enviroCar – Crowd Sourced Traffic and Environment Data for Sustainable Mobility

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Abstract. This paper introduces the enviroCar project which aims at crowd sourcing the collection of environmental and traffic data. For this purpose a data collection architecture relying on onboard sensors of cars, mobile phones and web services has been developed. Besides providing drivers with precise information about their driving style and its environmental/economical impact, the enviroCar system offers a new and complementary source of data for traffic planning tasks. The resulting data sets are published as anonymised open data and thus serve as a basis for collaboration between citizens, scientists as well as traffic planners in the sense of citizen science.

Keywords: traffic data, environmental data, SDI, Sensor Web, crowd sourcing, citizen science

1 Introduction

One of the big societal challenges of our days is to save and develop mobility in a sustainable way, i.e. to mitigate the negative impact of passenger transport on the environment. This challenge requires collaborative efforts of science, industry, public authorities and the citizens. Furthermore it needs a rich data base to be able to analyze and assess current traffic-related phenomena and to trigger change. While data from cellular mobile networks are a valuable source for traffic flow data, environmental information about noise or air pollutant emissions are not available sufficiently. At the same time, nearly every car that is operated today is equipped with a multitude of sensors [1]. These sensors deliver highly relevant data such as vehicle speed, revolutions per minute, throttle position and mass air flow. From these parameters it is possible to derive further information such as noise, fuel consumption and CO_2 emission which is directly relevant for assessing the environmental impact of car traffic. Thus, it is an obvious idea to make use of onboard car sensors as a complementary source of information.

A central motivation of the enviroCar project is to facilitate the collection of these data by citizens driving their cars. To facilitate the collection of such traffic and environmental data, a crowd sourcing architecture for collecting data from onboard sensors of cars has been developed which is discussed in this paper. It is a new citizen

science [2] platform, which supports the close collaboration between citizens, researchers and example traffic planners.

The remainder of this paper is structured as follows. In section 2 the enviroCar architecture is introduced. This is followed by a detailed overview of the current implementation in section 3. After this in section 4 future research challenges which need to be tackled for further improving the enviroCar systems and for better integrating the resulting architecture with other SDI systems are outlined. Finally, the conclusions of the presented work are presented in section 5.

2 The enviroCar Architecture

This section introduces the architecture underlying the enviroCar system[1] developed in close cooperation between the open source initiative 52°North[2] and the University of Münster. It comprises four core components (see **Fig. 1**):

- the sensors and the internal data bus of a car,
- a mobile phone app for collecting data from a car,
- a central server for storing and processing the collected data of all users, and
- a web site for presenting the collected data and allowing users to perform analyses on this data

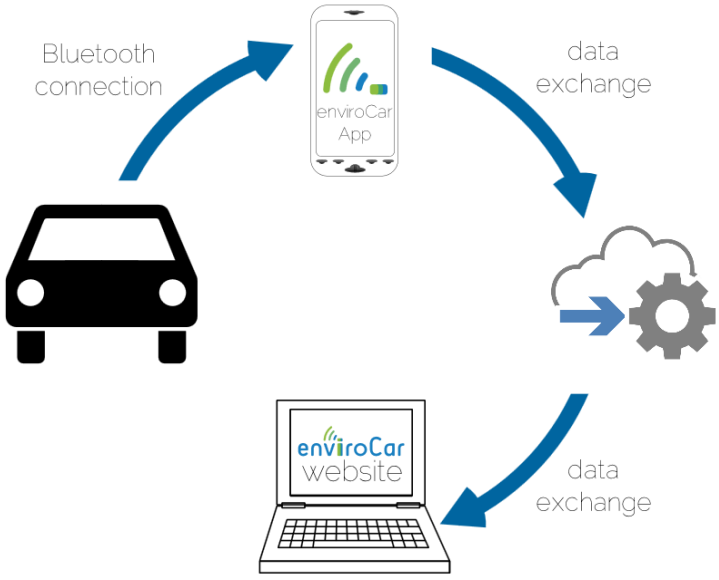

Fig. 1. Overview of the enviroCar architecture

[1] https://www.envirocar.org/
[2] http://52north.org/

The enviroCar system makes use of the OBD2 protocol [3] a standardized interface for accessing sensor data from cars. For several years the support of this standard by new cars is mandated by the European Union [4]. To connect to the OBD2 interface of a car, low-cost adapters are available which translate between the OBD2 bus and a Bluetooth connection.

Through this Bluetooth connection, the data collected by the sensors of a car can be accessed by mobile phones. For this purpose the so called enviroCar App has been developed. This App offers functionality to start and stop the data collection process, to organize the collected data in tracks, to visualize the current measurements in real-time, and to upload collected data tracks to the central enviroCar server.

The enviroCar server acts as a central data store. It provides the user management and interfaces for accessing the collected data. This functionality is used by the enviroCar web site. This web site provides access to the collected data and offers users a broad range of analysis functionality. Besides analyzing the own tracks of a driver (e.g. “Where was a high fuel consumption observed?”) it is possible to compare the own driving behaviour with other participants and to retrieve aggregated analyses of car traffic and its impacts.

In addition the server provides citizens, scientists and planners access to the collected and anonymized tracks. This way, the use of the collected traffic and environmental data is promoted. As a result, we expect benefits by supporting traffic planning processes and by getting citizens involved who gain further insight both into the cause-and-effect relations of mobility and environmental impacts and their own role within this context. We expect that the latter will increase the readiness of citizens to change their own behavior in terms of their driving style and their preferences regarding low emission vehicles.

3 Implementation

The enviroCar system is currently available in a beta version and first tests have been conducted to verify its functionality. **Fig. 2** shows a detailed view of the implemented system architecture. For realizing the Bluetooth connection between the OBD2 interface and the mobile phone app, low-cost off-the-shelf hardware was used. The mobile phone App has been implemented for the Google Android operating system and is available through the Google play store[3].

[3] https://play.google.com/store/apps/details?id=org.envirocar.app

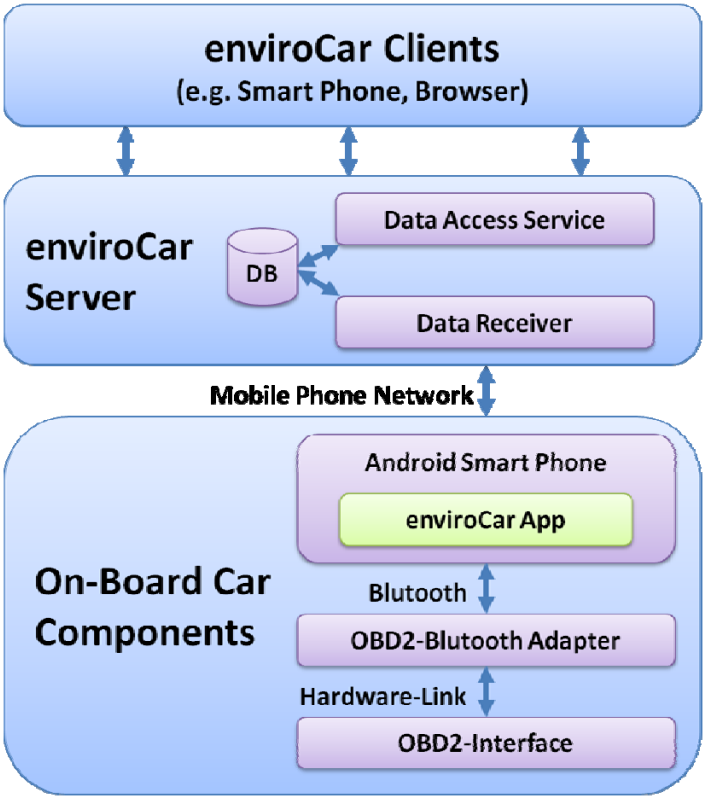

Fig. 2. System Architecture

Also the enviroCar Server and the web site are running in a preliminary operational mode. It currently provides several ways to display and analyse the collected data. For example, tracks showing the CO_2 emission and the speed (**Fig. 3**) of a car can be visualised.

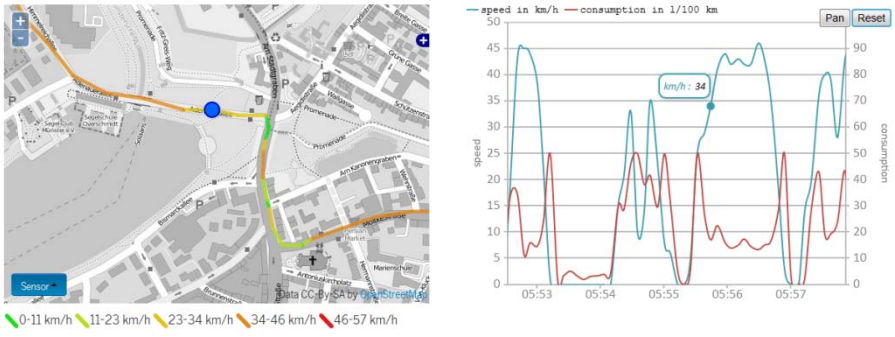

Fig. 3. Presentation of a single track showing the speed of a single car as well as its fuel consumption

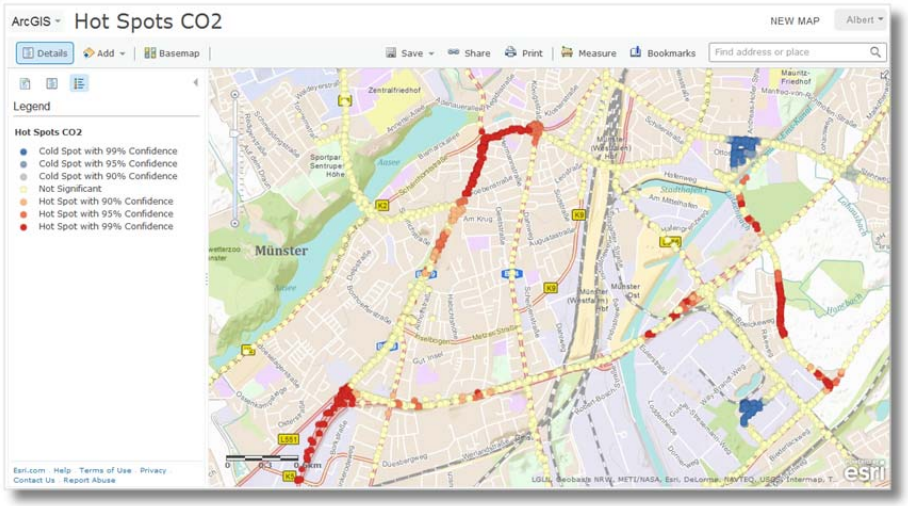

Fig. 4. ArcGIS Online Map showing CO_2 hot spots (accumulations of red dots) in the city of Münster

The platform ArcGIS Online developed by Esri was used for creating additional map representations of the collected data[4]. **Fig. 4** contains a hot spot map of CO_2 measurements in city of Münster (Germany). In this representation red coloured dots indicate regions with high CO_2 measurement values. It can be seen that for example traffic lights causing traffic jams or roads with speed bumps lead to higher CO_2 emissions as cars need to accelerate after stopping.

4 Outlook

The enviroCar system is currently in a beta stadium. By end of 2013 a release stage will be reached. After this, we see further challenges that need to be addressed.

Further work will focus on enriching the data base by providing more measured parameters and more information about the parameters, the sensors and the data quality. The existing platform provides a linked data interface using existing ontologies such as the Semantic Sensor Network (SSN) ontology[5] for sensor data, phenomena and measurements and the Vehicle Sales Ontology (VSO)[6] for car sensors and automobiles. The database is interlinked with the EEA Data dictionary [7] and the DBPEDIA knowledge base[8]. Future work will focus on exploring the combination of

[4] http://www.arcgis.com/home/group.html?owner=AlbertRemke&title=enviroCar
[5] http://www.w3.org/2005/Incubator/ssn/ssnx/ssn
[6] http://www.w3.org/2001/sw/wiki/VSO
[7] http://dd.eionet.europa.eu/
[8] http://dbpedia.org

linked open data and RESTful feature services as to find an optimized balance of design issues such as richness and flexibility of the data model, lean encodings and well performing implementations.

Additionally our work will focus on enriching the platform, which means to build an ecosystem of technologies and tools which facilitate data access, data analysis and visualization of derived information products. This will be based on existing SDI standards such as the OGC Sensor Web and Processing Services and go beyond as to explore the benefits of new approaches such as linked open data. The current beta uses the ArcGIS GeoEvent Processor to process the live data stream and to publish feature services in the ArcGIS Online Cloud. Additionally the 52°North WPS and R will be used to publish processing capabilities on the web, which support data aggregation and data analysis.

A special focus will be on developing and activating the enviroCar community by initializing, supporting and interlinking regional citizen science projects in the field of mobility and environment. For this purpose, research projects addressing the topics of environmental pollution and traffic as well as further players from public administration will be valuable partners. Further incentives and social media concepts will be used to attract a global user community.

5 Conclusion

In summary, the enviroCar system provides a valuable source of traffic and environmental data that complements official measurements. Relying on cheap hardware modules and commonly used mobile phones it is possible to realise a sophisticated, crowd sourced data collection platform. Going beyond the pure data collection process and providing various data visualisation/analysis tools, the enviroCar system demonstrates already now the value of the collected data. By broadening its user base, by facilitating the use of enviroCar data with external applications (e.g. thorugh common SDI standards), and by performing practical deployments in further scenarios, we envisage a further growth of the enviroCar data basis and an increased impact of the generated information.

6 References

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