI()
       set each["transport_id"] to smallArray-> getMI()
       set each["transport_code"] to smallArray-> getMCode()
       set each["lat"] to smallArray->getMLat()
       set each["long"] to smallArray->getMLang()
       set each["line_id"] to smallArray->getLID()
       set each["line_name"] to smallArray-> getLName()
       set each["type"] to smallArray->getLType()
       set each["icon"] to smallArray->getLIcon()
       set each["color"] to smallArray-> getLColor()
       set each["name"] to smallArray->getSName()
       set each["elt"] to smallArray->getElt()
       set each["toEnd"] to smallArray->getToEnd()
       IF iteration less than max-1 THEN
                array_push(data,each)
                add iteration by 1
       ENDIF
ENDFOREACH
```

IV. Result and Implementation

Real time public transportation navigator system is developed on three platforms: web application by using PHP, iOS and android operating system. The application is named "JalanYuk!", adapted from Bahasa Indonesia language that means "let's hang out". Figure 3 and 4 show several screenshots of JalanYuk! applications both in web and mobile platform.

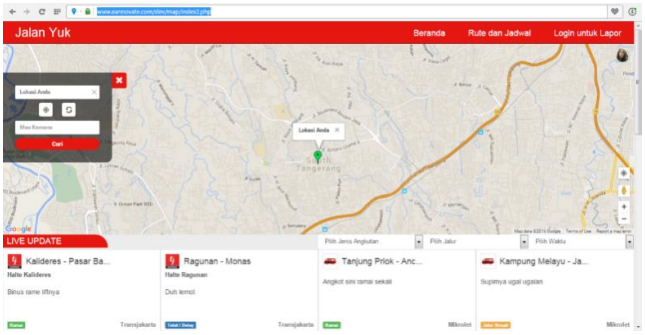

Figure 3: Screenshot of web application

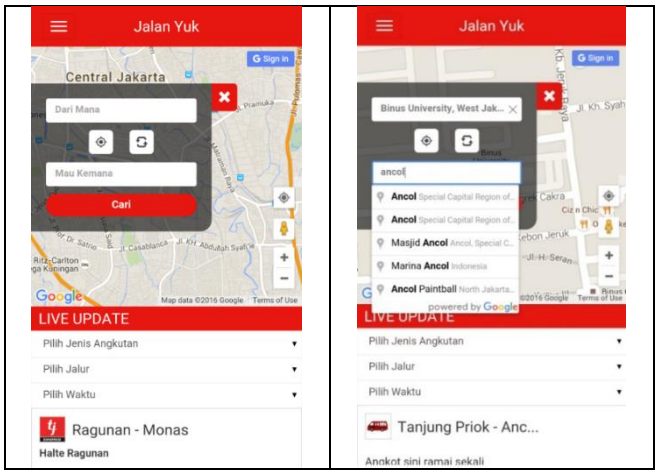

Figure 4: Screenshot of mobile application

V. Discussion and Conclusion

Based on survey conducted to review JalanYuk! application, the survey has shown that JalanYuk! positively able to fulfill aforementioned user requirement. Navigation routes generated by system provide 91% accuracy of distance, travel duration and total cost information. Greedy best first search algorithm implementation is proved to provide shortest route for user. Application availability in multiplatform satisfied user's usage diversity. However, other public transportation in Jakarta such as buses, metromini, angkot or MRT is not yet integrated to this system. Public transportation integration problem will be a research focus on the next development phase.

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