Playful Crowdsourcing for Energy-Efficient Automotive Navigation

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ABSTRACT
In this paper, we describe the work-in-progress state of a playful simulation using crowdsourcing to gather data of efficient routes for automotive navigation in the context of electro mobility. Users will contribute well-known routes of their local area by playing the simulation. The routes will be evaluated with regard to height structure, traffic volume, and traffic signal frequency in the context of the daytime, season, and further time-dependent events. Based on this data, the simulation will be able to calculate the most energy-efficient route.

Keywords
serious games, games with a purpose, electro mobility, energy efficiency, crowdsourcing

INTRODUCTION
In the past years, many European and Asian countries as well as the U.S. started huge investments in electro mobility. By far the biggest investments have been and will be made by the United States, investing around 25 billion Dollars through 2015 (public funding, loans, and guarantees together). China invests more than 3 billion, France and Germany 500-700 millions each plus more than a billion for related infrastructural projects (German DCTI Institute, 2010). Both countries expect a total of 3 million e-cars on their streets in 2020, whereas China even aims at an ambitious fraction of 50% e-vehicles for 2012 (Deloitte Research, 2010).

As governments, companies, and consumers become aware of the limited availability of fossil fuels, alternative energies and stewardship of available resources become focal points of interest. E-vehicles are a promising alternative to traditional cars powered by combustion engines. However, despite their undisputed benefits in terms of ecological friendliness, they come with some drawbacks with the limited cruising range being one of

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the most serious handicaps. For this reason, energy efficient manners of driving and intelligent route planning are even more important in e-mobility scenarios. This extends the demands on intelligent navigation systems, which will play an important role for e-mobility as a precondition for mass-market penetration. With regard to usability (Al Mahmud et al 2009, Kujala 2009) and traffic routing (Hu et al 2009, Yoon et al 2007) constant progress has been made during the last years. However, especially with regard to the challenges of e-mobility, there is still room for improvement. State-of-the-art navigation systems focus on finding the shortest or fastest routes but not necessarily the most energy-efficient ones. The proposed playful simulation shall not only be fun to play but also generate a data basis for future navigation systems offering energy-efficient routes for e-mobility. Furthermore, a desired achievement of the system is the user's reflection about energy-efficient driving behavior.

PLAYFUL CROWDSOURCING & SIMULATION

Since the huge success of web-based crowdsourcing platforms in the Web 2.0 context like Flickr and Wikipedia (Surowiecki 2004), a genre of games based on the idea of crowdsourcing emerged. Referred to as "games with a purpose", these games enable players to not only play a game for pure entertainment but also solve problems and tasks by doing so (von Ahn 2006). One main advantage of this game genre is the comparable small amount of time each player has to invest: Most of the games have a comparable low average game session length, but this does not matter as long as enough people play the game. There are several application areas for games with a purpose to date, with the semantic web being the most prominent one at the given time (Siorpaes & Hepp 2008). Inspired by already available games with playful geospatial data aquisition (Matyas 2007) and games building upon existing social networks (Rafelsberger & Scharl 2009), our goal is to adopt these ideas to the field of energy-efficient car navigation.

The goal of the simulation game is to motivate the players to contribute route data for optimizing itinerary planning. The first iteration of the game is a web-based game using the Google Maps API to generate game maps. Users will select an area they know well and chose a fictive role of the virtual car driver. Next to different family member archetypes, players can choose from a range of drivers of a parcel service, or a meals-on-wheels or mobile-nursing-service. Dependent on the player's choice, the system generates typical tasks with routes between two or more places. In the current prototype, the designers predefine these routes, but in a later stage of development, route generation will be processed automatically based upon real route data of navigation systems. Each task will consist of start and destination points, information about weather, daytime, whether it is a working day or holiday season, etc. Together with the positions of traffic signals, this data is stored in a model of the route object, we already established (Muenter et al 2011). According to these randomly generated context factors, the difficulty of the task changes. An impact of daytime could be higher rush-hour traffic or chances of a road accident on the highway.

After setting up the area, the user knows well, he will be able to choose from three randomly generated routes of different complexity with a rough estimation of the time needed for completion to have a better guess of how long the game session will last. By selecting a route, the player enters the simulation game and starts with a virtual car model on the map. The player controls his car from a bird's perspective indirectly by clicking on waypoints (e.g. road junctions), and the car will move with the maximum allowed speed to the next waypoint. Interrupting the current route of the virtual car and setting an alternative waypoint can change an already placed one. In addition, the car movement will be influenced by traffic signals, traffic jams and road blockings. Players can zoom in and out by themselves to get a better overview of the surrounding area. All actions are done in a time-lapse mode in order to ensure that the game does not get boring by setting up the right game speed. After reaching the target destination, a highscore will be calculated based on the energy-efficiency, the time needed and extra points for new and more energy-efficient route variants.

However, the biggest challenge of the simulation is to offer enough fun and entertainment to keep players engaged for a certain amount of time. Currently the game design focuses on competition between players from the same area with high-scores and head-to-head challenges. In addition, the game will feature some unlockables like new car models, further virtual driver roles, and a higher level rank. A random disaster mode will confront players with events like a twister or an alien invasion, adding more variety to the gameplay. We also plan to enable players to post their routes on Facebook to challenge their friends to compete with them in finding the most energy-efficient routes.

ENERGY-EFFICIENCY CALCULATION

As already mentioned, the highscore calculation will include the energy-efficiency calculation of the route. In order to calculate energy-efficiency based on route descriptions, we need a more detailed and machine-readable model of the itineraries. Route objects usually are described by a set of waypoints representing positions between origin and target locations. Our idea is to semantically enhance the waypoints with additional information by transforming route descriptions into semantic models, which allows us to characterize each route part on the basis of its properties comprehensively. In addition to the general information of an itinerary, such as location coordinates, street name and driving instructions, a semantic description includes further information, such as a classification of each route point on the nature and type of geographical conditions. Therefore we use several well-established web-based geo-services such as LinkedGeoData[1]. Those services provide comprehensive background knowledge related to spatial features of types, structures, and landscapes of the waypoints (Auer et al., 2009). Other services that offer additional information for route enhancement are OpenStreetMap[2], GeoNames[3], or Topocoding[4], which, for instance, enables us to add the related altitude value to each waypoint. The route model and a route protocol containing all data about the car movement of the solved route will then be transferred to an energy-efficiency calculator, connected to the geo structure information system.

FUTURE WORK

After the completion of the web-based prototype, the simulation will be integrated in a life-size car simulator, which uses a real Volkswagen Golf IV car with a large-scale projection. This simulator will feature a realistic 3D environment instead of the top-down perspective of the web-based simulation and will focus on the real- time tracking of routes. It will be used to compare the results of both simulations in order to optimize the energy-efficiency calculation. Future work will also address the measurement of the game experience of the playful simulation with different user groups.

ENDNOTES

1 http://linkedgeodata.org/

2 http://wiki.openstreetmap.org/

3 http://www.geonames.org/

4 http://www.topocoding.com/

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