RooWay: A Web-based Application for UA Campus Directions

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Abstract—**With the increasing popularity of Google Maps, the integration of web services with Google Maps has recently attracted considerable attention. Using Google Maps JavaScript API v3, developers can build highly customizable maps with their own content and imagery. To enhance visit experiences on The University of Akron (UA) campus, we present RooWay -- a web-based application for UA campus in this paper. RooWay is built upon Google Maps API and DoubleMap - a service which shows real-time location for Roo shuttles on UA campus. The primary goal of RooWay is to assist visitors and students when they travel to UA campus. When visitors and students arrive on campus, they can use RooWay to navigate around campus. With RooWay, from the moment visitors leave their home, they are able to have an enjoyable journey to UA and a pleasant visit on UA campus.**

Keywords—***Driving instructions, Web applications, Google Maps API, Data integration***

I. INTRODUCTION

A. Motivation

"*Life is a journey, not a destination*."--Ralph Waldo Emerson

The invention of the Internet and the emergence of the World Wide Web revolutionized our daily lives. As Internet services are accessible on all kinds of devices including computers, tablets, and smart phones, travelling becomes easy and convenient with navigation technologies like Google Maps, Bing Maps, Apple Maps and MapQuest. As a high school senior, a student needs to decide where to attend college. When seniors finish their college admissions process, sophomores and juniors are beginning their own search for a future home. For students and parents alike, one of the first tasks is deciding which colleges and universities to visit. When students and parents are planning to visit a university, administrators at the university want the visit experience to be delightful.

The University of Akron (UA) [1] main campus is made up of over 100 buildings on 222 acres near downtown Akron. While UA campus is a compact campus, it is not always that easy to navigate it. The Department of Parking and Transportation Services at UA realized that a visit starts before visitors get to UA campus. To enhance the visit experience, administrators at UA want visitors to see a scenic residential neighborhood on their way to UA campus instead of an unappealing view. When the visitors arrive on campus, there is an urgent need to provide a service for visitors to easily navigate around campus.

With the increasing popularity of Google Maps, the integration of web services with Google Maps has attracted developer attention in recent years. Developers can build customizable maps with their own content and imagery using Google Maps JavaScript API v3 [2]. In this paper, we present a Web-based application for UA campus directions named RooWay which is built upon Google Maps API and DoubleMap [3] - a service which shows real-time location for Roo shuttles on UA campus.

With RooWay [4], visitors can have a delightful trip to UA and a pleasant experience on UA campus. In addition to enhancing the visit experience, RooWay can also make students' daily campus life easy and smooth, especially for freshmen at the beginning of their first semester on a new campus. Students can use RooWay to easily get to their class buildings by either walking or taking Roo shuttles provided by UA Transportation services.

B. Related Work

Many web and mobile applications provide driving directions to users. These include Google Maps, Apple Maps, MapQuest, and Bing Maps. Google Maps [5] is one of the increasingly popular web mapping services which have been used in a wide range of areas including real estate, tourism, and weather forecast. Google Maps provides geospatial visualization of information so that users can analyze and understand the relationship between data and geographic location. Existing Map applications and tools typically provide the shortest or fastest routes which may not be the most enjoyable routes.

Spartan Directions [6] is an official system for driving instructions at The University of North Carolina, Greensboro (UNCG). It was developed to be a door-to-door service for visitors who travel to UNCG campus. Inspired by the effectiveness of Spartan Directions, we present RooWay to enhance the visit experience on UA campus in this paper.

II. OVERVIEW

RooWay provides users door-to-door directions, with the aim to assist visitors and students when they travel to UA campus. When visitors arrive on campus, they can use RooWay to navigate around campus. RooWay provides two primary functions: driving instructions and walking instructions. Not only do visitors receive scenic-ride instructions, they also find out where to park and how to walk to a campus building they want to visit on UA campus. To help a visitor easily find a building, RooWay displays a picture of the campus building selected by the visitor. Unlike existing map applications and tools, RooWay travel routes have been strategically selected to balance the shortest routes with pleasant views of Downtown Akron, in collaboration with UA transportation administrative staff and UA admission offices.

RooWay can also assist UA freshmen with their daily campus life, especially at the beginning of their first semester on a new campus. UA main campus is made up of over 100 buildings on 222 acres near downtown Akron. To easily navigate on campus, students can create a list of campus buildings (up to eight buildings) and submit the list to RooWay. Based upon the student's list, RooWay provides the student with walking instructions between two buildings and Roo Shuttle stations nearby each building, if any. Students can use RooWay to easily get to their class buildings by either walking or taking Roo shuttles provided by UA transportation services. We illustrate the driving instructions and walking instructions in subsection A and B, respectively.

A. The Driving Instructions

RooWay provides an easy-to-use interface for users. Figure 1 is a screenshot of the default interface of RooWay.
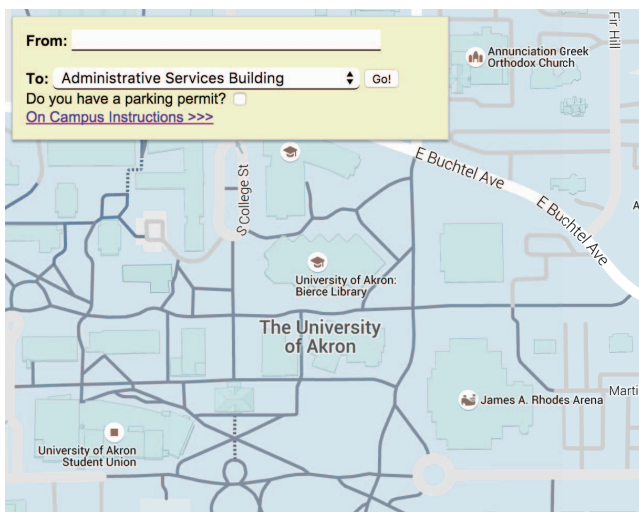

Figure 1. The default interface of RooWay

In Figure 1, the "From:" text box allows a user to provide a starting location. In the "To:" box, the user can use building dropdown list to choose a destination building on UA campus.

If the user does have a parking permit, the user can also notify RooWay by clicking the parking permit checkbox. If a visitor does not have a parking permit, RooWay automatically directs the visitor to a visitor parking lot which is close to the destination building. Assume the starting point is Case Western Reserve University and the destination is College of Arts and Sciences Building on UA campus, the visitor does not have a parking permit. Upon hitting "Go!", the visitor will be presented with driving instructions listed in Figure 2.
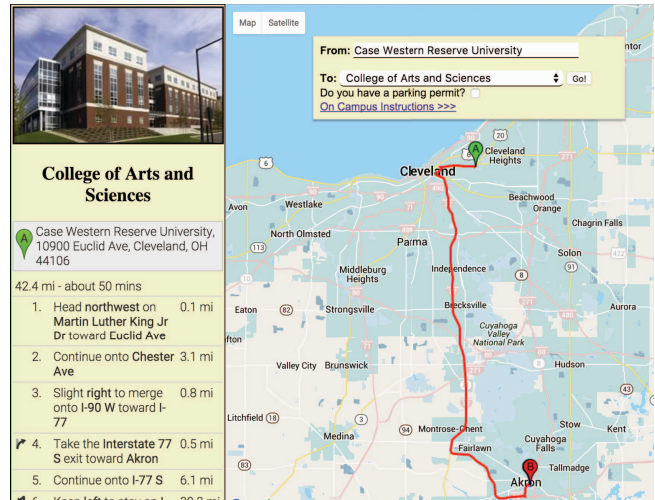

Figure 2. An example of driving instructions from Case Western Reserve University to College of Arts and Sciences building at UA

On the left hand corner of Figure 2, a picture of College of Arts and Sciences building is presented to the user along with textual instructions which are presented in a style similar to Google Map style. The travel routes have been strategically selected to balance the shortest routes with pleasant views of Downtown Akron. The path and waypoints on the map are generated using Google Maps API. Details on how the full travel route is generated can be found in Section III.A.

There are over 70 parking lots on UA campus. RooWay can inform a user where to park based upon the destination building selected by the user. In terms of driving instructions, RooWay directs the user from a starting point to a parking lot which is close to the destination building but also most likely to have available parking space. From the parking lot to the destination building, RooWay provides the user with walking directions. Figure 3 shows an example of walking instruction from a visitor parking lot to College of Arts and Sciences building on UA Campus. In Figure 3, the blue waymark, "P," indicates the location of the parking lot. The red waymark, "B," indicates College of Arts and Sciences building at UA. The red line represents the driving path from Case Western Reserve University to a visitor parking lot at UA, while the blue line represents the walking path from the visitor parking lot to College of Arts and Sciences building.
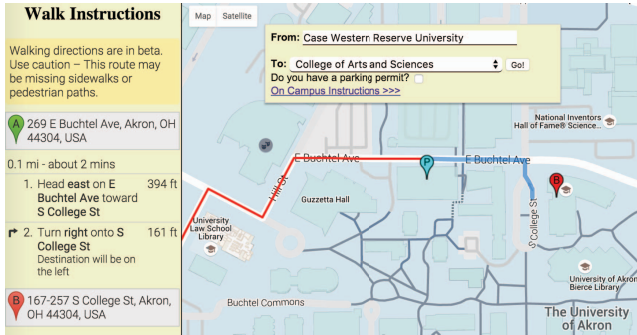
Figure 3. Walking Instrcutions from a visitor parking lot to College of Arts and Sciences building at UA

B. The On Campus Instructions

There is an "On Campus Instructions" link in Figure 3. This link can direct a user to the On Campus Instructions component of RooWay. There are over 100 buildings on UA main campus. UA freshmen can use RooWay to make their daily campus life easy and smooth, especially at the beginning of their first semester on a new campus. RooWay allows a user to create a list of up to 8 campus locations. From the user's current location, a shortest-path walking route is calculated using the Google Maps API to the locations on their list in sequential order. The University of Akron also provides on-campus shuttle services called Roo Express. At the time of this paper, there are three major routes: northeast, west, and south routes. These routes are provided on campus to help students travel around campus or from off-campus housing to campus. RooWay presents the user with bus suggestions based on the buildings in the user's list. Figure 4 shows a snapshot of using the On Campus Instruction feature provided by RooWay.
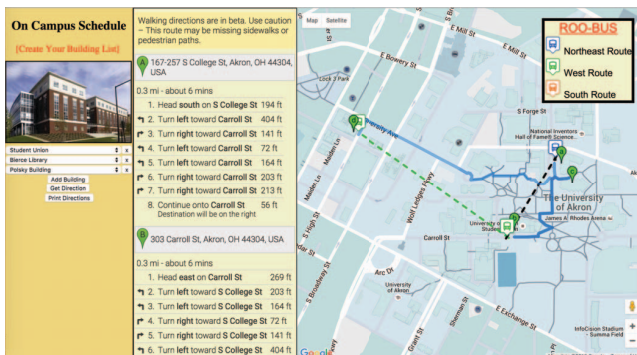

Figure 4. An example of using on campus instruction

In Figure 4, the student's current location is College of Arts and Sciences Building. The student's location list includes three buildings which are Student Union, Bierce Library, and Polsky building. Point 'a' indicates the student's current location. Point 'b' represents Student Union, point 'c' represents Bierce Library, and point 'd' represents Polsky building. Bus stops are presented using icons on the maps. Dotted lines are drawn between bus stops to denote where the student should get on the bus and where they should get off.

Note that the dotted line does not show the actual route. From 'a' to 'b', the student can walk or take Northeast Route shuttle. From 'b' to 'c', RooWay suggests that the student can walk to Bierce Library. From 'c' to 'd' , RooWay suggests that the student can walk back to Bierce Library and take West Route shuttle to Polsky building.

III. IMPLEMENTATION

RooWay is a web-based application, which supports both traditional web browsers and mobile web browsers. For mobile web browsers, it automatically resizes its interface for the browser window. Users can access RooWay on their computers, tablets, and smart phones. Several frameworks (including Google Maps, Google APIs, JSON, JQuery, and DoubleMap) and programming languages including HTML5, JavaScript, CSS, PHP, and SQL are used to implement RooWay. The system architecture of RooWay is shown in Figure 5.
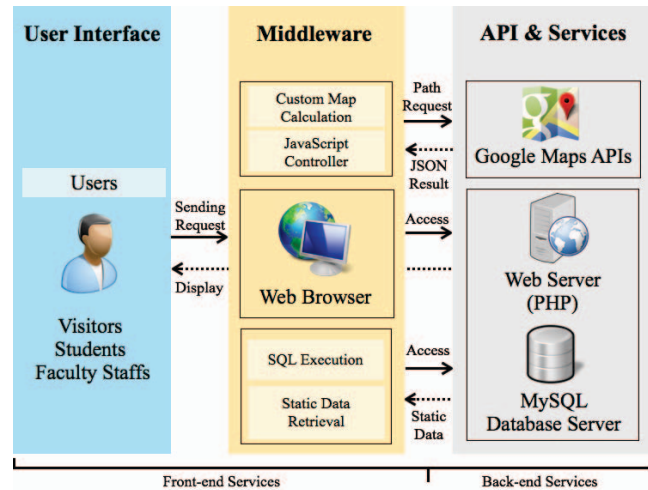

Figure 5. System Architecture for RooWay

RooWay website is hosted on a PHP web server at The University of Akron. Campus building data and parking lot data are stored in a MySql database. Access to MySql database is done through a set of PHP scripts on a web server which retrieve the data and serves them to a controller in JSON format. The controller is a set of JavaScript functions which handle most of the calculations. The JavaScript functions make queries to the web server's PHP scripts to populate lists of campus buildings, campus parking, highway exits, and bus stop information for Roo Express. The controller also interacts with Google Maps APIs to assist in path finding. JSON results returned by the Google Maps API are then analyzed to see if results can be improved (using the 'scenic' criteria proposed by UA transportation administrative staff). If the routes can be improved, another request is made with new waypoint parameters. In the end, the improved route is presented to the user.

A. Driving Instructions

Providing driving instructions is a primary function of the project. RooWay aims to produce a path from a start point to a campus building which avoids routes through bad neighborhoods or poor roads. Algorithm 1 in Figure 6 illustrates the major steps to generate RooWay routes. RooWay driving instructions are implemented based upon the assumption that most visitors travel on a highway to come to UA campus. If a user lives close to UA campus and only uses local roads, the RooWay driving instructions is the same as Google instructions. In collaboration with UA transportation administrative staff and UA admission offices, RooWay travel routes have been strategically selected to balance the shortest routes with pleasant views of Downtown Akron. One limitation of the current predetermined approach is its inflexibility as the ideal routes could never be changed to suit needs such as special events, real time traffic congestions, or construction. We plan to address this issue and overcome this limitation in the 2nd stage of RooWay development.

Algorithm 1: Construct Route Path

Input: Starting Point S, Destination Point d,
　　　　has_permit(T, F)
Output: A path P containing driving directions from
　　　　S to the ideal parking lot, and walking
　　　　directions from the parking lot to the
　　　　destination d, along the ideal route
Initialize:
　　waypoints = $\emptyset$;
　　highway_exits = {highway exits near UA};
　　post_exit_routes = {pre-determined ideal routes from
　　highway exit to campus building};
　　parking_mappings = {(building, has_permit) → lot};
Begin:
　　direct_route = google_maps_route(S, d, waypoints);
　　exit = find_highway_exit(direct_route, highway_exits);

　　// Set intersection should produce a single element
　　waypoints.add(exit);
　　parking_lot = parking_mappings.find(d , has_permit);
　　post_exit_route = lookup_post_exit_route(e,
　　parking_lot);
　　waypoints.add(post_exit_route);
　　P = google_maps_route(S , parking_lot , waypoints);
　　W = google_maps_route(parking_lot , d);
　　return $S + W$
End

Figure 6. Algorithm1: Construct Route Path

When a user is on the default page of RooWay (See Figure 1), the user enters a starting location, selects a campus building, and may also notify RooWay whether he has a parking permit or not. When the user hits "Go!", RooWay first sends a request to the JavaScript controller. Then, the JavaScript controller issues a request to Google Maps API containing pathing information. In the first request it sends the original start and destination points. The Google Maps API returns a path in JSON format. The JavaScript controller does not display the path in the first place. Instead, it traverses the geolocation data backwards (from destination to start) in order to find a highway exit within the set of highway exits near the campus which have been strategically selected by UA transportation administrative staff. The highway exit is added to the set of waypoints.

Next, RooWay makes a request to a PHP script asking for an ideal route from that highway exit to UA campus. Ideal routes are predetermined routes that a user should traverse from that exit. All roads on the post exit route returned by the PHP script are added to the waypoints. Then, RooWay uses campus buildings to parking lot mappings to identify suitable parking lots for the user. These mappings take into account whether the user has a parking permit or not. These mappings are also predetermined by UA Parking and Transportation services based on their data. The mapping includes a ranking system for each lot. The lot with the highest ranking for that building is used as the ideal lot. The ideal lot is added to the waypoints. The start, destination, and waypoints are then passed to Google Maps API for route calculation and the result is then displayed to the user. If the parking lot suggested to the user requires a meter, a warning will be displayed in the written instructions telling the user to park at the meter.

B. On Campus Instructions

On Campus Instructions provides walking directions between campus buildings and Roo shuttle recommendations. The interface of the On Campus Instructions is presented in Figure 4. A user can enter up to 8 campus locations. From the user's current location, a shortest path for walking directions is found for any two contiguous locations on the path and rendered to the user. Users can click on waypoints to view pictures of the building in their path. Additionally, RooWay provides a bus suggestion for any two contiguous locations on the path within 200 meters of a Roo Express bus stop. The bus suggestion draws a bus icon on the map for the start and stop.

C. Collecting Data

There were several challenges in the early development of RooWay. One challenge is related to accurate and consistent data for each building and parking lot. The data used in RooWay are from multiple sources. We obtained the campus building data set, parking lot data set and Roo bus data set from UA transportation services. The campus building data set includes building information such as building name, building number, an abbreviated identifier, and an address. The parking lot data set includes parking lot information such as parking addresses, campus building to parking lot mappings, and information on meters in the lots. Roo bus data set includes bus stop names, and stop locations (in latitude and longitude format). The second data source is The University of Akron web pages [7], and the third is from Google Maps API calls.

At the early stage of developing RooWay, the data we collected was incomplete and inconsistent. Another challenge is that data are presented in multiple data files with various data formats. Some files are in spreadsheet format while others are JSON. In some cases, across different files, building names are not consistent, or some building names were abbreviated in one case while others were not. Locations scraped from UA web pages are often offices inside actual buildings, outdated and no longer there, or not actually campus buildings. To solve name conflicts, we developed a Python program to fuzzily match these building names, parking lot names and their corresponding latitudes and longitudes. After preprocessing the data, we manually fix missing or mismatched data. For an example of the data integration process for campus buildings see Figures 7, 8, and 9. Figure 7 shows the partial data of one of the raw data sources that we extracted from UA web pages. Figure 8 shows the original partial raw data that we received from UA's Parking and Transportation Services. These two tables from two different sources needed to be merged into one consistent table. Figure 9 shows the results after the integration process.

	name	abbreviat	address	markdow	image_fil	active	lng	lat
105	Trecasos Building	TRE	NULL		NULL	Y	-81.5114	41.07938
104	Superior Building	SUP	32 S. College St.		NULL	Y	-81.5103	41.08175
102	The Center for the History of Psychology (Roadway Building)	RDWY	NULL		roadway.j	Y	-81.511	41.08053
97	Honors Residence Hall	HRH	NULL		honorsCo	Y	-81.5115	41.07762
93	Gas Turbine Testing Facility	GTTF	NULL		NULL	Y	-81.5176	41.07561
92	Fir Hill Plaza	FHP	NULL		NULL	Y	-81.5069	41.08033
82	Bath Nature Preserve	BNP	NULL		NULL	Y	-81.65	41.18098
187	InfoCision Stadium Summa Field	SFIS	427 Nash St Akron, C		summaFie	Y	-81.508	41.07234
76	Parking Deck North	PDN	255 East Buchtel Ave		parkingSe	Y	-81.5122	41.07821
69	Polymer Engineering Academic Center	PEAC			peac.jpg	Y	-81.5136	41.07942
254	Gioninos Pizzeria (Main St)		1522 S. Main Street			Y	-81.5275	41.046
242	Zip Card Office - Honors Complex					Y	-81.5115	41.0773
246	Rallys		711 East Market Street			Y	-81.4951	41.07634
250	Penn Station (Howe)		753 Howe Avenue			Y	-81.4723	41.11924
62	Folk Hall	FOLK	150 East Exchange		folk.jpg	Y	-81.5177	41.0736
60	Schrank Hall (North)	SHN	240 Carroll Street		schrankN	Y	-81.5138	41.07508
59	Schrank Hall (South)	SHS	240 Carroll Street		schrankSo	Y	-81.5138	41.07456
58	Electric Substation	ESUB				Y	-81.5164	41.07499
57	Express Building (PFOC)	EB				Y	-81.5172	41.07666
56	Buckingham Building	BCCE	220 Wolf Ledges Pkw		buckingha	Y	-81.5166	41.07721
200	South Residence Hall	SH			south-hall	Y	-81.5154	41.07316
53	Business Administration Building	CBA	South Broadway Stre		cba-buildi	Y	-81.5177	41.07766

Figure 7. Partial data of building information scraped from UA web pages.

BLDG NO	BUILDING NAME	ABB	STREET ADDRESS
9124	122 South College *(Trecaso's)*	TRE	122 College Street
9002	178 South Forge Street *(Wonder Bread)*	WBB	178 South Forge Street
6030	32 South College *(Superior Auto Service)*	SUP	32 South College Street
9030	464 Carroll Street *(TKE Fraternity Lease)*	CSBL	464 Carroll Street
5006	Administrative Services Building	ASB	185 East Mill
9411	Akron Innovation Campus North	AICN	411 Wolf Ledges
9441	Akron Innovation Campus South	AICS	441 Wolf Ledges
9087	Akron Polymer Training Center *(Foundation)*	APTC	225 E. Mill Street
1501	Auburn Science & Engineering Ctr.	ASEC	235 Carroll Street
1204	Ayer Hall	AYER	250 Buchtel Common
1102	Ballet Center	BC	354 East Market Street
1910	Barnett Hoover Farm House	WCBH	1901 Smucker Road, Orrville
6014	Bath Nature Preserve	BNP	4240 Ira Road
3002	Bierce Library	LIB	315 Buchtel Common
1705	Buchtel Field Tennis Facility	BFTF	322 Wheeler Street
4001	Buchtel Hall	BH	302 Buchtel Common
1902	Buckingham Building	BCCE	220 Wolf Ledges Parkway
7007	Bulger Hall	BRH	265 Buchtel Common
1002	Business Admin. Bldg.	CBA	259 S. Broadway Street
9079	Carriage House	CARR	60 Fir Hill
5003	Center For Child Development	CCD	108 Fir Hill
9040	Central Hower Community School	CHCS	145 S. College Street

Figure 8. Partial data of building information from Parking and Transportation Services.

BLDG_NO	BUILDING_NAME	ABB	STREET_ADDRESS	Longitude	Latitude	Building_picture
1001	McDowell Law Center	LAW	150 University Avenue	-81.5159	41.0774	mcdowell.jpg
1002	Business Admin. Bldg.	CBA	259 S. Broadway Street	-81.5177	41.0777	cba-building-400p
1101	Kolbe Hall	KO	328 Buchtel Common	-81.51	41.0762	kolbe.jpg
1102	Ballet Center	BC	354 East Market Street	-81.507	41.081	ballet.jpg
1104	Thomas Performing Arts Hall	PAH	198 Hill Street	-81.5154	41.0782	ejthomas.jpg
1105	West Hall	WEST	225 Wolf Ledges Parkway	-81.516	41.077	west.jpg
1106	Guzzetta Hall	GH	157 University Avenue	-81.5142	41.0774	guzzetta.jpg
1107	Olson Research Center	OLRC	260 South Forge Street	-81.5142	41.0798	olson.jpg
1108	Folk Hall	FOLK	150 East Exchange Street	-81.5177	41.0736	folk.jpg
1201	Crouse Hall	CRH	252 Buchtel Common	-81.5124	41.0762	crouse_02.jpg
1202	Knight Chemical Lab.	KNCL	190 Buchtel Common	-81.5151	41.0764	knight.jpg
1204	Ayer Hall	AYER	250 Buchtel Common	-81.5131	41.0763	ayer2.jpg
1301	Leigh Hall	LH	308 Buchtel Common	-81.5106	41.0763	leigh.jpg
1304	Olin Hall	OLIN	361 Buchtel Common	-81.509	41.0769	olin.jpg
1306	College of Arts and Sciences	CAS	290 E. Buchtel Ave.	-81.5107	41.0777	arts_sci.jpg
1401	Zook Hall	ZOOK	276 Buchtel Common	-81.5116	41.0764	zook.jpg
1501	Auburn Science & Engineeri…	ASEC	235 Carroll Street	-81.5138	41.076	auburn_1.jpg

Figure 9. Integrated data from Figure 7 and 8. Data is merged into one consistent format.

IV. CONCLUSION AND FUTURE WORK

In this paper, we presented RooWay, a Web-based application to enhance visit experiences on UA campus. RooWay provides visitors door-to-door directions. With RooWay, from the moment visitors leave their home, they are able to have an enjoyable journey to UA and a pleasant visit on UA campus. When visitors arrive on campus, they can use RooWay to navigate around campus. RooWay can also make students' daily school life easy and smooth, especially for freshmen at the beginning of their first semester on a new campus. Students can use RooWay to easily get to their class buildings by walking or taking Roo shuttles provided by UA Transportation services.

RooWay is currently in prototype phase and has several features that may be added in the near future. One goal is to provide a set of driving plans which end at different parking lots, all of which may be viable parking locations for the user's destination. One feature which may be of particular interest to some users would support a variety of scenarios for handicapped visitors. For example, directions for a handicapped driver might direct him to the nearest available handicap-accessible lot or parking space. Directions for drivers with a disabled passenger, on the other hand, may provide driving directions to drop the passenger off as near as possible to an accessible entrance for the desired building, then from there to the nearest parking location. Another plan is to draw actual bus routes for the user when using the "On Campus" feature of the application. Ideally, these routes would also take into account the actual shuttle locations, as per the information provided to the University's DoubleMap application. User interface improvements will also be made available to RooWay down the line. Such improvements include a cleaner interface and administrative tools for non-programmers maintaining the system.

REFERENCES

[1] The University of Akron, http://www.uakron.edu/

[2] Google Maps JavaScript API v3,
     https://developers.google.com/maps/documentation/javascript/

[3] Double Map at UA, http://akron.doublemap.com/map/

[4] RooWay, http://pausch.cs.uakron.edu/~sj70/rooway/index.html

[5] Google Maps. https://developers.google.com/maps/

[6] Spartan Directions, http://parking.uncg.edu/access/access.html

[7] UA Map, https://maps.uakron.edu/