A workflow to improve the availability of routable data (OSM) for logistics in agriculture using data from telematics systems and community-based quality management

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The increasing use of contractors in the agricultural sector and the increasing sizes of farms require optimization in the field of agricultural logistics. An example of this is the supply chain for biogas plants. An improved transportation planning of the agricultural produced biomass to the plant and the deployment of the nutrient-rich solids is increasing the economic efficiency enormously. Such a system needs a much higher effort in logistics, as there are usually a larger number of service providers, farmers, and transportation companies involved. Harvesting is a time-critical task depending on weather and other factors, and a fast response is a must. Planning an optimized transportation schedule for such a task is very complex. In order to optimize the logistics chain, efficient route planning is a fundamental need. One of the biggest problems in finding the best transportation routes is the lack of accurate map data containing all routes that can be used for agricultural machines. The commercial mapping companies are not mapping these routes because surveying the tracks cannot be accomplished in an economical manner.

This subject isn't new, and there are a few, unsatisfying solutions on the market. In the field of agricultural logistics, there are partially used truck navigation systems. The advantage is the more comprehensive map data compared to standard car navigation systems. There are some attributes lacking, such as the clear height and the width of roads. Further, they've avoided mapping roads for hazardous goods or vehicle weight limitations. But this is only for trucks. The vehicle structure in agricultural business is more multifaceted than only some classes of trucks. Agricultural vehicles such as harvesters and tractors, which may have a multiplicity of possible accessory equipment, have many different requirements for the road tags. Still, most of the needed field paths that are mainly used by those vehicles to reach the fields are missed, so it is not possible to calculate a route directly from farm to field.

In our prototypical implemented software we used test data from productive resources. The telematics data comes from the Claas Telematics system, a system to track and log machine data of harvesters and other agricultural vehicles. As base map we used the community generated OpenStreetMap data. Using the processed telematics data, we can upload the new road segments and improve the quality of the base dataset. To calculate gateways to reach the fields we took the field record system of farm management software and calculated the gateway points using a geometrical intersection. The calculated points are similar to geo coded addresses as we know from usual navigation systems.

We propose and develop a method to solve this problem. We present a workflow that shows how to get routable maps as an additional benefit from surveyed data. This data can originate from, e.g., a telematics system that tracks agricultural machines. To average the GPS trajectories we used the graph reduction approach of Morris et al (2004). The generated network data can be used to improve an open-source base map (OpenStreetMap).

Furthermore, a method for the calculation of field gateways is shown and, finally, some examples of software and services are given that use the data to solve routing problems.

The routing was realized in a modified version if our OpenLS route service that implements the OpenLS specification Mabrouk et. al. (2005), Neis, P., Zipf, A. (2008).

Our work demonstrates an approach of a workflow that automates the generation of street networks that are appropriate for routing to a large degree (Lauer 2008). The integration into the existing OpenStreetMap data set requires manual editing in order to solve conflicts with existing street segments. A major factor for the automated generation of the street network is the availability of a large set of raw data such as GPS tracks. It has been shown that the data of telematics systems such as Claas Telematics can be used to generate a street network for routing purposes in a cost-efficient way. Attributes of the street segments can be generated from data provided by the different agricultural machines that are being tracked. The different types of machines are known and available in a database. The measurements and weights of the machines allow us to infer basic attributes with respect to routing for each street segment. If a street has been used by a distinct type of machine, it can also be used by other machines of the same type or of smaller measurements or less weight. A similar classification of the trafficability of roads is being used in forestry logistics (Hauck 2003) and can be adapted.

OpenStreetMap offers a good database for the integration of new routes and streets. The attributes can be chosen freely by the user and are not restricted as in commercial datasets such as TeleAtlas or NAVTEQ. The workflow introduced offers a foundation for generating street data suitable for routing applications from GPS tracks. The components such as the weighting of tracks or the calculation of the field parcel access points are encapsulated in components that can be improved or exchanged individually.

In general, we can state that a geo data set that is kept up to date by a user community can include very recent and actual data. In our case, the new community of farmers and companies using the system can check and improve the data set on their own. The realized method and workflow to generate street networks for routing can be adapted to other types of routing applications if they also have access to some kind of sensor information. For example, there is a first version of a routing prototype for people with wheelchairs or similar restrictions regarding mobility (http://www.rollstuhlrouting.de). They do not have telematic systems, but more and more smartphones with velocity sensors or similar functionality are being used.

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