METHODS AND APPARATUS FOR PROCESSING ROAD DATA

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Applicant (for all designated States except US): TELE ATLAS B. V. [NITNL]; Luchthavenweg 48, NL-5657 EB Eindhoven (NL).


STUDZINSKI, Witold [PL/PL]; Hipoteczna 11/5, PL-91-335 Lodz (PL).

Agent: DENMARK, Jim; Clickfile IP, Orchard House, 41 Altrincham Road, Wilmslow, Cheshire (GB).


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CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Provisional Patent Application No. 61/236,547 filed August 25, 2009, the entire disclosure of which is hereby incorporated by reference and relied upon.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] This invention relates to digital maps of the type for displaying road information, and more particularly toward a method for augmenting and updating digital maps.

Related Art

[0003] Electronic devices 10 like that shown for example in Figure 1, may be configured to utilize digital maps and possibly combined with accurate positioning data from GPS or other data streams. These devices have been developed for many useful applications. The effectiveness of these electronic devices 10 is inherently dependent upon the richness and accuracy of the information as provided in the form of digital maps. Typically, the device 10 includes a display screen 12 that portrays a network of road segments 14. Such devices 10 can be portable units, or in-dash mounted systems. Alternatively, digital maps can be displayed on various forms of computing devices, such as personal computers, cellular phones, hand-held navigation devices, etc. For the avoidance of doubt, it is to be understood that the principles of this invention are not limited to mobile navigation devices, but rather can be implemented through any electronic system configured to utilize a digital map.

[0004] Digital map providers continuously strive to improve and update the content in their maps. Inaccurate data, for example, may be unsuitable to compute the optimal routes in response to a navigation query, or to provide other reliable information to a traveler. Inaccurate or incomplete content in a digital map can result in poor or erroneous navigation instructions and lead to undesirable navigation decisions.

[0005] To an ever increasing degree, digital maps are expected to provide information about roadways displayed on the screen 12, such as the local speed limit, the road number, the road class, as well as many other useful details. These pieces of information are referred to as attributes, which can be associated with a particular road segment and contained in the
data system of a digital map for display, reference and/or navigation uses. It will be appreciated, therefore, that digital map data is more valuable when its information content, including attributes associated with road segments, is accurate and complete.

[0006] Road attributes, however, frequently change. New roads are created, old roads are discontinued, construction activities introduce temporary changes, speed limits change, bus and taxi stop positions are moved, and the like. Accordingly, there is a continuing need to update digital maps with the latest and most current information available including information about attributes such as speed limits, road numbers or designations, road classes, toll road details, and the like. There is therefore a desire for improved methods for updating digital maps so that the information contained in them will be current and of the maximum possible value to users of the map data.

**SUMMARY OF THE INVENTION**

[0007] This invention relates to a method for updating certain attribute specifications for road segments in a digital map, and more particularly for attributing road data such as posted speed limits, road numbers and toll classifications from one area of a digital map to another with respect to a defined processing area. According to this method, a digital map is provided having at least one road corresponding to a road in reality. A portion of the digital map is designated as a processing area. The processing area has a boundary defining its parameters. The road provided in the digital map is composed of a plurality of adjoining segments. The road crosses the boundary so that an incoming portion of its road segments lay within the processing area and an outer portion of its road segments lie outside the processing area. The road has at least one attribute. The value of the attribute for the incoming road segment directly adjacent the boundary is unknown. According to the principles of this invention, at least one of the outer road segments has a known value for the attribute. The known value of the attribute associated with the one outer segment is populated to the incoming road segment directly adjacent the boundary. By this method, known attributes for road segments located outside the processing area are used to attribute road segments within the processing area which are otherwise unknown. As a result of the application of this invention, substantially more accurate attribution of road segments can be acquired with less effort than required using prior art techniques.
BRIEF DESCRIPTION OF THE DRAWINGS

[0008] These and other features and advantages of the present invention will become more readily appreciated when considered in connection with the following detailed description and appended drawings, wherein:

[0009] Figure 1 is an exemplary view of an electronic device according to one embodiment of this invention including a display screen for presenting map data information to a viewer;

[0010] Figure 2 is a portion of a digital map showing, for example, a dual carriageway roadway having partially attributed and non-attributed segments;

[0011] Figure 3 shows an example of a processing area for a road database representing a region of land in reality;

[0012] Figure 4 describes a portion of a digital map comprising a processing area having a defined boundary establishing the perimeter of the processing area;

[0013] Figure 5 is a close up view of a portion of a digital map wherein a section of processing area is distinguished from an outer region by the boundary;

[0014] Figure 6 is an extended view of the digital map shown in Figure 5;

[0015] Figure 7 shows an exemplary data table relationship diagram for use in one embodiment of the invention wherein data from surrounding regions of the process area is used for populating the known value attribute to an incoming road segment within the processing area; and

[0016] Figure 8 is a simplified view of a small graph derived using the principles of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] Referring to the figures, wherein like numerals indicate like or corresponding parts throughout the several views, an electronic device 10 has a display screen 12 representing a portion of the digital map containing road segments 14 as previously described and shown in Figure 1. The device 10 may be an in-dash system in a motor vehicle enabled with position determining capabilities, as well as any personal, portable or handheld device. Alternatively, the device 10 may be a computer terminal or other computerized processing device having access to digital map data either directly, via network access, or through an internet connection.
[0018] It is common in the industry to continuously improve the attribution of highways and other road classes reflected in a digital map. This invention is directed to map making and updating techniques that include attributing road segments from known events situated outside of a processing area. The processing area comprises that section or region of the digital map that is analyzed by trained editors to determine whether updates are required to the map content. Updates may be in the form of new attribute information, new geometries, or other changes relevant to the content found in a digital map database. According to known processes, attributes are assigned to road segments on the basis of some known information, such as verifiable ground truth or other sufficiently credible information. Ground truth or other reality based information systems usually contain information about events. The term "events" may be defined as features existing in reality that describe or otherwise confer attribute values to a road or segments of a road. One common example of an event is shown, for example, in Figure 2 at 16. The event in 16 in this instance may be any of various types including, for examples, a speed limit sign, a sign identifying the road number, a toll booth, or the like.

[0019] According to observed traffic rules, some attributes should be assigned to more than just the one road segment closest to the event 16. These conditions would rather assign an attribute value to a chain of consecutive road segments. An example of this could be a speed limit sign (i.e., event) which affects not only a particular segment of a road nearby, but is persistently applicable to all succeeding road segments until a condition arises that would cancel or modify the speed restriction. This condition change could be the occurrence of another speed limit event 16 setting a different value for the attribute.

[0020] Rules like these applicable to certain types or classes of attributes can be used in the context of this invention for populating attribute values of successive road segments automatically. However, it is unfortunately the case that a fully automatic application of these principles is not possible due to the great variety of unique conditions that my arise in road geometries, the point at which a processing area is placed, unusual attribute conditions, and the like. It was also found that road segments that come into the processing area, i.e., those situated between the border and the first event, cannot be reliably attributed during an automatic or manual process. It is conservatively estimated that border segments which cannot be automatically attributed can make up approximately 10 percent of all processing segments in the processing area. Those gaps require additional human work after merging...
processing areas together. All of the segments that come into a processing area are not attributed after the application of an automatic process like that described above. Those gaps require manual work and by using the concept of this invention can be performed substantially more efficiently — test results have suggested a reduction of human interaction in these scenarios by up to 80 percent.

[0021] Figure 2 shows, for example, a typical scenario that may occur in any type of area, e.g., city, county, state or country, and affect any type of attribute. This problem concerns generally how to pass on the attributes to a processing area from signs or other boundary events located outside of, but having impact on, the processing area.

[0022] The following detailed description sets forth two embodiments which may be used separately or in combination to solve the problems described above. Both methods are composed of two general steps. According to the first embodiment, a database is created which contains events located in a trimming region just outside the border of a processing area. Such trimming regions may extend a distance of, approximately, 15 miles. In a second step, event points located within the trimming area are assigned to the road segments located outside the processing area. The incoming segments are then connected to the outside segments so that known attributes can be propagated into the processing area. According to the second embodiment of this invention, the processing area and all areas which have border along the processing area are attributed. All "not attributed" incoming segments from the processing area can then be connected with segments from the surrounding areas. Those segments can then be attributed by propagating attributes from the surrounding areas.

[0023] In Figure 4, the processing area is generally indicated at 18, and includes a boundary 20 sharply delineating its perimeter. The processing area comprises some portion of a much larger road database representing some region, e.g., a county or city. As described previously, the road database often includes separate data layers so that road segments with geometry of road network reside on one layer and events with objects that are used to attribute the road geometry are contained on a different layer. The term "incoming segment" is used to define a segment of the road whose one end is connected only with the boundary of a processing area to which that segment belongs, and for which an attribute specifying direction of driving allows it to move into the processing area from the
boundary 20. In other words, an incoming segment lies within the processing area 18. This is shown, for example, in Figure 4.

[0024] According to a first embodiment of this invention, border events 16 (i.e., events geo-located within the trimming area) can be used to attribute road segments 14 within the processing area 18. For example, in referring specifically to Figures 5 and 6, a boundary area geometry can be created by trimming the processing area 18 plus incoming segments from the processing area 18. The distance from the boundary 20 of the processing area 18 which makes the trimming can depend on the road class and populating attributes. Then, all signs and other event features which are in a scope of the project and are within a specified distance from the border 20 of the processing area 18 are mapped to newly created boundary geometry.

[0025] Having border events 16 mapped to boundary areas of the processing area 18, it is possible to create a list which contains all of the "not attributed" incoming segments of the processing area 18. For each segment from that list, its identifier (ID of the segment) is then used to find a corresponding segment in the outer area. This is illustrated graphically in Figure 6. The corresponding segment in the outer area may be termed the "initial_segment".

[0026] In the next step, an algorithm searches the outer segments in backward direction for all segments directly connected with the initial_segment. Then, for each found segment, the algorithm may check whether it is possible to populate attributes from this segment to the initial_segment (condition stop is check). When there is no segment from which it is possible to populate attributes to the initial_segment, the algorithm takes next the incoming segment from the list. For each segment from which it is allowed to populate attributes, the algorithm checks if there is a boundary event 16 mapped to this segment. If yes, the attributes of that event 16 are assigned to the chain of segments leading all the way to the initial_segment. In a different case, for the segments from which it is allowed to populate attributes to the initial_segment, the algorithm may take directly preceding segments and use the same procedures as described above to determine if populating the attributes can be done from the found segment. That activity is repeated until there will be found a segment to which a border event 16 is assigned or when the stop condition is encountered. In other words, the method works similar to propagating speed limits according to reverse rules.

[0027] For example, and referring again to Figure 6, in this example an incoming "not attributed" segment (ID 580) is matched to the segment with the same ID in the boundary
area, and informs the initial_segment. The algorithm next acquires the interior segment (ID 19718) and connects with the initial_segment. Next, condition stops are verified with segment ID 19718, and population can be done from that segment if there is a border event 16 mapped to this segment. However, because there is no border event 16 mapped directly to segment ID 19718, the next sequential segment is considered, i.e., segment ID 19717. Again, a check is made to determine whether a border event 16 is mapped directly to this segment. The answer is negative, and therefore the next sequential segment (ID 20249) is considered. It is found that no border event 16 is mapped directly to segment ID 20249, and therefore the next sequential segment is considered, namely segment ID 20253. When a check is made to determine whether a border event 16 is mapped to this segment, it is discovered that there is a boundary event 16 mapped to segment ID 20253. As a result, the attribute value associated with segment ID 20253, derived from border event 16, is populated in reverse along the chain all the way to the initial segment ID 580. The process can then continue into the processing area, next attributing segment ID 14323, and so forth. In this way, it is possible to assign attributes from border events 16 to some, if not all, incoming segments. Initial tests indicate that approximately 80 percent of incoming segments may be attributed using the principles of this invention. Having a list of attributed incoming segments, it is then possible to populate all areas using the standard methodology used for populating inside the region.

[0028] According to a second, alternative embodiment of this invention, data from all surrounding regions of a processing area 18 may be used for populating into the processing area 18. In connection with this alternative embodiment, reference is made to Figures 7 and 8. According to this technique, first the processing area 18 is attributed on the basis of events captured inside that area. Then, all areas are taken which have a common border or boundary 20 with the processing area 18 and attribute those which have not been attributed. Next, a list is created of all "not attributed" incoming segments of the processing area. Moreover, for each segment in the created list, specific segments can be specified on which to populate attributes. In this manner, it is possible to create one feature class and one table. The feature class may be named "Not Attributed Incoming Segments" and used to keep information about "not attributed" incoming segments. Thus, this feature class may contain the following data:

- Processed_Area_ID. This is the processing area identification code.
- Segment_ID. This is the incoming segment’s identification number or code.
• Shape. This is the incoming segment's geometry.
• Attributed. This is a Boolean value describing whether a segment was attributed (preferably initially set to "false").

[0029] The table in Figure 7 named "Segments To Populate" keeps information about segments which would be populated if an incoming segment would be attributed. That table has the following columns:

• Incoming_Segment. This is the not populated incoming segments ID.
• Segment_ID. This may be referred to as the segment's ID. This is the ID of the area to which segments belong from previous columns.

[0030] Also, all attributed outgoing segments from the processing area can be put in a separated feature class, named, for example, "Attributed Outcoming Segments" to which the following data is added:

• Processed_Area_ID
• Segment_ID
• Shape

[0031] Having all of the "not attributed" incoming segments from the processed region and all attributed outer segments from the boundary areas, it is possible to collect geometry of those segments and as a result obtain small graphs like that shown in Figure 8. For each small graph, attribute populating can be performed on the incoming segments according to the techniques described earlier. When the incoming segment is attributed, the attributed value is set to true in the "Not Attributed Incoming Segments" table for that segment. Next, the "Segments To Populate" table is read to its segments the attribution of incoming segments has a cause and those segments are attributed as well.

[0032] Accordingly, using the principles of this invention, it is possible to attribute road segments inside a processing area based on events 16 situated outside the processing area. Both techniques represent advances over known processes in the field of digital maps, and are useful for updating maps.

[0033] The foregoing invention has been described in accordance with the relevant legal standards, thus the description is exemplary rather than limiting in nature. Variations and modifications to the disclosed embodiment may become apparent to those skilled in the art and fall within the scope of the invention.
What is claimed is:

1. A method for attributing road data such as a posted speed limit, road number or toll classification from one area of a digital map to another with respect to a processing area, said method comprising the steps of:

   providing a digital map having at least one road corresponding to a road in reality; designating a portion of the digital map as a processing area, the processing area having a boundary defining its perimeter;

   the road comprising a plurality of adjoining segments; the road crossing the boundary so that an incoming portion of its road segments lie within the processing area and an outer portion of its road segments lie outside the processing area;

   the road having at least one attribute; the value of the attribute for the incoming road segment directly adjacent the boundary being unknown;

   characterized by,

   at least one of the outer road segments having a known value for the attribute;

   and

   populating the known value of the attribute associated with the one outer segment to the incoming road segment directly adjacent the boundary.

2. The method of claim 1 including establishing a trimming region of the digital map surrounding the processing area and directly adjacent the boundary; and providing at least one point event in the trimming region that establishes an attribute value.

3. The method of claim 2 wherein said step of providing a known attribute to one of the outer road segments includes mapping the point event to one of the outer road segments; said mapping step including associating the known attribute value of the point event to the one outer road segment.
4. The method according to any of the preceding claims wherein said populating step includes assigning the populated attribute of the incoming road segment directly adjacent the boundary to the next successive incoming road segment.

5. The method according to claim 4 further including repeating said assigning step to each next successive incoming road segment having an unknown attribute.

6. The method according to any of the preceding claims wherein said populating step includes applying the known attribute associated with the one outer segment to at least one other outer road segment situated between the one outer segment and the boundary.

7. The method according to any of the preceding claims further including varying the dimensional properties of the trimming area as a function of the road class.

8. The method according to any of the preceding claims further including varying the dimensional properties of the trimming area as a function of the point event type.

9. A navigation device configured to display a digital map according to the method of claim 1.
# PATENT COOPERATION TREATY

## PCT

### DECLARATION OF NON-ESTABLISHMENT OF INTERNATIONAL SEARCH REPORT

(PCT Article 17(2)(a), Rules 13ter.1 (c) and Rule 39)

<table>
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<th>IMPORTANT DECLARATION</th>
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**International Patent Classification (IPC)** or both national classification and IPC:

G09B29/10

**Applicant**

TELE ATLAS B V

This International Searching Authority hereby declares, according to Article 17(2)(a), that no international search report will be established on the international application for the reasons indicated below:

1. [x] The subject matter of the international application relates to
   - [ ] scientific theories
   - [ ] mathematical theories
   - [ ] plant varieties
   - [ ] animal varieties
   - [x] essentially biological processes for the production of plants and animals, other than microbiological processes and the products of such processes
   - [ ] schemes, rules or methods of doing business
   - [x] schemes, rules or methods of performing purely mental acts
   - [ ] schemes, rules or methods of playing games
   - [ ] methods for treatment of the human body by surgery or therapy
   - [x] methods for treatment of the animal body by surgery or therapy
   - [ ] diagnostic methods practised on the human or animal body
   - [x] mere presentations of information
   - [ ] computer programs for which this International Searching Authority is not equipped to search prior art

2. [x] The failure of the following parts of the international application to comply with prescribed requirements prevents a meaningful search from being earned out:
   - [x] the description
   - [ ] the claims
   - [ ] the drawings

3. [ ] A meaningful search could not be earned out without the sequence listing, the applicant did not, within the prescribed time limit:
   - [ ] furnish a sequence listing on paper complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in a form and manner acceptable to it
   - [ ] furnish a sequence listing in electronic form complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in a form and manner acceptable to it
   - [ ] pay the required late furnishing fee for the furnishing of a sequence listing in response to an invitation under Rule 13ter1 (a) or (b)

4. Further comments

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**Name and mailing address of the International Searching Authority**

European Patent Office, P B 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel (+31 -70) 340-2040
Fax (+31 -70) 340-3016

**Authorized officer**

VASILAKIS, Styhanos
Tel +49 (0)89 2399-8554

Form PCT/ISA/203 (.July 2009)
The claims relate to subject matter for which no search is required according to Rule 39 PCT, namely software and mental acts. Given that the claims are formulated in terms of such subject matter or merely specify commonplace features relating to its technological implementation, the search examiner could not establish any technical problem which might potentially have required an inventive step to overcome.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.