Stories as Route Descriptions

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Abstract. While navigation instructions in terms of turn instructions and distances are suitable for guiding drivers on roads, a different context of use - like pedestrian navigation - requires extended routing data and algorithms as well as adapted presentation forms to be effective. In our work we study alternative forms of navigation instructions for pedestrians in city environments. In this paper we explore the usefulness of directions given in the form of a short story. To aid retention of navigation instructions and recognition of decision points along the route we have expanded a landmark-based navigation system to present navigation instructions as a sequence of story elements. In this paper we introduce the concept of stories as route descriptions, describe the current prototype implementation, and present preliminary evaluation results from user tests that will guide further development.

Keywords: navigation, wayfinding, route directions, storytelling

1 Introduction

Current pedestrian navigation systems mainly use maps combined with positioning and routing information to represent geographical knowledge. Research that examined the specific context of use in pedestrian navigation has suggested that landmarks are well suited to identify important places along a route [1] and thus can form a valuable extension of route descriptions. Experiments with the use of landmarks in route descriptions have shown to increase the perceived quality of maps [2]. It is generally acknowledged that landmarks represent a central concept in successful route descriptions for pedestrians [2,3,4,5,6]. However, experience shows that some users still have difficulties in memorizing route descriptions, even when they are augmented with landmarks. Experiments with existing systems [7] have also shown that different usage scenarios (e.g. guidance during a sightseeing tour through a city vs. guidance with the aim of reaching a destination on the most efficient route) result in completely different expectations and requirements of users. In inner city navigation a particularly common task is to reach a specific location from a given starting point by the most effective route. In contrast to sightseeing systems and many proposed location-based services the users in this scenario are not interested in additional information on their surroundings or targeted advertisements. Instead, they

want a route description that is easy to memorize and can be executed without repeated interaction with a navigation device. Since this use case is very common it seems useful to examine how memorable route description can be synthesized and presented.

The approach to memorable route description presented in this paper builds on digital storytelling techniques and is inspired by the mnemonic techniques associated with the "Method of Loci" attributed to Cicero [8] and the system of “songlines” across the Australian continent, as popularized by the author Bruce Chatwin [9]. The method of loci is a technique used to remember large amounts of information by associating each "unit" of information with a (virtual) place. Forming a story connecting these places and mentally revisiting these places can help to recall the information "units" associated with them. "Songlines" are part of the aboriginal Australian creation myth of the dreamtime, in which each place has its own creation story in the form of a song. According to Chatwin the songlines form a system of interconnected paths across the Australian continent that corresponds to the routes taken by the ancestors who have sung everything into existence. In this sense songs can be viewed as route descriptions, with the strophes of a song following the linear structure of one of these paths. Strophes of the song are based on places, e.g. landscape features like rocks, mountains, springs, groups of trees, crossings etc. From a navigation perspective the system of songlines can thus be thought of as a map with interconnected routes that is passed on from generation to generation in the oral form of songs.

2 Related Work

2.1 Route descriptions for wayfinding

Directions are a specific kind of spatial discourse used to communicate spatial relations to other people. The purpose of directions in navigation tasks is to convey all information that is necessary to guide someone from a starting point to a destination. Therefore the route is subdivided into sequential instructions. An analysis of conventional verbal route descriptions reveals that the most important elements in these instructions are the reference to the direction of movement and landmarks [2,3].

To generate appropriate route directions automatically it is necessary to understand the underlying structure of human generated instructions and how landmarks are incorporated in them. Following [10] directions are given in wayfinding narratives. The understanding of directions is guided via narrative structures in which landmarks are embedded.

But route descriptions are not only communicated in verbal form. According to [11] the communication of spatial relations is appropriate both in verbal and graphical form. The general structure and content of directions and route maps is the same and it is assumed that an automatic translation between both representation forms is possible [12]. Since techniques for automatic map generation are comparatively well developed route maps are commonly used in navigation instructions.

2.2 Digital storytelling

In recent years techniques and approaches that originate in the entertainment domain have found widespread use in serious applications. The most prominent example is the exponential growth of 3D graphics performance in personal computers which was driven by the 3D game market and has enabled a multitude of 3D visualization applications in other domains. In the geo context examples include the use of 3D technologies originating in games to communicate 3D geo-information (e.g. [13]) and to train users in geographic analysis tasks (e.g. [14]). Digital storytelling is an emerging discipline in which digital presentation media (which might be generated automatically) are used to relate a complex story. Digital storytelling and game techniques have been used successfully to communicate relevant information to users, e.g. by requiring users to solve quests for which information has to be discovered in a virtual environment [15]. Cartwright [16] considers entertainment technologies as helpful to deliver geographical information efficiently by exploiting the familiarity of users with spatial concepts in games. Thus new users, who are experienced with web and game technologies, can be made 'geographically aware' of map based information. First experiments with this approach suggest that game like interfaces can improve the way new users interact with geographical information spaces.

3 Generating stories from route directions

In the "KuGeRou" ("short story routing", in German "Kurz-Geschichten-Routing") system we aim to use short memorable stories as route descriptions. The hypothesis is that stories related to the sequence of places that a user encounters when following a route can be used as memorable descriptions of it. The use of a story instead of a map could reduce complexity for the user. While the data space of a map contains the complete network of possible routes and thus easily overwhelms the memory capacity of a user, the linear path of a route and the corresponding linear experience of following it contain far less information. By mapping this experience to a similarly linear story taking place at the decision points along a path we aim to create a mental representation of the route that could be easier to memorize than both the complete map and abstract route descriptions. In our approach route descriptions are mapped to general story elements: a route is related as a story, a decision point / landmark location is represented as a scene in the story, a navigation (e.g. turn) instruction corresponds to a similar action within the story, and objects (e.g. landmarks) and agents in a route description are mapped to actors and items in the story.

In the system we use a conventional route planning system to generate position information, route actions, landmarks and distances to decision points on a route and encode this in a data structure, similar to existing systems. A navigation tuple is placed at each decision point and consist of a landmark, the street/place name and a direction as well as the distance to this decision point. We augment this with information for the storytelling system in a second data structure. Each decision point is also associated with a story tuple, consisting of three pre-authored presentation sequences, a main actor, a set of additional actors and objects determined dynamically

from the navigation tuple, a set of actions, and possible user interactions. Figure 1 shows an example of both data sets for a specific decision point where the user should turn right into "Georgstrasse" at a "H&M" Shop. The navigation tuple contains the relevant information from the route planner. The story tuple encodes the "story" in a sequence of three templates that can be interpreted as follows: The mouse "George" (name determined by the street name) meets the main actor, gives him a hat (object determined by H&M landmark) and disappears to the right (animation direction determined by turn instruction). Figure 3 (left) shows how this sequence is rendered by the Flash player. The first sequence template also contains the instructions to display standard information (e.g. turn arrow, street-name).

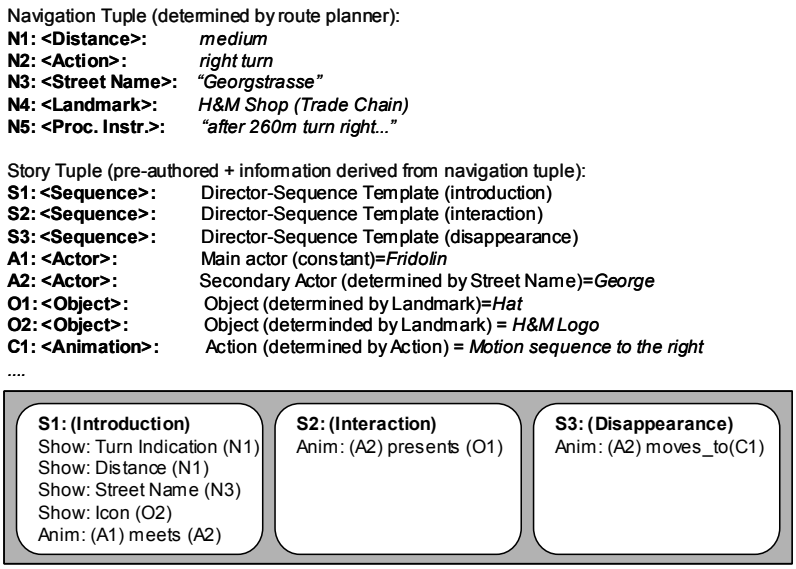

Fig. 1: Composition of navigation tuple and story tuple

3.1 Story design

While the design of navigational stories can be informed to some degree by existing research on spatial cognition, cartography and digital storytelling, the complex interdependencies between design components make predictions with regards to the performance of a proposed design difficult. As the basis for future systematic developments insights are required that generalize and apply to large user groups. Valid statements with regards to complex information presentation designs (such as story based navigation instructions) can only be established by systematic testing with users under controlled conditions. Our initial goal is to establish the viability of story

based navigation instructions and to provide a foundation for such evaluations in a systematic way. To achieve this, we have implemented a test system using a scenario based design approach with an iterative development process following the ISO 13407 cycle [17]. For the initial development we have focused on a single use-case in inner-city pedestrian navigation, where the user arrives by train at the central station of Hanover (giving him time to familiarize himself with the instructions prior to arrival) and than navigating to different destinations in the inner city from memorized instructions. For the technical implementation we have reused existing components for the navigation and storytelling functionality and used standardized techniques (e.g. Macromedia Flash) for the presentation where possible.
A central design decision with regards to navigational stories is the type of story and the relation of its content to the underlying navigation instructions. It is therefore necessary to study different story types and constructions. For our approach we have selected the following story design variables for further study:

Story type: Different types of stories could result in different recall properties. Due to limitations of the currently used storytelling system certain restrictions are placed on the story type and content. In particular we are currently restricted to use a set of pre-authored story elements for each decision point that are then adapted to the current route description by a template mechanism. We have therefore limited the initial study to two types of stories: The first approach is the most simple and uses non-coherent scenes for each decision point. Thus, there is no logical connection in the sequence of story elements and the main actor is confronted with a unique event at each decision point where new actors, objects and actions are introduced as appropriate. This approach corresponds to the story types invented for the method of loci and lends itself to automatic story generation. However, it may be harder to memorize the sequence of events.
The second approach presents a coherent story line throughout subsequent scenes. The story concept that we have used for this approach is a detective story where a suspect is followed through different places with corresponding clues. This story type follows the ideas of the prominent computer game “Where in the world is Carmen Sandiego” [18] and also allows to generate scenes based on spatially located story templates. More complex storylines would demand a more advanced storytelling system as their basis and are therefore beyond the scope of the current prototype.

Connection between geographic location and story elements: The story segment at each decision point should establish a reference to the real world location so that the user can recognize it and apply the corresponding navigation action. In our prototype each story segment follows the simple structure of introduction, interaction, and disappearance. During various iterations of our prototype development we have examined the following connections between geographic location and story elements:

Connection based on landmarks: If a landmark is available at a decision point it can be used as a story element, either directly or by symbolic reference. Figure 3 (left) shows an example where a landmark (a shop from the H&M chain) is used both directly (as a shop) and indirectly by verbal allusion (Head&Mouse = H&M).

Connection based on street names: Street names can be used as story elements. Again the reference can be direct or indirect as shown in Figure 3, where the street name (“Georgstrasse”) is used directly in the scene and mirrored by the name of the main actor in the scene (a mouse called "Georg").
Connection based on action: Locations that are characterized by specific actions (e.g. railway gates) can also be used to establish a reference between story and real world environment. Another connection based on action was inspired by the concept of minimally nonintuitive narratives as proposed by Norenzayam [19]. Here an unusual aspect (object, actor or behaviour) is combined with an otherwise very normal situation to create a memorable event. E.g. in the case of a place called “Brühlstraße” phonetic similarities like yelling (“brüllen” in German) are exploited to combine statues (landmarks at this location) with a memorable action (yelling statues).
Connection based on actor names and objects: Actor names and objects can be chosen to reflect arbitrary geographical information that could be relevant to the user and are especially suitable for minimally nonintuitive narratives. E.g. in a story segment where the location "Appelstraße" is relevant, apples are picked up.
Connection based on direction: The direction of movement of the main actor in a scene can be used to convey the direction in which the route continues. In our experiments we have found that a useful convention is for the main actor to appear at a decision point from the same direction as the user and to leave in the intended direction of travel. E.g. in the situation of Figure 3, where the user should turn right at the H&M Shop onto the Georgstraße, the actors in the scene disappear to the right.

Static vs. dynamic vs. interactive stories: Animation and the possibility for user interaction could improve retention of story content. While static scenes are easiest to define, animated actions can help to present more information in a scene and were found to be essential in early pilot tests to convey the direction of travel. Interaction could help to further improve instruction retention, e.g. by forcing users to select correct objects and directions during the learning phase. The current prototype only supports simple user interaction like moving between scenes.

Realistic vs. virtual/abstracted content presentation: Both realistic and abstracted visual styles have benefits and shortcomings when it comes to the presentation of story segments. Guided by the results of a study of visual presentation styles for landmarks [20], we have focused our initial study on the use of an abstracted cartoon-like presentation style. Benefits of a cartoon style include it's suitability for a wide range of mobile devices ranging from mobile phones over PDAs to laptops as the performance and memory requirements are much low than with photorealistic styles; the simplification of the authoring process and the abstraction from possibly changing temporal detail. In the future alternative presentation styles should also be examined.

3.2 KuGeRou Prototype

The initial prototype was build using existing components for the navigation and storytelling functionality and used standardized techniques (e.g. Macromedia Flash

[21]) for the presentation where possible. Although current capabilities are limited the modular construction was chosen to be extensible for future experiments with a wider scope of design options.

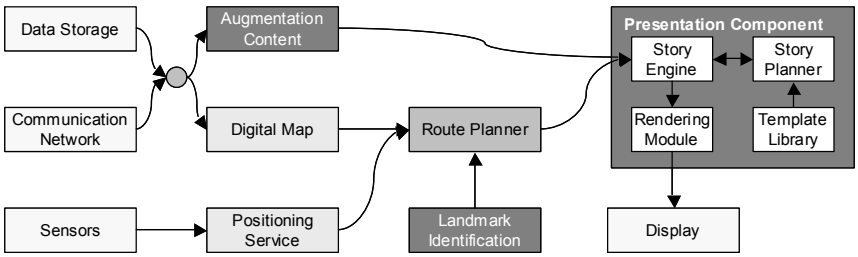

Fig. 2: Prototype system architecture

The principle structure of system (see Fig. 2) is similar to conventional navigation systems, with modifications and extensions shown in dark grey. In the first step digital map data is used by the route planner to generate a route, consisting of segments and decision points that connect them, e.g. in the form of turning instructions. In the second step landmarks along the generated route are identified using the techniques described in [22] The process identifies objects with unique features that could serve as landmarks. A digital surface map (DSM) is then used to ensure the visibility of the identified potential landmarks from the user's direction of approach. Objects with limited visibility are discarded at this step. For details of the landmark identification process, see [6]. Both the landmarks and the route itself are then passed on to the presentation component. The presentation component then uses a story planner to generate a story based route description from this data. For our initial prototype we use an existing route planning systems for offline generation of the route and landmarks that is then transferred to the mobile navigation device, e.g. a PDA. Only the presentation component is currently implemented on the PDA for interactive mobile use. While interactive story generation in general is a very challenging research problem, the task in our system is significantly simpler as the stories are typically short, non-branching and are restricted to motion related storylines. In the initial prototype we use a simple mechanism based on pre-defined templates for the overall story structure. For each decision point a suitable story template is selected from a library, according to the instructions provided by the route planner. The template contains slots for all elements of the information tuple that is associated with the decision point. By filling the slots with pre-authored multimedia content according to the identified landmark and the turn instructions the story segment is constructed. Individual scene description templates for decision points with the corresponding actors are stored in the augmentation content database. According to the turn instructions provided by the route planner the story planner thus identifies a suitable template and composites the corresponding scene elements accordingly (E.g. in the scene described by the structures in Fig. 1 and shown in Fig. 3 the H&M landmark is represented in a template in which the head and the mouse

are pre-authored elements selected by the navigation instructions). Dynamic element (slots) that are filled according to the chosen route include the name of the mouse and the direction of travel. The name of the mouse depends on the chosen street and the direction of the animation is adapted to the direction of travel). The resulting story can then be presented to the user by a story engine, using standard media formats and players for output. The current prototype employs Flash to present cartoon like animations of the story content and the MobEE engine to compose stories from the pre-authored elements. MobEE is a story engine for mobile entertainment computing that support run-time presentation of content on a wide variety of mobile hardware platforms by using device-independent story structures [23]. An advantage of MobEE is the possibility to use standard tools for media creation and presentation within the system. The device-independent representation of the story structure in MobEE is implemented by hierarchical finite-state automatons that communicate by a common variable pool. This hierarchical structure is well suited to support the composition of stories from predefined elements as in our prototype. The adaptation mechanisms of MobEE was extended to implement the template filling mechanism described above. Figure 3 shows different scenes in a story generate by the current prototype for a trip from Hanover's main station to the university.

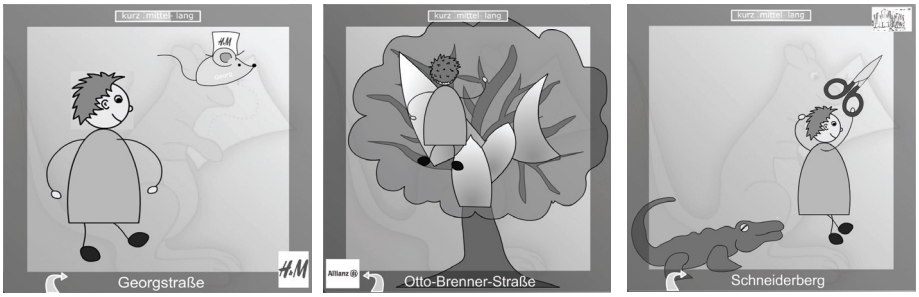

Fig. 3 : KuGeRou Prototype

3.3 Chosen Test Routes

In addition to digital map data (suitable for pedestrian routing) pre-authored story templates for each possible decision point in the test area and corresponding multimedia elements are required. We have therefore restricted our test system to the inner-city area of Hanover, extended with two longer routes, both starting at the central station and leading to the stadium and the university, respectively. Most story templates were realized for the non-coherent story type. A smaller sample was also realized for the coherent detective story type. All presentations are realized in an abstracted cartoon style. In the current test routes each story segment starts with a short audio commentary that provides an overview of the coming events. Then the story segment itself is related, consisting of the introduction, interaction, and disappearance of a main actor. Figure 3 shows exemplary story segments for the test

route shown in Fig. 4. After the story is completed a summary is presented in which all scenes are first presented in a table with the main geographical information and story elements that is followed by visualization in which the geographical context of story elements and landmarks is repeated.

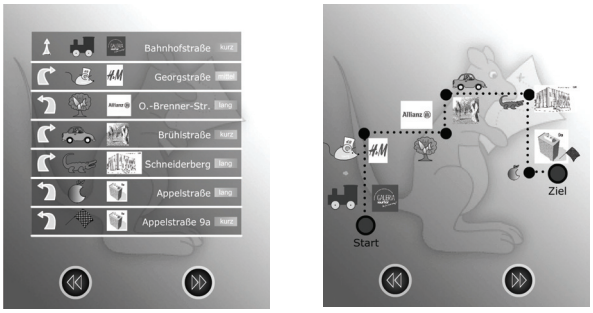

Fig. 4: Alternative representations of the test route

3.4 Evaluation

During the iterative development of the prototype several evaluations of the approach were conducted. The main goal was to guide the development of the system. While the results also provide some insight into the usefulness of the approach it should be kept in mind that these tests were not designed to test the general hypothesis that a story can be used as a route description. To test the general hypotheses requires not only a well designed system but also a carefully designed tests approach under controlled conditions as will discussed in the following sections. The test approach was two-fold:

The primary objective in the initial development phase was to validate that story-based descriptions aid the recall of route descriptions of significant length. The secondary objective was to ensure that our story-based approach produces viable descriptions for a concrete route.

To simplify the test approach a pure recall test was used for the majority of test-users that they could complete using a PC at an arbitrary location. For this purpose a between-subject design was chosen in which test-users were provided either with the story-based route description or a description using conventional guidance instructions plus landmarks. In the test user were asked to envision that they were travelling to Hanover by train and planning to walk to a specific university building approximately three kilometres from the station. The instructions then asked the users to familiarize themselves with the route description (either story-based or conventional) during a five to ten minute period. Following this, users had to perform a task unrelated to navigation, namely to search for a train connection, to simulate some distraction from the recall task after arrival. Users were then asked to write down what they recalled from the route description. Finally, users were asked to evaluate this against the true description and asked for further feedback on different aspects of the system. The key benefit of this approach is that it allows conducting

frequent and fast evaluations with user who are unfamiliar with the real environment to guide the development process.

During the development of the initial prototype 22 participants were asked for feedback on different aspects of the system, with 8 completed overall evaluations. However, this approach does not provide a real check for the suitability of the description for navigation purposes. Therefore, a second test approach was used in which the suitability of the description was evaluated. Here both an expert critiquing approach was used in which test-users who are familiar with the area were asked to critique the route description against there real-world experiences and unfamiliar users were asked to check the use of the system in practice.

Due to the prototypical state of the "KuGeRou" system we did not yet conduct a formal experiment to verify the hypothesis that a story-based presentation improves retention of instructions and used only a limited number of participants. Thus, the results of this pretest are only informal and used to refine the system and give advices for the design of the final evaluation. Due to these limitations no statistical significant performance improvement of a story-based navigation approach can be asserted at this time, but users tend to better memorize the route if it was presented in a story-line format. Many test users reported that they enjoyed the multimedia presentation but some complained that it was at first difficult to accept an "unserious" story description as an aid to memorize a route. Most participants agreed that once they accepted this way of information representation, it was easy to memorize the route. The expert reviews confirmed that the idea of using stories to memorize route descriptions is suitable for pedestrian navigation. Test users who checked the system in practice reported that they found their way easily. Even if it was not possible to memorize the complete information tuple for a navigation point, landmarks or street names detected on the route helped to recall the complete information tuple.

4 Discussion and Future Work

From our initial experience we think that the use of stories is an interesting and potentially relevant format for guidance information. It is obvious that our initial experiments related here are only a first step in this direction, posing many new questions. The limited scope and simple structure of the required stories make this domain an interesting field for experimentation in virtual storytelling. As an example, a simplistic generator often produces absurd stories. It is however unclear if this is really problematic as it is non obvious whether users prefer simple, coherent, sense-making stories. From a mnemonic perspective absurd stories may even be preferable to some users. However, the testing of navigation instructions is subject to a number of difficulties that preclude the direct application of established test methods as they are regularly conducted in usability laboratories. The key problem is to conduct tests under controlled conditions: While outdoor tests allow to cover the complete use of a navigation systems the complex outdoor environment can not be controlled and the results depend on prior location knowledge as well as navigation and spatial orientation skills of the participants. In addition to the problems of repeatability and control it is also difficult to capture all relevant test data in a mobile outdoor use

situation. Indoor laboratory tests, on the other hand, allow repeatable tests under controlled conditions and more complete recording of tests data, but fail to cover the important aspects of unequivocal recognition of decision points and the enactment of the instructions.

The initial results seem to warrant further investigation of the "KuGeRou" concept of navigational storytelling. Obviously, the development of stories for navigation purposes is still in very early stages. Based on our experiences with the initial prototype several research directions seem worth pursuing , including:

The systematic examination of the design space of story designs (and the corresponding implications on story generation) for navigation systems. This includes an extension of the possible environment for navigation from cities to a wide variety of possible environments.

The creation and implementation of different story types. The extension of the system to larger areas and more diverse content will probably require a more sophisticated story generation and management system. Existing storytelling systems should be evaluated to judge their suitability for this application context.

The integration of route planning into the mobile system as well as dedicated authoring tools to create scene descriptions and possibly new story templates must be considered to make the inclusion of larger areas possible as a prerequisite for realistic use.

The extension of system scope will then enable relevant user tests under more realistic conditions and the comparison against conventional baseline systems.

Since the evaluation of different types of navigation instruction is hindered by a number of aspects that are difficult to control, including spatial knowledge of test users and the impact of outdoor situations we are also interested in the use of virtual environments for such test. In particular we aim to examine the use of virtual environments based on digital 3D city models for the tests. The use of virtual environments allows to repeatedly generate environments with prescribed features (e.g. cityscapes of a certain type and complexity) that are unknown to test users, to test navigation in specific situations and for the complete use cycle from instruction recognition to enactment, and to automatically record large portions of the desired test data. A central aspect of the work will be to establish the relevant characteristics of the virtual test environments and to validate them against real outdoor test data.

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