Abstract

Floating Buses: Optimizing bus routes and passenger allocations based on real-time collaboration.

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With the current implementation of our public transportation systems, people are forced to adhere to strict timetables and fixed routes on their journeys, and are negatively impacted by the growing issue of vehicles reaching overcapacity, either having to stand or be refused entry completely. Conversely, buses have to make needless journeys to allow for the possibility of demand, with no way of knowing whether the trip is worthwhile or not until completion. This has a harmful effect on the environment, with wasted trips leading to harmful emissions being released for no reason. A better solution would be a more dynamic system that caters to passengers needs as they arise. This system wouldn't need to adhere to strict timetables and routes, but instead run when and where the need arises. It would be able to assure admission for each user who signs up for it, while also being able to guarantee that there are passengers available before setting off, cutting out needless journeys completely, reducing wasteful journeys that are harmful to the environment. This better system would allow more communication between passengers and drivers to create a more suitable transportation system for modern life. With modern technology keeping commuters connected 24/7, there is no need for people to still have to rely on outdated, inflexible modes of transportation.

The current state of the art is currently lacking an implementation and justification for a public transportation system with dynamically changing destinations based on live user input. There exist various proposals and prototypes of dynamic bus routing systems with dynamic stops, but few have publicly shown justifiable results for their implementations. Thomas Kearns et al. at the Illinois Institute of Technology (IIT) put forward a prototype solution of a dynamic bus routing system for the city of Chicago, proposing a system that created localised pickup and destination locations for groups of users based on an analysis of demographic data. This is a clever solution to bus routing, but doesn't account for stochastic demand, as user requirements can change daily. Electronics giant Philips proposed a system using existing infrastructure, such as street lights, as dynamically allocated bus stops, but didn't properly implement their system out of expectations that a robust IT architecture overhaul would be needed to bring the system to fruition. Other current public transportation routes only with fixed locations between its start and end points, and studies into the area of improving bus flow look at changing the route taken between these static in between points. Existing approaches to vehicle routing exist mainly in the domain of transporting packages to fixed locations, and existing ride-sharing applications focus purely on

individual requests rather than servicing a larger community. Furthermore, existing bus route allocation methods only look at fixed routes and timetables, and seating allocation techniques don't take dynamically changing capacity into account.

This study proposes a practical solution for a dynamic public transportation system, known as a floating bus. This floating bus system takes advantage of dynamic input via user requests from an Android application, to create floating bus stops and plot dynamic routes that cater to their assigned passengers needs. Requests are posted to the web application backend, sending the users email with their pickup coordinates, their destinations coordinates and the required number of seats for their journey. The system accepts requests and assigns them either to existing waypoints, which are aggregations of pick-up and drop-off coordinates from all requests received, or creates new ones to cater for them if they fall out of range of the existing ones. These are then used to create a route, which is then assigned to a free vehicle, or an existing route attached to a vehicle may be updated if one of its waypoints is updated to allow for a new request that lies within its aggregation radius. These waypoints are updated to be positioned at the nearest segment of real road network to function as position of the floating bus stops. Feedback and information is provided using Google Maps and Google Directions APIs, painting the ideal routes onto a Google Maps image, as well as displaying concentration of requests via a heatmap on top of the map.

The results show that a floating bus system has the potential to be a viable solution to creating a better city transportation system. Simulations were run against the system using mock data with different pickup and drop down locations and varying passenger amounts. This involved issuing multiple requests to the system at different locations across Dublin city for multiple vehicles to handle, where results showed that vehicles were assigned the most efficient routes based on their direction and capacity at each waypoint. The vehicles were then simulated to follow the set routes realistically, with passenger allocation changing at each floating bus stop. The metrics recorded from these simulations were time and distance, as well as the distance from a passengers desired pickup and drop off locations to their assigned pickup and drop off locations. passenger convenience. Using the distance travelled metric combined with average pollution output over time the environmental impact of the floating bus routes is also calculated. These are then compared with fixed route alternatives to show an improvement in delivering passengers to capacity while reducing the impact on the environment.