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Abstract

Automatic story generation is the subject of a growing research effort. However, in this domain, stories are generally produced from fictional data. In this paper, we present a task model used for automatic story generation from real data focusing on the narrative planning. The aim is to generate récits (stories) from sensors data acquired during a ski sortie. The model and some preliminary analysis are presented which suggest the interest of the approach.

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1 Introduction

Stories are pervasive in everyday life and humans have developed cognitive abilities which are tuned to the production and comprehension of stories. Philosophers, linguists and communication scientists have recognised since the Antiquity the fundamental role of story as primary human communication means [4, 21, 5, 16, 13, 11, 15]. The advantage of story over other communicative modes lies in the availability of various means at the structural and linguistic level to convey temporal and causal information, to allow perspective-taking and framing of events, and to emphasise the most relevant information. It is therefore unsurprising that written and oral stories are the main form in which collections of events are conveyed by humans, whether the intention is to report, explain, illustrate opinions or transmit knowledge. According to the Narrative Paradigm [11], stories are widely used even in technical communication (e.g., medical case histories, reports of engineering faults, forensics) and are central in social interaction to establish and strengthen social groups. Stories are also the discursive basis on which our identity is fleshed out.

Computerised story generation, modelling and analysis has already been the subject of research in Computing Science and has recently emerged as being part of what it is called Computational Narratology [17]. Contrasting with this field of research, our aim is to make story generation from real non-linguistic data possible. Our goal is more precisely to record daily life events from sensors capturing people's location, physiological state or activity and to process this data in order to generate stories of daily activities. The widespread development of lifelogging systems, the dissemination of mobile devices such as smartphones able to sense their environment open the door to these new applications. However, to the best of our knowledge, this has been an under-developed area.

The amount of applications that story-generation from real data could support is very large : social interaction for people with disabilities; education; cultural heritage; publishing news or stories for local communities; or helping patients understand complex medical data

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about themselves. For instance, robots with enhanced communication capabilities for people lacking social interactions will also benefit from a technology that seeks to simulate basic human communicative abilities [27].

In this paper, we focus on the narrative planning which, in narrative generation system, is in charge of defining the overall structure of the story. The hypothesis is that a narrative plan of a story generated from real world can be abstracted by a task model that can be used to ensure consistency in the planning process. In the creativity domain, narrative planning has often be approached by automated planners which find the possibles sets of actions that change an initial state (beginning of the story) to a final desired state (end of the story) [18, 30] with more of less constraints on characters, objects, etc. [29, 25], or interaction with the users [7, 23]. Another emerging field of research is concerned with automatic learning of narrative structure from annotated corpus such as StoryBank [10] or NarrativeML [17]. Nevertheless, they are based on models build from the fictional literature which are not adapted to the narrative generation from real world data where, for instance, characters or goal does not fit into predefined or stereotyped categories. Some systems, such as Tag2Blog [19] or BabyTalk [20], aim at generating reports of events from real data. However, the produced texts are still far from a story [24]. Our approach based on task model would help to deal with real data that are uncertain and incomplete in order to obtain story-like texts or at least close to a story.

The main application domain of the project is pervasive computing domain, exemplified by smart phones equipped with several different types of sensors, to generate everyday life stories that we call *récits*. More precisely we focus on the ski touring domain which is introduced in Section 2. Section 3 provides some formal definitions regarding the notion of récit and how it is formalized in the proposed approach. Section 4 provides a focus on task-based narrative planning and gives a presentation of the methods and tools involved in this specific step. Early experiments with annotations and an evaluation about them regarding the task-based narrative planning are reported Section 5. The paper finishes with a short discussion on related work and issues to address in further work.

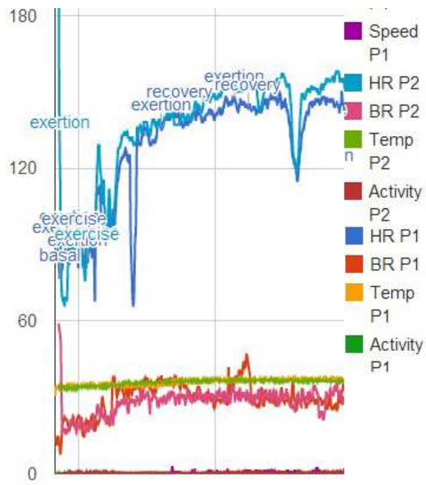
2 Generating stories of ski sorties: main issues

In this paper, we focus on the ski touring. In this sport, skiers go either alone or in team, following a predefined route, to climb in the snow, often in difficult weather conditions. After their sortie, skiers regularly use online portals to share their experiences with their peers in the form of stories (e.g., www.skitour.fr). These stories are intended to help other skiers to organise their sorties and to alert on potential security issues. They combine environmental data (weather, snow conditions, slope. . .), temporal data and social or evaluative elements. Events, such as route changes, avalanches or accidents are often reported. These stories are framed to give more emphasis on recreational, environmental or emotional aspects, depending on the profile of the writer and also on the experience that has been lived. Hence, this domains is particularly well-suited to récit generation in that it provides a large collection of human stories about their experience, while making raw data collection possible using smart phones which are equipped for the purpose. Figure 1a provides a narrative from the ski touring domain. Physiological and actimetric data were specifically collected for this sortie using two devices (smart phone and physiological sensors). These data involve time, location, altitude, heart and breath rate, etc. An exemple of the collected data is provided in Figure 1b. For details about the data processing the reader is refereed to [20, 31].

Various processing steps are needed to cross the abstraction levels from raw data to full récit generation, as may be seen in Figure 2. We distinguish between (i) the physical world, which is captured through sensors; (ii) the abstracted world, which is an interpretation of the observations captured; (iii) the story world, which is 'one' way of making sense of a subset

10.00, rotten weather, we went to Chamechaude, a usual destination in case of bad weather. In order to add some more climbing, we start 100 m below the Col de Porte, down the lift. The weather is not beautiful, objectively not very cold but we slippers under a fine rain that freezes a bit. We climb quickly and we warm up quickly. Above the rain stopped and I even have the feeling it was too hot in the humid atmosphere! We took only a few breaks, and I do not remember having eat or drink. The snow is pleasant and the track easy to follow up to half of the meadow, then it gets too stiff to our taste and we retrace the end in a thicker snow before attacking the final meters. [Translated from French]

(a)



(b)

Figure 1 Example narrative from the ski touring domain and the corresponding raw data captured along a ski touring activity (two persons involved P1 and P2)

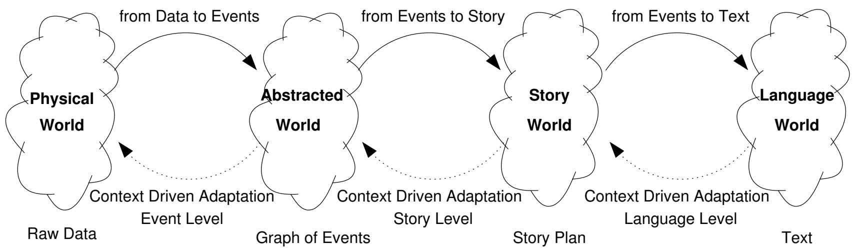


Figure 2 Representation layers for story generation

of the interpretations by choosing, ordering and relating them to each other; and (iv) the natural language world, which is 'one' way of expressing the story world discursively (i.e., the narrative).

Each of these steps raises difficult issues, involving signal processing, data interpretation, event graph construction, story planing and Natural Language Generation (NLG). Viewed from a bottom-up perspective, the processing of raw data involves recognition, inference and/or abstraction. Viewed from the opposite perspective, top-level representations provides framing constraints that gives context to drive the interpretation process, e.g. directing attention to some relevant aspects. This process must be seen as dynamic: the framing evolves as different phases of the story unfold. For instance, elements that are necessary for the introduction can be rendered in a factual manner while more emphasis can be put on external conditions or emotional/personal information, depending on the events occurring in the course of the sortie. For instance, in the example in Figure 1, the fact that few short resting periods are observed during a sortie, might be used as a frame to drive story generation.

In the rest of the paper we focus on core issues of the story planning: what is the structure of a ski touring récit? What are the elements that are relevant to a récit? How to ensure coherence in a récit? This calls for proper models that will provide the skeleton on which the overall process will draw. These elements are described in more details in the following sections.

3 Defining récit

Narrative defines a large amount of different literary forms and artefacts as well as events collections (e.g., narrative in the Event Calculus definition). In this approach, we consider the Mieke Bal's[2] definitions:

> "A *narrative* text is a text in which an agent relates ('tells') a story in a particular medium, [..]. A *story* is a fabula that is presented in a certain manner. A *fabula* is a series of logically and chronologically related events that are caused or experienced by actors. *Actors* are agents that perform actions. [..] To act is defined here as to cause or to experience an *event*."

In our approach, the fabula is the set of connected events that are either directly observed by sensors (i.e., the abstracted world). We call this set the *graph of events* where nodes are particular instance of events and edges are relationships between events. From this graph of events, *scene*s of interest are identified as the atomic components of a *récit plan*.

For Brémond, a récit is a discourse about a succession of events in the same unit of action relevant for humans [5]. Genette suggested that 'récit' indicates the content of the narrative and that 'narrative' is the statements used for communicating the story [14]. The Barthes' definition of récit implies a sequence of events and actions linked by causality [4]. In [1], Adam provides the characteristics of a récit, whether fictional or real with respect to the other kinds of stories. The following definitions are in line with the Adam's perspective.

▶ **Definition 1** (Récit)**.** A real-life *récit* is seen as a sequence of activities with unity of theme and action focused on communicating the actors' experience. It is a succession of events related to facts that have been effectively experienced, observed or captured. In the ski tour context, example events are the tracks actors followed, which dangers were encountered, who was met along their way, etc.

▶ **Definition 2** (Récit Plan)**.** A *récit plan* is a set of selected scenes from the fabula that are ordered and logically related to each other so as to ensure temporal and causal coherence. In ski tour récits, the beginning and end are always identified as the starting point and the ending point of the sortie. Scenes are selected to produce a particular inflection of the fabula.

In this paper, coherence and ordering is ensured by using an *a priori* model based on a task model (cf. Section 4.2). All input data should percolate up to the story through different layers of abstraction, filtering and aggregation constrained by the task model. The planning process should thus be driven by data and knowledge at the same time. One important feature in the récit is the temporal aspect. There is a distinction between the story time and discourse time [9]. Here, the récit presents details and context of scenes in the story time.

▶ **Definition 3** (Scene)**.** A *scene* is the basic temporal unit of récit plan. It belongs to a predefined set of classes of a ski sortie (climbing, resting, observing the environment, etc.) and present a unity of trajectory or location, of activity and of actors.

4 Task-based Récit Planning

In the creativity domain, narrative planning problem is often defined as finding the sequence of character's actions that transforms an initial world state into a world state in which goal propositions hold [25]. However, in the real world, the problem is, given raw data, to extract the scenes that might be connected that can explain the transformation from an initial state to a final state. Important challenges are to be addressed to be able to perform such as planning, such as dealing with the uncertainty and incompleteness in the data. Indeed, while in fictional story, the world is completely defined (e.g., in the phrase "the king's death causes grief to the queen", the consequence of death to cause grief is explicit and thus can be used as the reason for the queen's sorrow) it is incompletely known in real data (e.g., the reason why 'the group had a break' may not be extractable from the data). This incompleteness in the data impacts many other functions of the story generation, such as perspective taking as what a character knows might be unknown.

To account for this uncertainty, the récit planning does not uses crisp logical planning but a task modelling that mostly bases its reasoning on time constraints and preconditions rather than a chain of state transforms in a closed world. The task model does not only ensure consistency of the sequence of scenes but also tolerates a certain amount of incompleteness in the data. This model is particularly well suited to the fields in which the events are relatively constrained (e.g., ski tour, tourism visit, intensive care operations). Other approaches have recognized the power of task modelling for interactive storytelling [7]. The proposed approach for the generation of récit plan relies on two models:

- Domain model: based on an ontology of the domain knowledge, this defines the atomic components of the fabula emerging from the data.
- Récit model: based on a task model which describes actions, schedule, links between tasks and actors

The instances of the ontology and récit are extracted from the actual data according to the model. Thus, a récit plan generated from these data which populate the ontology will be conform to the the task model schedule (here a ski sortie). The two following subsections give more details about these models.

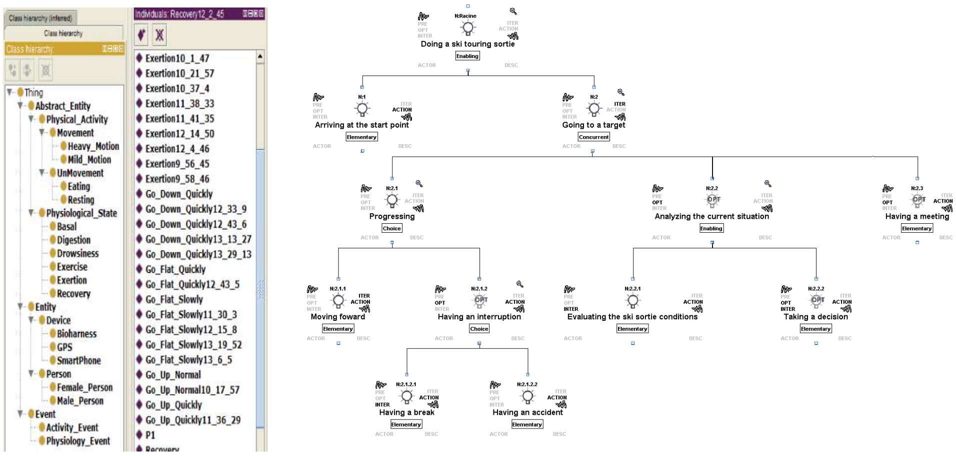
4.1 Ontology

In order to support definition, reasoning and to ensure uniqueness of semantic meaning of the information handled by the different processing step, the domain knowledge was represented by an OWL (Web Ontology Language) ontology. This ontology is expressed in Descriptive Logic (DL) a formal knowledge representation language. In DL, the knowledge is distinguished between the TBox (Terminological Box) and the ABox (Assertional Box). The TBox contains the definition of the concept hierarchies while the ABox contains definitions of the individuals (relations between individuals and concepts). Figure 3a shows an excerpt of the ontology TBox and ABox. The taxonomy is divided into abstract and physical entity as well as event. All events involve at least one entity. For instance physiological events relate one actor with a physiological state at a certain time.

4.2 Task Modelling

Task models have been used for decades in the Human Computer Interaction field (HCI) to express user's activities. It describes how a user acts with interactive systems by hierarchically composing the activities by goals and sub-goals. Thus, a task model describes human activity by composition of actions (i.e., tasks) that are linked by abstraction level and temporal relations. Several notations have been developed to express task models [3] which highlight different activity points according to the designer's preoccupations [6]. One of them is K-MADe (Kernel of Model for Activity Description environment)[1]. Figure 3 shows the task model in K-MADe currently employed to represent a ski tour récit. In this model, the activities of actors are represented in the form of task trees, from the most general (e.g., 'Doing a ski touring sortie') to the most detailed (e.g., 'Moving forward'). Each task

[1] `www.lias-lab.fr/forge/projects/kmade`



(a) (b)

Figure 3 (a) Domain Ontology in OWL (b) the task model employed to support récit planning.

is characterized by an actor (individual, group, system...) and associated with objects describing the actor's environment. These objects influence the course of the activity (e.g., snow storm ...) and can handled by the actors. Constraints between the tasks include 'Enabling' (the task on the left side must precede the task on its right), 'Concurrent' (tasks can be performed in parallel), etc. Thus, this model makes it possible to represent temporal constraints between tasks, dependencies as well as causality. In this model, each récit starts with an introduction ('Arriving at start point'). Then, each scenes consists in going from the current point to another ('Going to the target') till the starting point in a sequential order (cannot be concurrent). Each target task can then be refined into analysing the situation (e.g., checking the weather or the route, keep going or meeting other skiers).

A task is instanced only if the *conditions for execution* are valid (e.g., preconditions). Moreover a task is associated with *side effects* (e.g., postconditions such as creation or removal of objects, events being generated during the execution of the task, etc.). A succession of tasks respecting the expressed constraints and objects values, namely a *scenario*, expresses a specific execution flow of the activity. In this work, a récit plan is represented by a scenario.

The planning problem becomes to build a scenario that respects the task model or more concretely to find a path in the graph of events that respect the task model constraints. Given the incompleteness of the data, in the course of the plan building, missing scenes are identified by the task model. Once identified, the process can either generate an empty event that will be rendered as an ellipsis or discard the path if the scene is mandatory to ensure coherence.

5 Early Experiment

To validate the task model approach, data were extracted from real textual stories written by skiers. These textual stories have been annotated using a schema annotation that has been defined from studies applying the methods used to construct a task model from interviews [28] and from a study identifying the terminology in the field. The annotations are then transformed into scenarios (i.e., an instance of the task model) and checked with the reasoner of K-MADe. Inconsistencies with the model can thus be emphasized.

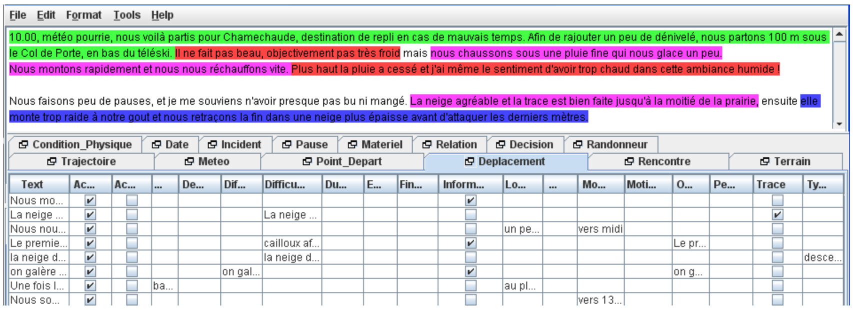


Figure 4 Example of an annotated story using Callisto.

5.1 Corpus Collection

For the experiment, we collected a few texts from the skitour website (c.f. `www.skitour.fr`). The website offers the opportunity for who practice the ski touring to share their experiences about their journey. Some skiers publish texts containing advices, recommended landscapes, difficulties or, a really important feature, the itinerary of the sortie. Many stories were written as if the author was directly interacting with the reader (recreational conversation, private jokes etc.) and are thus not conform with our definition of a ski tour récit. Thus, "conversational stories" were discarded and the selection was restricted to a few summits. Up to now, 17 texts were selected. We also collected a small parallel corpus consisting in people going for a sortie equipped with sensors (smart-phones and physiological sensors). These people then wrote the récit of their sortie so that most of their experience can be found in the raw data. This corpus will grow to become the main development corpus.

5.2 Annotation

The texts were annotated with the Callisto annotation tool. The software allows the creation of personalized tag-set which are used to annotate the selected phrases with a highlight colour. Callisto employs a Document Type Definition (DTD) to characterise each the tag-set as well as its attributes. The output format file is XML. Figure 4 shows an annotated text (in French, translation can be found in Figure 1a). Each of coloured text segments corresponds to an annotated scene. The elements attributes are put automatically in the lower half of the window in the form of a HTML form (most of them, text fields). It is possible to specify all the attributes of the scene (in the task sense) and to connect each scene to one or several actors. Actors are also annotated in the text. Up to now, 11 texts were annotated.

5.3 First analysis of the annotated texts

During the annotation, some phenomena linked to the nature of human-written text were observed. For instance, some text segments indicate several pieces of information at the same time. This was addressed by labelling several times the same segment (e.g., implicit information about the trajectory in a observation). Moreover, in some cases the narrator decided to omit some details that, however, did not impede the reading. These ellipses were mainly related to trajectory, information that will hopefully be captured by sensors. Others discarded information were references to the past or to the future. Regarding the actors, it was decided to identify the main actor (can be a group) for each récit and to indicate the actor in the scene only when the event was not experienced by the main actor ("we climbed quickly" vs. "I do not remember").

Even if emotional expressions were found in the texts (e.g. surprise, frustration . . .), the récit structure is mainly a sequential narration of the sortie phases which describe the itinerary followed as well as the environmental conditions (weather and ground characteristics). Recall that the purpose of the récit generation is to generate from sensor data, thus information hard to measure, such as skiers' opinion and emotion are not the focus of the present study. 14 tag types were used for the annotation and from the 11 récits (125 segments), 44% corresponds to a moving forward, 16 % to a terrain description, 10% breaks, 8.8% were meetings, 6.4% mention the starting point. Making a decision and the weather conditions got 5.6% each while checking the physical condition and having an accident got a 0.8% each the 1.6%. Finally, even if all the human aspects exposed were not included in the annotation scheme, we found that the annotation system and their later validation in the K-MADe simulation were capable of capture the itinerary of all the ski touring récits.

5.4 Validation plan of the Task Model

After being annotated, the annotated text was translated into récit plan, that is scenario in the K-MADe format. In this transformation, we assumed that the text order was the chronological order (actually the annotation was performed to make sure this was the case). The purpose was to know if the task model is able to cover all the executed activities in the ski touring. K-MADe has a task editor in which we can set as parameters the activities linked to a specific task and how many times it could be executed. The simulation starts with a point of departure and after that we must choose between all the activities proposed the next one. Each time an activity of a task is chosen, we fill in the attributes with the values that belongs to the activity. Once the simulation done, an XML document containing the succession of tasks chosen with their respective values is obtained. It is the récit plan. This plan is going to be evaluated in a human based experiment to assess the coherence of the final generated texts based on the annotations.

6 Discussion and Future work

The early experiments undertaken in this study suggest that task modelling imposes a flexible domain dependent récit structure and ensures coherence in the way the scenes are organised. However, there are many issues to be addressed to definitely conclude about its relevance. The first issue is related to missing information in the text. For instance some of the scenes are implicit such as in "The snow is pleasant and the track easy to follow up to half of the meadow" where the description of the snow suggests that the group had moved forward. When some scenes are missing (e.g., a decision without explanation) we intend to use ellipses (i.e., empty task in the task model). How many and what kind of ellipses can be permitted for a human reader is still an open question. Another issue is the lack of information about the temporal aspect in the annotation. Annotation scheme such as TimeML [22] could help capturing important temporal elements in the text. Our work follows a line of research similar to the one that was early developed by Mark Finlayson's StoryBank [10]. As we are not dealing with fictional stories, but rather with real world stories, generated from real world data to represent daily life activities, we were mainly concerned by a dedicated dimension of annotation that we might called "task-driven", a part of the "Plans and Goals". As discussed by him, other dimensions for annotation should be considered in further research. The specificity of Daily life récits in this respect should be studied in depth.

An important step will be the text generation. The approach will be a simple translation of the scenes and their links in order to help system evaluation by humans. However, the most interesting issues will be the study of the dependences between the récit generation layers for dealing with uncertainty in the data. For instance if a break is identified with a low confidence, the récit planning might not take it into account or might include it as justification for an other scene then the NLG part would express this uncertain using modals or other linguistic means (e.g., “the group discussed a lot may be during a break”) [12]. The evaluation of the récit planning will be a big issue in the project. Though recent attempt to approach this challenge methodologically (see for instance [26]) there is no consensus. In this study, we will introduce simulation techniques involving stories of varying complexity built at different levels of detail and abstraction. The validation will be conducted in a qualitative manner, by human “experts” and “naive” participants. These assessments will also validate narrative and linguistic choices according to the user model. Indeed a naive participant will not look at the same events and will not use the same language as an expert. Probably one of the most decisive parts is the long term is the data processing that will be put in place. We plan to perform data abstraction based on an hybrid top-down bottom-up approach based on statistical models and logical model to recognized a set of high-level scenarios in physiological data [31] as well as on statistical-relational models which were used to recognize human activities from pervasive sensors [8]. With this approach, raw data would be abstracted in a graph of events logically and probabilistically linked.

Our work is comparable to others that are focused on computational narrative structure representations, such as the Hierarchical Task Networks planning (HTN). In this work, the HTN has been applied to storytelling [7] to structure a story through the decomposition of a main task in subtasks. However, while the authors in [7] are interested by the emergence of story variants from the interaction of autonomous actors, we are rather interested by the emergence of story variants from the interaction between a planned activity, with some a priori known starting and ending point (the car park and the summit) and a set of unpredictable contextual conditions (weather or quality of the snow for example). How these contextual elements will cause variants to story generation is an open line of research to be followed.

In any of the issues mentioned above there is a need for a larger corpus. We are pursuing the data acquisition in order to record this ‘parallel’ corpus with to the best of our knowledge is currently non-existent in the community. Despite the limited outcome of this study, the findings could be beneficial for others fields. For instance, the ski touring domain is close to domain in which a predefined route and wearable devices can be used such as in rescue operation, city travel or tourism.

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