Route Description Using Natural Language Generation Technology

XueYing Zhang

Dept. of Geographical Information System, Nanjing Normal University, 210046, China
zhangsnowy@163.com

Abstract. This paper aims to solve the problems of generating natural language route description in Chinese way-finding systems, on the basis of datasets of geographical information systems and natural language generation technology. The techniques of deriving important information e.g. paths, roads, directions and landmarks from geographical information systems are discussed in detail. Through examples we describe the construction of linguistic knowledge base for route description including the categories of Chinese terms, grammar rules and syntax schemata. The experimental output indicates that there are no more distinguishable from human route description.

Keywords: natural language, route description, electronic map, text planning.

1 Introduction

Natural language generation (NLG) is the subfield of artificial intelligence and computational linguistics. It is concerned with the construction of computer systems that can produce understandable texts in human languages and form some underlying non-linguistic representation of information in order to meet specified communicative goals (McDonald, 1987). The technology has been used in a wide variety of systems and contexts (Reiter, 2000).

Route description is interesting for at least two reasons: first of all, as navigation aides in general they help to solve a real world problem; second, despite their apparent simplicity, especially with regard to surface form, they require the solution of a number of non trivial linguistic and discourse problems, which are intimately rooted in human cognition (Fraczak, 1998). Language can be effective at relating a simple scene of people, objects, and landmarks. Routes are schematized as a point changing direction along a line or a plane, or as a network of nodes and links. Route description can be broken into segments consisting of four elements: start point, reorientation/direction, path/progression and end point (Denis, 1994). Human's route description always misses a start or an end point or path/progression information. However, many communications contain missing information that can be inferred from context or medium (Clark, 1977). Two simple rules of inference allow recovery of most of the missing information: According to "continuity" rule, if a start point is omitted, it is assumed to be the same as the previous end point, or conversely. According to "forward progression" rule, the direction of motion is assumed to be

H. Li et al. (Eds.): AIRS 2008, LNCS 4993, pp. 454–459, 2008.

forward (Tversky, 1998). Gedolf (2002) described an approach to developing a mode of interaction which supports the cognitive involvement of the user in performing the task of following a route description.

There already exists a considerable research in automatic generation of natural language route description. A majority of these approaches are all concerned with establishing a link between GIS knowledge and linguistic realization principles. Pattabhiraman (1990) pointed the importance of salience and relevance in content selection, and reported some aspects on generating descriptions of bus route directions from a given source to an intended destination within a city. Fraczak (1998) developed a system producing variants of subway route directions by mapping the relative importance of information entities onto syntactico-semantic features. A multimodal concerning with the generation of multimodal route description that combine natural language, maps and perspective views is developed for computer assisted vehicle navigation (Maaß, 1993). Maaß (1995) indicated that incremental route description can be classified by a small set of syntactic and semantic structures. Williams (1999) studied the collections of the corpus contains 56 monologue descriptions of routes around a university department building, which was used to improve a natural language generation systems that generates prosodically annotated routes to be spoken by a speech synthesizer.

There are a lot of successful way-finding systems based on NLG technology, which provide navigational services in the context of city public traffic and driving directions, such as MapBlast[1], MapPoint[2] and MapQuest[3]. However, there are only a few such web-based systems in Chinese. With the example of 51map[4], it is the biggest port of electronic maps, in which the start address and target address can be visually identified on the map and natural language descriptions of its route plans can generated automatically.

Although there are some differences of detail in the user interfaces, all these systems are similar in concept and content. The route description approaches commonly-used by Chinese way-finding systems are identified four typical disadvantages:

- The instructions are normally in the simple form of "turn by turn", e.g. left, right, north, west, east and south etc.
- Instructive landmarks and visible features of the environment to identify turning points are omitted, whereas the systems generally describe these points by quantitative distances or times of travel from previous decision points.
- These systems generate route description by one-sentence-per-step mappings using a limited few terms and clause structures, while humans typically produce complex clause structures and gathering related information together into single sentences in order to shorten or ignore some redundant instructive information.
- Only bus route description or driving information is provided. In fact, route description involves knowledge of different granularities. In some cases, the bus route description also includes walking route information.

---

[1] Supported by the Specialized Research Fund of Nanjing Normal University
http://www.mapblast.com

[2] http://www.mapoint.com

[3] http://www.mapquest.com

[4] http://www.51map.com

Our work is concerned with the techniques of Chinese route description for way-finding systems based on the datasets of underlying geographical information systems (GIS), which incorporates NLG technology to produce more natural-sounding route description.

2 Architecture of Route Description

There are many ways of building applied NLG systems. From a pragmatic perspective the most common architecture in applied NLG systems includes three stages.

Text Planning: The most popular technique used for text planning for the development of practical systems in limited domains is schemas. A route description schema provides the semantic of a route description. Basic constituents of a description schema are paths, locations, directions, distance, landmarks, and temporal structure etc., and events and states are used in higher-order structures. A majority of this information can be derived from GIS datasets.

Sentence planning: This stage combines sentence aggregation, lexicalization, and referring expression generation. Once the content of individual sentences has been determined, this still has to be mapped into morphologically and grammatically well-formed words and sentences. Sentence aggregation is the process of grouping messages together into sentences. It can be used to form paragraphs and other higher-order structures as well as sentences.

Linguistic realization: It is the task of generating grammatically correct sentences to communicate messages. From a knowledge perspective, the realizer is the module where knowledge about the grammar of the natural language is encoded. It includes syntactic and morphological knowledge, such as rules about verb group formation, agreement and syntactically required pronominalization.

Route description is always accompanied by intentions. Main intention of the model of route description is to follow a path from a starting point to a destination. By referring to the path finding process, man knows where to go at a decision point. Path-related intentions control the focus of attention. But these intentions are also important for the language generation process.

3 Route Description Information Based on GIS

The GIS datasets represent the world in terms of nodes, arcs and polygons. Nodes (points) typically represent junctions or decision points in a road networks; arcs are the travelable paths between points; and polgygons are used to represent areas such as parks or railway stations. A GIS system typically also provides street names, the lengths of paths, categories of points of interest and so on.

The first step of route description is to get paths mapping the user's query requirements based on a given GIS. The shortest route algorithm is effective to implement this task. In this paper, we select the commonly-used algorithm developed by Dijkstra (Paul, 2006). Based on path plans, other information important for route description can be derived easily.

Road names are one of the most useful reference information from the view of travelers. Road names can be easily extracted on the basis of a definite path.

Distance is usually expressed in terms of its value, i.e. the distance between two points is less than 200m for walking directions or less than 500 m for driving directions. In our system we simplify the task of distance estimation by directly representing distances in terms required by the text planner.

Direction is the most important inductive information in the route description. Absolute directions refer to the cardinal points of the compass marked as north, south, east and west. Relative directions refer to the relative aspects of direction and are locationally and culturally variable. People usually are confused by the identification of absolute directions. Therefore, relative directions are very important, i.e. left and right. However, the identification of left and right directions is dependent on absolute directions, the location relations between the objective point and the moving direction. Computation of direction information requires availability of a co-ordinate system and additional inference modules. The text planner uses additional procedural domain knowledge for retrieving or computing orientation information.

Location information is crucial at transfer points. Additional descriptions of routes in terms of landmarks crossed give the prospective traveler a feel for how long she needs to be on the bus, train, etc, and assure her that she is still on the right back. The additional information such as landmarks, while not essential, may be important for keeping the traveler confidently on track. It anticipates that travelers may become uneasy when there is a relatively long distance without a change of orientation or distinguishing feature or when there is uncertainty about the identity of a landmark (Denis, 1994).

Retrieving landmarks for describing locations of sources and destinations requires examining finer-grainer spatial layout information at the neighborhood of these points. Along with the task of choosing the landmarks comes the task of computing the locative relation between the two objects, and expressing the relation in language as in right by.

4 Linguistic Knowledge Base for Route Description

Route description information derived from GIS must be combined sentences via specific terms. These terms can be divided into five classes according to Chinese language characteristics and human spatial cognition custom.

- Common verbs:步行(walk)、走(walk or go)、行至(get at)…
- Spatial verbs: 穿过(pass)、到达(get)、拐(turn)、转(turn)…
- Connection:然后(then)、那么(then)、再(then)、接着(then)、紧接着(then)…
- Direction:左(left)、右 (right)、东边(east)、南边(south)、西边(west)…
- Preposition:
  沿着(along)、顺着(along)、穿过(across)、往前(forward)、附近(near)、旁边(beside)、靠近(near)…
- Phrases: 从…..出发(Start at)、沿途会经过(see along this road)…

The grammar rules for Chinese route description (in short RD) are defined by:

< RD> : : = { < Unit RD > }
< RD > : : = { < Modifier phrase> } < Action> [<Object>]
<Modifier phrase> : : = < Action> < Object> | < Common modifier>
< Object> : : = < Geographical feature> | < Distance> | < Direction>
< Action> : : = < Common verb> | < Spatial verb>
< Geographical feature > : : = < Geometric object > | < Road >
< Distance> : : = < Number> < Metric>
< Direction> : : = < Absolute direction> | < Relative direction>
< Common verb> : : = 行走(walk or go)| 步行(walk)| …
< Spatial verb> : : = 经过(Pass)|到达(Get)|…

A description schema provides the semantic of a route description. Over 60 unit schemata are stored in the linguistic knowledge base, such as follows:

- Phrase + start point
- [Phrase] + [Directional preposition]+Action+[Distance]+Objective point
- [Connection] + [Preposition] + Phrase + Road names + Directional preposition + Action.
- [Directional preposition] +Action+ [Phrase] + Progression point.
- Action+ [Directional or other preposition]+ [Phrase]+Landmarks

It should be noted that the elements labeled square brackets are optional, and all the terms can be chosen randomly providing that one term can not used frequently in a route description. According the continuity and forward progression rules described in section 1, a combined schema is defined as the incremental integration of unit schemata. Based on the above mentioned techniques, we develop a prototype of route description system. An example is given as follows:

Departure:金鹰国际购物中心(Jin Ying Shopping Center)

Destination:华联大酒店(Hua Lian Hotel)

Route description: 从金鹰国际购物中心出发,向右到达路口,再向右沿着王府大街行走,路上会看到南京华联集团,南京市现代测绘科技开发公司,步行一会到了石鼓路,沿着石鼓路行走,这就到了最后一个路口了,这时候再向前步行约17米就会在右边看到华联大酒店了。(Start at Jin Ying Shopping Center, turn right at the junction, and walk along Wan Fu Da Jie, see Nanjing Huan Lian Group, Nanjing Modern Survey Technology Company along this road, at Shi Gu LV go forward until the last junction, and then walk about 17m, and finally find Hua Lian Hotel on right hand.)

It is very interesting that the same query may generate a different route description at a different time, because the system can select some terms and schemata randomly in order to generate more natural-sounding descriptions.

5 Conclusion

In this paper we presented an approach that takes as input datasets of underlying GIS, and uses natural language generation techniques in constructing the textual output of route plans. Chinese linguistic knowledge base for route description focuses on the categories of terms, grammar rules and syntax schemata. Further experimentation demonstrates that the presented approach can achieve more satisfactory performance than the existing way-finding systems e.g.51map and some driving navigation systems.

References

1. Clark, H.H., Clark, E.V.: Psychology and language. Harcourt Brace Jovanovich, New York (1977)
2. Denis, M.: La description d'itineraires: Des reperes pour des actions (The description of routes: Landmarks for actions). In: Notes et Documents du LIMSI, Orsay, France, pp. 14–94 (1994)
3. Fraczak, L., Lapalme, G., Zock, M.: Automatic generation of subway directions: salience gradation as a factor for determining message and form. In: Proceedings of the International Workshop on Natural Language Generation, Niagara-on-the-Lake, Canada, pp. 58–67 (1998)
4. Geldofe, S., Dale, R.: Improving route directions on mobile devices. In: Proceedings of the ISCA workshop on Multi-Modal Dialogue in Mobile Environments, Kloster lrsee, Germany (2002)
5. Maaß, W., Wazinski, P.H.: G. VITRA GUIDE: Multimodal route description for computer assisted vehicle navigation. In: Proceedings of the 6th International Conference on Industrial and Engineering Applications of artificial Intelligence and Expert Systems, Edinburgh, Scotland, pp. 144–147 (1993)
6. Maaß, W., Baus, J., Paul, J.: Visual grounding of route descriptions in dynamic environments. In: Srihari, R.K. (ed.) Proceedings of the AAAI Fall Symposium on Computational Models for Integrating Language and Vision, Cambridge, MA (1995)
7. McDonald, D.D.: Natural language generation. In: Stuart, C.S. (ed.) Encyclopedia of Artificial Intelligence, pp. 642–655. John Wiley & Sons, New York (1987)
8. Paul, E.B. (ed.): Dijkstra's algorithm, in Dictionary of Algorithms and Data Structures. US National Institute of Standards and Technology, US (2006)
9. Pattabhiraman, T., Cercone, N.: Selection: Salience, relevance and the coupling between domain-level tasks and text planning. In: Mckeown, K., Moore, J., Nirenburg, S. (eds.) Proceedings of the 5th International Workshop on Natural Language Generation, pp. 79–86. Linden Hall Conference Center (1990)
10. Tversky, B., Lee, P.U.: How space structures language. In: Freksa, C., Habel, C., Wender, K.F. (eds.) Spatial Cognition 1998. LNCS (LNAI), vol. 1404, pp. 157–176. Springer, Heidelberg (1998)
11. Reiter, E., Dale, R.: Building natural language generation systems. J. Spatial Cognition and Computation 1, 227–259 (1999)
12. Williams, S., Watson, C.I.: A profile of the discourse and international structures of route description. In: Proceedings of the 6th European Conference on Speech Communication and Technology, Budapest, Hungary, pp. 1659–1662 (1999)