REACH-U MOBILE GEONAVI: AN SAMPLE OF SEMIAUTOMATIC NAVIGATION DATA COLLECTING TECHNOLOGY FOR FIELD SURVEY

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Abstract

A rapid growth in the demand for personal navigation systems has resulted in an increased need for navigation data. Until now, producing and updating navigation data has been time- and resource-consuming and therefore it demands optimizing processes to meet the market needs. Methods for collecting and processing navigation data are generally divided into three main categories: (1) by human operators, (2) full automatic and (3) semiautomatic. Using human operators to produce data is both labor- and time-consuming. Fully automated collecting process, on the other hand, is fast but prone to data errors. There are various approaches for semiautomatic field data collecting.
To meet the challenge of creating a navigation database for all Baltic States and producing fast updates, a technology called MobileGeoNavi (MGN) was developed. Previous field survey method demanded four extra hours of data processing time for every fieldwork hour. Such a waste of resources was unacceptable. New semiautomatic technology has diminished the data processing time by more than thirty times. The amount of collected attributes and features has been increased from five up to thirty two. MobileGeoNavi technology allows entering the market with more frequently updated and richer data content.

Reach-U MobileGeoNavi – Why?

From the user's perspective, an info system cannot be better than the data it contains. Users of navigation devices are mostly displeased with the astronomical prices of various data, such as maps and points of interest, but also with the frequency of updates. In his presentation at CEBIT 2009, Michael Minch noted that only 40% of the users were satisfied with the price of updates and no more than 47% of them were satisfied with the frequency of updates. In the year 2008, 71% of the questioned users considered a period of 1 month or less to be of satisfactory updating frequency and about one quarter of the users wanted automatic updates in real time. Interestingly, in the year 2006, at least 40% of the users wanted automatic updates - this rapid change has most likely been caused by the global financial crisis. For example, in the year 2008, 29 per cent of the users did not want updates more frequently than

once a year. In the year 2006, on the other hand, only 18% of the users were satisfied with such arrangement.
Navigation info is an important topic for LBS, too: real-time dynamic traffic info was required by 87.9% of the questioned users and road condition info and warming by 86.3% of them (Minch, 2009). Most of the users of navigation devices are willing to pay for accurate up-to-date information but prefer moderate prices, which would not rise over 2 EUR. Therefore, as we can see, a demand for cheap navigation data exists.
In the year 2007, Reach-U/Regio faced a task of gathering navigation info from all three Baltic States in a very short period of time (3 months). Logically, buying a data gathering system was considered. Our survey, which was held in 2007 and repeated in 2009, showed that such systems do not exist as "in box" solutions. On the market, systems for collecting navigation data can be found as tailor-made or need to be built out of survey systems. It turned out that those systems are very expensive and strictly limited, therefore we decided to create our own system.

Critical review of Data gathering methods
At first glance, entering single parameters by a human operator is a simple and generally understandable method of data gathering. In a method like that, a paper map is considered to be a classical instrument of collecting data. Nevertheless, along with its simplicity, it also brings many complications, such as the readability of handwriting, different styles of making notes, limited space for specific information (notes tend to be written on images because of that limitation) and a relatively small amount of maximal data that can be gathered. But the method's biggest flaw lies in its large work consumption.

The next option for collecting survey data is the so-called **digital paper map**. The observations of the survey are inputted to a **reference map** in free form. This makes observing and reading GIS in the correct spot possible, lessening the workload of the **data processing team**. Digital paper map method is comfortable but has most of the downsides of the normal paper map method (different styles of input, difficult data correction and exact pin-pointing of objects, big workload and a high possibility of errors).

A fully automatic data gathering system where a fieldwork vehicle gathers and captures its trajectory with a sequence of positioning points is another quite widespread method. The latter are supplemented by **digital imagery** taken in 360-degree angles or a **video stream**. The team complements by taking notes with the digital paper system and audio recordings. Furthermore, the system can also include LIDARs or radars. This method needs a single fieldwork team that collects hundreds of gigabytes of data each day. The overall amount of data may rise up to terabytes per object.
The downsides of that impressing method are:

1. **Enormous amount of data** which is mostly noise from the end-user's point of view
2. The time-loss of post-processing which exceeds the time taken to gather data by multiple times
3. Mainly manually done post-processing where usually a lot of errors occur and which needs subsequent error-correction
4. Expensive data gathering hardware and its limited specialization

Fore mentioned results of our analysis show that neither the manual labor based nor so-called fully automatic methods are not sufficient enough to fulfill our needs. Reasons for that lie mainly in the high usage cost, not to mention that the price-quality relationship does not meet the end-user's requirements.

MobileGeoNavi Concept

We decided to create our own system which would be based on Norbert Wiener's "The Human Use of Human Beings". This means giving both humans and machines different tasks - assignments that fit their capabilities best. The idea of MGN is to let humans make decisions. Carrying out infotechnological operations is left for the machines. Therefore, MobileGeoNavi has become a semiautomatic system where survey data is collected directly from road network lines. That way, each event, object and POI is linked to an existing or new road segment.

The purpose of such method is to get all the field-collected data into the database with a minimal processing cost. This means that no raw data attributing is done manually, and the only thing done case by case is controlling and checking the quality of processing and collecting. In an ideal situation, the data collected from 6-hour fieldwork would be processed, inserted and checked in one hour (6 to 1).

MobileGeoNavi means an entire spectrum of technology solutions and methodic of data managing from start to end:

- Incoming data (client based, Regio based, third party)
- data management
- implementing software and specifications
- software training/support
- end product to Handset, PND, Web etc. (example Garmin, Nokia, Google map etc).

MobileGeoNavi is divided into four main segments:

- Navigational system,
- Pedestrian navigation,
- POI (enabling rich content POI) ,
- Address points.

Current situation

MobileGeoNavi is the first navigation database of the Baltic states with full coverage including house numbers and points of interest (POI). Since the year 2007, MobileGeoNavi software has been used daily in AS Regio database (Estonia, Latvia and Lithuania). The annual cost of regular update in 2008 for all Baltic states was only half of what it was in 2007, therefore the new system has been very economic and reduced annual costs remarkably.

For example, only four MobileGeoNavi systems were enough to survey over 40,000 km in 3 months. More than 30,000 objects were measured and coded. At the moment, over 250,000 km is not only maintained but regularly updated in MGN database. Some of the most successful global companies, such as Garmin, TeleAtlas, Navteq, Imagis, Navngo and MapScape are our proud clients.

	MGN version 1.7 (2007)	MGN version 1.10 (2008)
Kilometers per Hour	5.5	4.0
Price per Kilometer	5 EUR	4.5 EUR
Objects per Kilometer	1.9	4.5
Price per Object	2.56 EUR	1.35 EUR
Office work per KM	2.56 EUR	0.8 EUR

Development of MobileGeoNavi versions (prices are compared with the medium salary level of EU)

Target area	Road lines	Time to execute	Fieldwork	Indoor processing
Baltic states 30% road network	60 000 km	5 months	4 months (6 teams)	3 months (2 teams)
Big region example 30% road network	150 000 km	7 months	6 months (13 teams)	4 months (3 teams)

System efficiency

FUNCTIONS

> Main Functionalities

MobileGeoNavi can be considered indispensable for two main reasons. First of all, a full path from data gathering during survey to the end-user's application exists, which means all activities are covered and optimized. Secondly, manual digitalization is limited due to automatic splitting of road geometries and attributing of road lines by adding user-defined values to specific road segments.

The software is operating with road line dataset that meets the requirements specified for MGN. Using GPS-positioning, the data, events or Points of Interest are linked to road segments, with the direction and real situation taken account.
The automatic data check is in constant progress during fieldwork processing, due to the possibility of finding mistakes. This method is built up on the experience derived from mistakes that have already occurred during earlier processing of fieldwork. It is also based on the checks for inserted values with predefined value ranges (project specific).

> Basic Functions

- direct attributing of road geometries;
- automatic checks on inserted data;
- automatic processing of survey data;
- building shape and attributes survey;
- POIs, addresses, street names, house numbers survey;
- landcover/landuse information survey;
- fast GPS support;
- automatically take pictures for verification of attributes during survey or data processing;
- geotag survey pictures, and use a special interface to process attributes having picture support;

- MobileGeoNavi is configurable according to user specific requirements.

	GPS support during process	Digital archive of survey data	Semiautomatic attribution	Automatic picture and voice capturing	Easy "Four click method" inserting data	Automated checking of survey data
MGN ver. 1.10	YES	YES	YES	YES	YES	YES
Digital paper	YES	YES	YES	YES	NO	NO
Paper plots	NO	NO	NO	NO	NO	NO

Comparison between MGN and other systems

MGM advantages vs. old data capturing systems

One of the numerous advantages of MGN is that the software fully supports linking live picture- and voice messages with GPS points. It also includes components for browsing pictures both during fieldwork and indoor processing. The data produced and processed by MGN will be in client-specific database format.

All in all, MobileGeoNavi end to end system is much more cost-effective than usual data gathering technologies. It enables to collect more than 30 attributes.

System examples	**Roads Km**	**Events**	**Events per KM**	**Events cost /EUR**	**Km/h fieldwork**	**Km/EUR (office +FW)**
Highway	33000	62000	2,6	2,6	5,5	**2,7**
City	2320	15100	6,5	1,1	3,0	**5,1**
Town	208	1500	7,2	1,5	1,2	**7,1**

Collecting and processing speeds and workforce cost

Software components

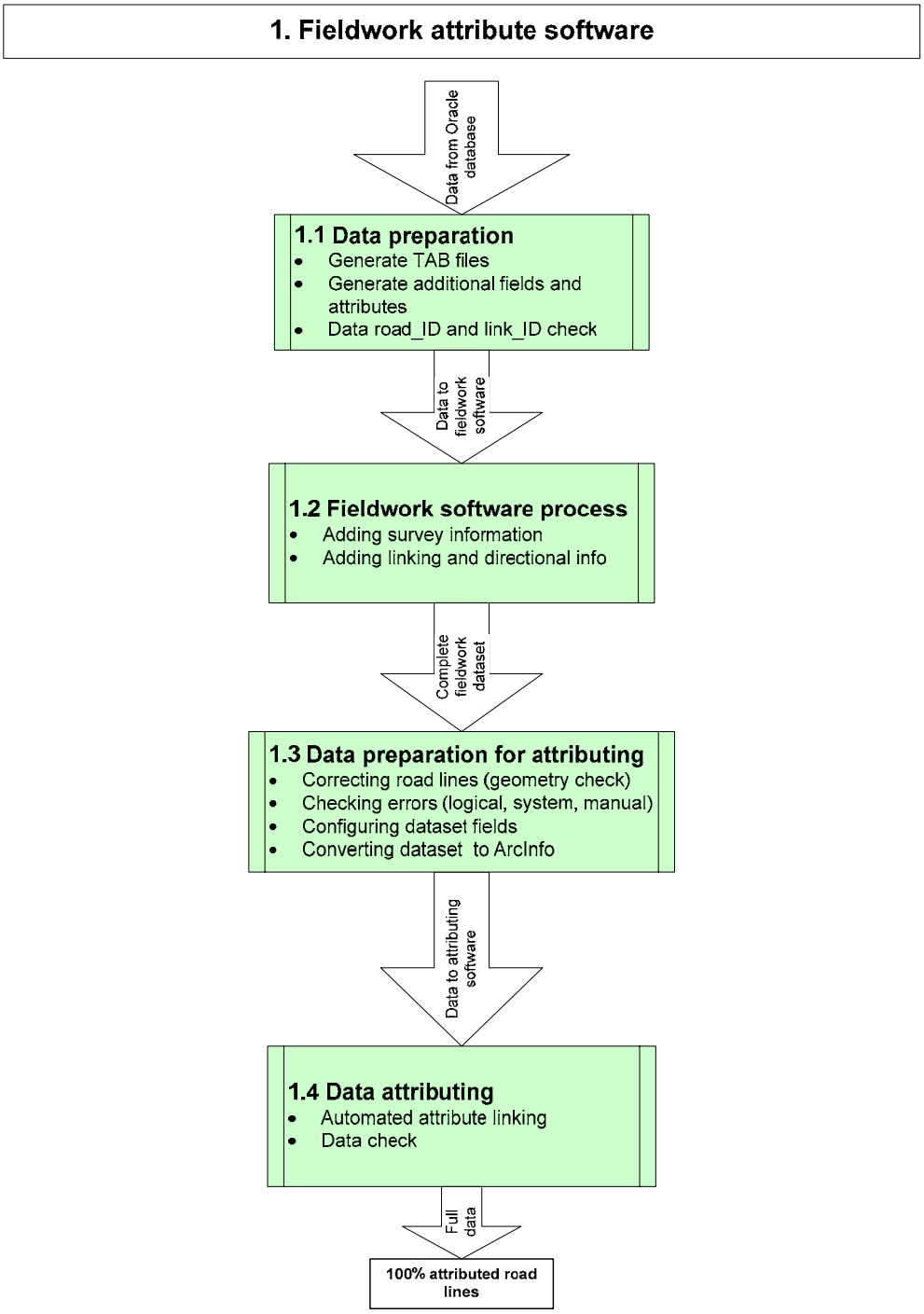
- OS Windows XP/Vista
- Software module MGN ver. 1.10
    - Basic component “C” base tool MapX 5.0
    - module “Mardi_vidinad”
- Software module “Rolli_tarkvara”.
    - Basic component ESRI ArcGIS
    - module “Regio_tööriist”
- Automatic picturing program “Sirvi_mind”

Requirements

- MS Windows (XP, Vista)
- Tablet computer or laptop
- High Speed GPS
- Web camera
- Minimal system requirements: 30MB hard disc, 1.4 GHz processor, 1GB RAM

Processes for data collection technology using MGN software

MobileGeoNavi system allows each process to be executed as a single service. The full technology chain will result in a navigational database, completely ready for the end-user.



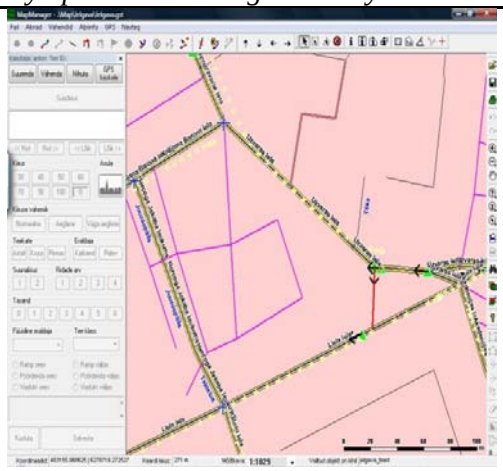
Overview of fieldwork software operation

Process description

1.1 Data preparation

- MapInfo TAB files generation
  - *It is possible to use any data sources in MGN. Input data quality is main factor that preestablishes quantity of data processing work. Final result will be functional navigation system for end-user.*
    - *For example input for Lithuanian database was "spaghetti". Amount of road lines with different data structure from disperse sources (Governmental, Private etc.). After using MGN, end product was fully operational navigational system.*

1.2 Fieldwork process



- Dataset check: coordinate system check, table check (field names, values, field type), geoset check (required tables, names).
- Adding survey information as events on vectors and comments on road lines.
- Start „blank sheet" with GPS trail with adding events, comments while driving .
- Road naming is checked.
- Ability to gather building footprints; gather changes in forest, park and industrial area shapes.
- Controllers: visual check (event modifying rule: check EACH event), automatic FIRST event on NEW ROAD, predefined value check, 100m GPS position rule.

1.3 Data preparation for attributing

- Correcting road lines (geometry check)
  - New geometry and geometry corrections
  - Traffic events
  - Turn restrictions
  - POI's
- Checking errors (logical, system, manual)
  - Delete area overlaps
  - Filling area gaps
  - Correct alignment errors
  - Split bows and teardrops
  - Eliminate short links
- Formatting to data attribution
  - Configuring dataset fields
  - Converting dataset to ArcInfo

1.4 Data attributing

- Automated attribute linking
- Data check

Summary

There are two basic trends in technology: the first one leads to creating more expensive and complex solutions every day; the second one, on the other hand, is a certain branch of high-tech that results in creating accessible devices which would reach to the level of the so-called "super-technology".

Our experience shows that a simple combination of a contemporary car, a portable computer with a web camera and a GPS-device is efficient enough for gathering data in the field. Its efficiency, however, is not caused by the extraordinary qualities of the hardware, but Regio's MGN system instead. MobileGeoNavi can be considered a system where the most important component is the knowledge based on long-run practice.