Tourism Information Systems based on Trail Network Information

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Abstract

The purpose of this project is to develop methods for organizing and collecting information about trail networks for future use in a Tourism Information System. Some questions that are answered concern how to organize and structure the basic information as well as the location based data so that it can be processed, stored and presented in digital format. The practical work has resulted in an evaluation of equipment and methods for collecting location based data using a GPS-receiver.
The project has resulted in:

- A topological data model for the collected information with focus on describing the trail system.
- A data base with a number of tables containing the collected data from the GPS measuring.
- A simple GIS application for presenting the available information in a number of different themes.

Keywords: Global Positioning System (GPS); topology; tourism information system; trail network.

1 Introduction

Särna, Idre and Grövelsjön are three minor villages in the northwestern mountain region of Dalarna that are to a great extent relying on tourism for their future economic outcome. Since 1997 local businesses in cooperation with local and regional authorities have run an extensive destination development project to improve conditions for the area to remain a living part of the region with a good service level, increased occupation and strengthened competitive power.
Most of the tourism activities are oriented towards physical activity and wilderness experience in the surrounding mountains and forests. A large number of trails exist in the area and they are used for a number of organized tourism activities in both summer and winter. Hiking is a major summer activity while in the winter guided ski

tours and dog-sledding are offered at some of the tourist facilities. Snowmobile activities are also offered where local organizers provide snowmobile adventures, guided tours and snowmobile rental.

These activities, using the trail network in the area, are highly dependent on the availability of maps and other location-based information. Today information about the trails is available in brochures with detailed descriptions and simple maps for over 60 suggested hiking trips and 30 cross country skiing trips. For snowmobile tourists the local snowmobile clubs have prepared a map showing all the marked snowmobile trails. Maps and brochures are available for sale at any of the three local Tourist Bureaus or at local shops. Some of the proposed trips are also presented on the official Internet home page of Idre Turism.

1.1 Problems

There are a number of problems that concern the availability of tourism information in the area. One problem is today's limited possibility to update the information at regular intervals. For example, information about trail conditions must be updated regularly to maintain an acceptable information quality.
Another problem is that much of the information is not available from one single source. Often the information has to be collected from a large number of unrelated sources - in written form or as knowledge from staff or local inhabitants.
A third problem is that a majority of visitors tend to stay only on the largest and most well-known trails. This has a negative influence on both the experiences of the visitors due to crowded trails and the impact on the sensitive wilderness environment. This problem is related to the lack of detailed descriptions of the trails.

This lack of detailed descriptions of the trails in combination with present maps getting out-of-date and trail signs and markings not always being consistent throughout the trail system makes snowmobile tourism one area that urgently needs further development. One reason for the planned development of snowmobile tourism is the fact that snowmobile tourists are estimated to be willing to spend much money with local tourism operators. Another reason for the development is the environmental aspect. By developing a well defined and maintained trail system tourism authorities hope that snowmobile traffic will be limited to these specific snowmobile trails. This would result in a lower impact on the sensitive wilderness environments.
In order to accomplish these goals trail maps and a consistent system for signs must be developed for the 1000 km trail network in the area. The comfort for the tourists using the network must also be increased by developing resting places with a guaranteed level of maintenance. Responsibilities must also be resolved; one organization must have the full responsibility for the maintenance of the trail network which also includes the responsibility to provide accurate information about the network. Today tasks and responsibilities are shared between regional authorities and several clubs.

1.2 The need for a tourism information system

In order to continue development of the destination Särna-Idre-Grövelsjön the local tourism authorities have several needs for the future. Among other things they need to offer consistent and updated information about the total existing trail network. They also want to increase their offers by including several minor trails that today are known only by a small number of local experts.

One way to accomplish this is to develop a Tourism Information System which has many possible uses e.g.:

- To facilitate the maintenance of the trail network.
- To produce detailed, updated and high quality maps of the trail network.
- To provide accurate information about service facilities related to the trail network.
- To provide weather information related to the trail network.

This type of information is of interest both to the people who are responsible for the maintenance of the network, to personnel at Tourist Bureaus and to tourists. In order to develop the tourism information system it is important to collect and organize information about:

- the structure of the trail network;
- different types of trails, e.g. snowmobile trails, ski trails;
- trail conditions, e.g. how the trail is prepared and how hard it is to travel on;
- locations and places related to the network;
- service facilities, e.g. shops and fuel stations related to the network;
- resting places.

The purpose of our project is to develop methods for organizing and collecting the information described in the list above and these methods include:

- modeling and structuring the information;
- collection of digital location-based information using GPS-receivers;
- storing the information in a data base management system;
- distribution to suitable software for presentation.

2 Business Analyses and Data Modeling

The project started with a business analysis which showed that today's information about the trail network is inadequate. There is a lack of: names on all trails, information about types of trails (width, trail conditions) and other objects of interest (huts etc.). In order to develop the Tourism Information System a mapping of the trail network in the area was performed as a first step. The reason for this is that the trail network is the basic business object for the tourism activities in the area and therefore high quality information about the network is a basic element of the system.

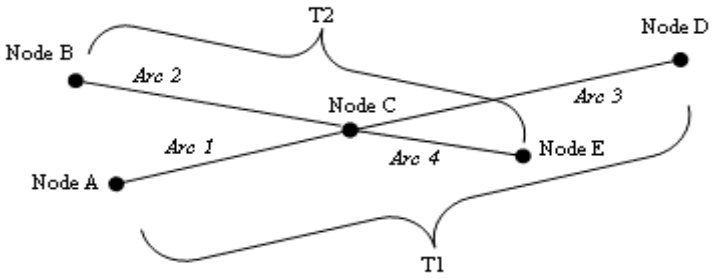

Fig. 1 Trail network

The trail network can be seen as a transport network (Bernhardsen, 1999) through which people travel, either by walking, skiing, dog-sledding or driving a snowmobile. The network can be described on a conceptual level as a number of arcs and nodes (see Figure 1); this is called the topology of the network. The nodes represent start- and end nodes and junctions in the network. This means that the basic arcs show how navigation can be performed through the network. Transport network models are used for describing roads, railways, paths and trails by combining the arcs in different sequences, e.g. Figure 1 shows that Trail T1 is constituted by Arcs 1 and 3, and Trail T2 by Arcs 2 and 4. This implies that the basic information structure of the tourism information system will be the trail network (see Figure 1) and most of the information that is gathered and communicated has to be related to the network.

The objects needed to model the trail system and to maintain the topological relations are described in the following table:

Table 1 Objects of the data model

Object	Description
Point	The exact coordinate of a geographic position given with a meter precision – the value is shown with x-, y- and z-coordinates.
Node	The start- or end of an arc. A node is something that is of importance for navigating through the network, e.g. start, end or junction in the trail-network system. A node can belong to many arcs.
Arc	The distance between two nodes. An arc always consists of a start- and an end node which means that it has a direction. An arc can belong to many trails.
Trail	Consists of a number of arcs. Has a name, e.g. Valley Trail. The trail may have attributes to describe something of interest to the users, e.g. day trip, easy, hard.
Tourism object	Something of interest to the target group that doesn't concern the navigation (examples are huts and rest areas). Has descriptive attributes and is related to a location-based point (coordinate). In this context the term "tourism object" is used as a collective name to exemplify the possibility to relate any kind of information to the trail system.

The objective of the data modeling process has been to find a suitable adaptation of the topological model to use as a base for the trail system. The basic idea behind using this topological network model is to separate the topology from the geometry (Lundgren, 2000). This separation is important because the topology describes the basic structure of the trail network and the geometry how it is located in the geography. This also means that information can be related to the network by using the nodes and arcs that constitute the topology. The resulting data model is shown in Fig. 2 below.

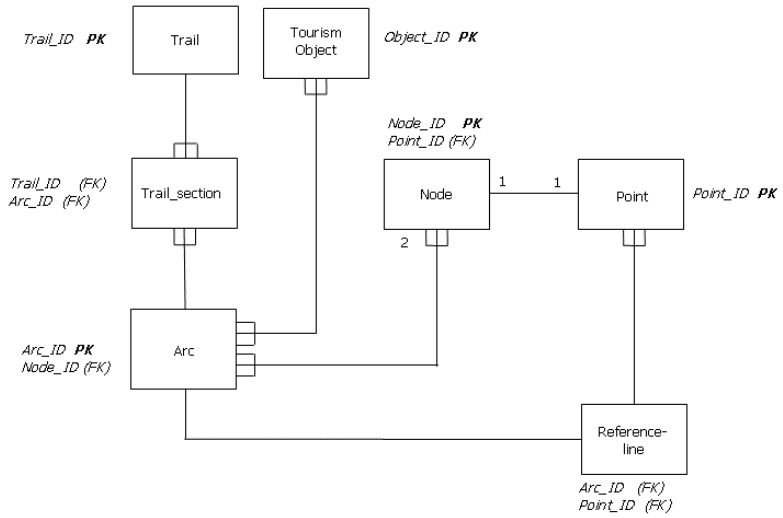

Fig. 2 Data model

3 Data Collection

3.1 Data collection using GPS-receivers

To collect data about the trail network and tourism objects related to the network GPS-receivers has been used. With the help of the GPS-receivers has information about geographical positions been stored as x- and y-coordinates and saved in the WGS84 format (latitude/longitude). It is also possible to use the z-coordinate to show elevation. There are two alternate ways of collecting geographical positions with the help of the GPS-receiver: manually or automatically.

- **Automatically:** The first way is to store coordinates automatically. While the GPS-receiver is turned on geographical coordinates are automatically saved in a track file. Tracking can be adjusted and set to a desired interval between 50 meters and 2 km´s – or be used in the *Auto Mode*.
  While using the *Auto Mode* coordinates are automatically saved at longer intervals while travelling along a straight line and at closer intervals when changing directions more often.

- **Manually:** The second way of saving coordinates is to store them manually. The points that are collected this way are called waypoints. A waypoint is stored by manually pushing a button on the GPS-receiver. The position will then be stored in a separate waypoint file.

3.2 The data collection in Grövelsjön

The initial mapping of snowmobile trails has been conducted in a limited area maintained by one of the local snowmobile clubs.

- **Mapping the nodes:** Coordinates for the nodes in the trail system have been measured and saved manually as waypoints.
- **Mapping the arcs:** On collection of track coordinates for the arcs in the trail system the GPS-receiver has been set to store coordinates at a 200 meter interval.
- **Mapping the tourism objects:** No clear directives have yet been worked out for the mapping of different types of tourism objects. At this early stage of the project these objects (mainly huts) have been mapped as if they where situated on the track. These objects have been measured and saved manually as waypoints.

4 Data Storage

4.1 Extracting data from the GPS-receiver

The coordinates stored in the GPS-receiver have been extracted using a program called Kartex. This program saves the information from the GPS-receivers into separate files: one waypoint and one track file. In both files the information about the coordinates is represented with an index number and the coordinate values (x-, y- and z). Also stored in the track file is the actual time for when the coordinates were saved. Upon transfer the positions are in this case converted from WGS84 to the local reference system (RT90). At this initial stage values transferred to the data base have been only the x- and y-coordinates. The basic information collected in the two files – the waypoint file and the track file – has to be processed in a number of ways to store the information in the database adhering to the data model (see Fig. 2 above).

4.2 Storing the information in the database

The coordinates from the track-file have been merged with the coordinates of the nodes from the waypoint file and all this has been stored together in the *point table*. This table is important for describing the geometry of the trails.
In order to generate the topology all the information from the track and waypoint files has to be matched. The coordinates of the track-file have been scanned sequentially and at the same time matched with coordinates of the waypoint file which contains information about the nodes. Every new node along the track has created a new entry in both the *node table* and the *arc table* because every new node implies the start of a new arc.

In order to resolve *many-to-many-relationships* in the database some additional tables have been added to the database. These tables consist of two foreign keys from adjoining tables that together make up a new unique combination.

Additional information about the relationship between the topology and the geometry of the trail network has been stored in the *reference-line table*. This table includes information about every point along the arc and is important for the final drawing of each arc. For every arc an ordered list of points has to be created to describe the geometry of the individual arc.

To be able to deal with arcs that contain several parallel trails the *trail-section table* has been added in the final data base.

The original waypoint file from each mapping session also includes geographical coordinates for other objects of interest to tourists. These coordinates are stored and treated separated from the point, arc and node tables. Additional information about these objects will be also supplied as attributes in the resulting *tourism object table.*

5 Presenting the information in GIS software

To present information from the database, the GIS software ArcView has been used. Here information from the database is presented in different layers called themes. In Fig. 3 we can see that there are five different themes presented.

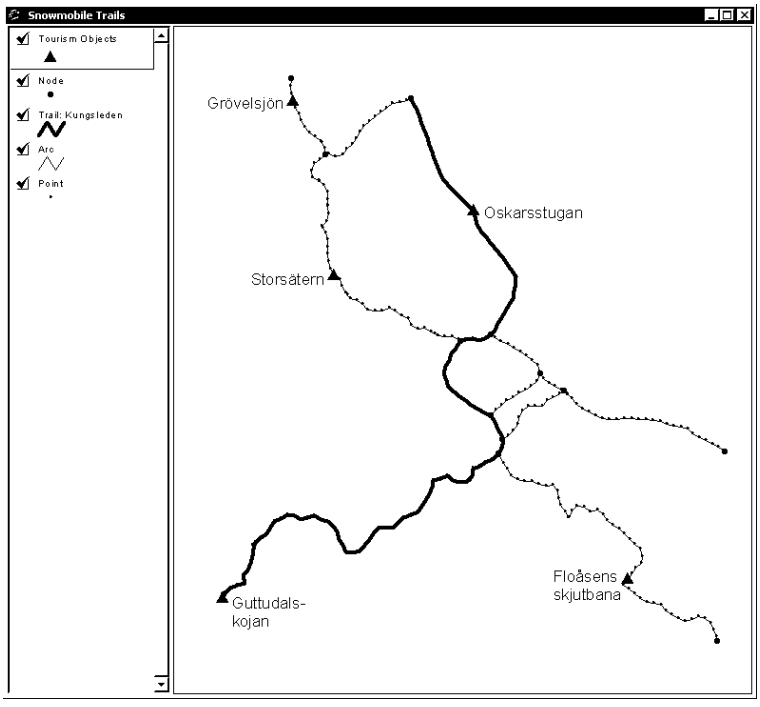

Fig. 3 Information presented as themes in ArcView

The themes used in this presentation are:

1) The point theme
2) The node theme
3) The arc theme
4) The trail theme
5) The tourism object theme

All themes have been constructed by selecting information and joining tables from the database. This has been accomplished by using the SQL-Connect function. This function makes it possible to use a SQL-query for selecting the desired information and the output of the SQL-statement is presented in each theme.

- In the point theme the points are presented as small dots and the information presented is collected from the point table.
- In the node theme the nodes are presented as large dots and the information presented is selected from the node table and the point table.
- In the arc theme the arcs are presented as thin lines. To produce the arcs a special program extension has been executed to convert the original point theme to a polyline theme by joining all coordinates to a number of line segments that make up the individual arcs. This theme is based on information from the reference-line table.
- The trail theme shows the selected trail as a thick line. The same procedure as for the arc theme is used to produce the resulting polyline theme. The information presented is selected from the trail table, the trail-section table, the arc table and, the reference-line table.
- The tourism object theme shows the objects as triangles and the information is selected from the tourism object table.

5.1 GIS and Information Systems

The big advantage with the GIS-software is that it can be used for presentation and analysis of location based information based on co-ordinates. This means that software like ArcView can present information in different themes and matched based on geometrical relationships. This implies that the software can be used to answer questions like “Show all huts that are situated within a buffer zone of 500 meters from the X trail”.

This is a major advantage, but to be able to build a flexible information system based on location based information, the information has to be structured from a business object perspective.

It is worth emphasising that location based information is something more than just maps and coordinates. This is important to recognise because we do not normally communicate locations and positions in terms of coordinates (Couclelis 1992), instead we use geographical identifiers (ISO/DIS 19112) like addresses and names of places. Another reason why this is important is that information about tourism objects has to

be combined with other information (e.g. trail network information, see above) and in many cases geographical identifiers (e.g. node-ID, arc-ID) are easier to use than coordinates to combine different information sources (Eriksson, 2002).

One problem experienced when performing the data modeling in the project was that the analysis of location based information tend to be focused on the geographical aspect and not the business aspect.

- With the geographical aspect in focus geographical objects (points, lines, areas) and their coordinates are stressed, while things like huts, trails etc. are primarily seen as attributes to the geographical objects.
- With the business aspect in focus business objects (huts, trails etc.) are stressed and the geographical aspects are primarily seen as attributes to the business objects.

Our experience is that both the business and geographical aspect are important, but in order to build a flexible information system based on location-based information it is important that the analysis and data modeling are based on business objects and their relationships.

Another important experience from the project is that the information collected should be stored in a data base management system. The reason for this is that it must be possible to restructure the information in an easy way and it must be possible to access and present location based information in other types of systems than GIS-software. It is also important to be able to present the information in different clients, e.g. using mobile terminals.

6 Conclusions

The purpose of our project has been to develop methods for organizing and collecting trail-network and location-based information, not building a complete tourist information system. In the project we have reached a number of important conclusions and experiences which are presented in the list below. These conclusions and experiences imply that it is important:

1. To stress that the tourism system described in this paper is not intended to be a GIS-system – it is an information system built on location based information, which is another matter.
2. To build the mapping of the trail network on a good topological data model. The topological model is the foundation for good quality information about the trail network. The model should describe and identify the basic arcs and nodes in the trail network.
3. To use efficient and well proved methods to collect data about the trail network.
4. To store and make the information available in a relational database. This means that information about the trail system can be related to other information not only based on geometrical relationships but also based on object relationships.

5. To integrate knowledge from both GIS-experts and the system development area. This is necessary to create conditions to build information systems based on topological data structures and geographical information.

All this shows that the tourism information system discussed in the paper cannot be fully developed using only traditional GIS (Dueker & Ton, 2000). Instead we have to develop an information system where the information is integrated and accessed with a data base management system. This implies that there is a need for methods which integrate knowledge from different areas. Today there are specialized methods oriented towards GIS, transport modeling and information systems development, but there is a lack of methods which integrate knowledge from these different areas. This is a major problem because knowledge and systems integration will be a key factor in order to develop tourism information systems because transport (trail) networks constitute the basic business object of many information systems in the travel and transport business. Thus there is a need for extended knowledge about how information about these basic business objects should be structured, collected, stored and presented.

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