MOBILE CONTEXT-AWARE STORIES

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ABSTRACT

An interactive narrative is a story that is shaped by digital technology and that allows the dynamic presentation of scenes or sequences based on input from the user. In this paper we present a new foundation for interactive story-telling that allows a mobile user to interact with a story. The user is placed at the center of the story and the story comes to the user in transit. The behavior and actions of the user influence the scenes and sequences of the story the user experiences. The framework for this system is an ad-hoc network. Ad-hoc networks allow localized presentation of story elements to users who are in transit and able to receive story elements on a mobile device. Furthermore ad-hoc networks have the capability to be context-aware and respond to the physical and social context of the user both on an individual and group level. This mobile context-aware story form is a powerful format in the fields of education and entertainmen.t It allows the story to be connected with the surrounding environment and it allows the user to see cause and effect of individual and group behavior. In this paper we present an ad-hoc network story system and examine a case study of its use for a prototype mobile context-aware story.

1. INTRODUCTION

Story is one of the oldest forms of human communication. As authors and receivers, good stories allow us to make sense of our own life experience through the experience of real or fictional characters and circumstance. Story form has evolved over centuries to match the available technologies for delivery [1] and over the last 20 years, pioneers of the digital arts have explored the shape and form of interactive stories. Interactive stories allow the user to have an impact on how a story progresses and the outcome of the story.

Interactive stories can be based on simple mechanisms such as hypertext [2]. More complex structures consisting of sensor base systems that map the actions and of the user and other inputs to the progression of the story have also been designed. Media Actors, Characters in Search of an Author [3] presents a taxonomy of computational approaches to the interactive experience. We are interested in further evolving interactive narratives and creating what we call mobile context-aware stories.

A mobile context-aware narrative consists of discrete video, image, text and/or audio elements that can be delivered in variable sequences to a mobile user whenever and wherever the user chooses to engage with the story and in accordance with the behavior of the user. Mobile context-aware stories provide a new story form that places the user in the center of the story and brings the story alive around the user. They can make the story specifically relevant to the user. They can link a story with the surrounding environment in an educational or informative manner. They allow a user to interact with the story in a natural way (e.g. by simply walking in a particular direction and following a specific physical path that corresponds to a virtual story path) and in a way that is far more dynamic than clicking the next choice. They allow a user to see the impact or implications of their actions and choices on the emerging story.

A mobile context-aware narrative that truly advances the field of interactive narrative therefore needs a wireless communication system that can deal with the random mobility of the users, that can be context-aware sensitive, and that can respond to both individual and collective behavior. It has emerged through our research in the area that ad-hoc networks provide the ideal solution to these demands. An ad-hoc network is a collection of wireless mobile nodes that will dynamically form a temporary network without the use of any existing network infrastructure. Ad-hoc networks replace the centralized hierarchical administration structure of contemporary networks with a distributed approach to routing management that allows each network to grow, reduce in size or fragment in real-time without referencing any central authority [4].

We propose that an ad-hoc network, consisting of fixed multimedia nodes embedded in the environment and mobile nodes associated with users, is an ideal infrastructure for facilitating the mobile context-aware story. In such a system the mobile users can receive the discrete segments of story on mobile devices or trigger the fixed nodes into revealing the next story scene as they move through the relevant space and come into contact with the fixed nodes. Section 2 explains how the self-

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creating, self-organising and self-administering capabilities of ad-hoc networks are ideal for providing the mobility and interaction needed for these stories. Section 2 also demonstrates how ad-hoc networks have the ability to be context-aware in terms of the individual as well as the group and thereby facilitate the type of complex interaction not previously possible in the interactive story world. In section 3 the technical details of an ad-hoc based context-aware story system is presented and analyzed. Section 4 gives details of a story case study and section 5 concludes.

2. AD-HOC NETWORKS

The ad-hoc network is an ideal platform for mobile context-aware story delivery. There are four main reasons why ad-hoc networks have a significant role to play in interactive narratives.

2.1 Low-cost Distributed Infrastructure

Firstly, from a practical point of view, the ad-hoc network provides a low cost distributed network infrastructure for placement and retrieval of the story elements. The ad-hoc network does not require the construction of base stations and extra infrastructure. Nodes can be low powered if so desired and the distances over which uses can interact with the fixed nodes and other moving nodes can be small.

2.2 Ability to react to an Individual or Collective Presence

Secondly an ad-hoc network can leverage the random and chaotic behavior of the people in the space to allow individual and group behavior to have an impact on the story.

In terms of interacting on an individual level, as a mobile user comes into contact with the fixed node a simple network is formed and the story segment can easily be triggered into action or transmitted to the user. The network between the story-provider nodes and the mobile user exists when needed and disappears when no longer necessary.

In terms of group interaction an ad-hoc network can be formed with a group of mobile nodes. When a network is formed consisting of a group of mobile nodes and a stationary story-provider node, the story element can react to the some function of the group. A simple example is the case where the story segment revealed at a multimedia node depends on the number of mobile nodes in the area. For example the viewers could experience a tranquil scene when very few other mobile nodes exist or a far more upbeat scene when many people are in the vicinity.

A more complex example of group behavior naturally mapping to a story element is the case of two islands of nodes that are out of radio range of each other. The islands only become connected if adequate numbers of ad-hoc mobile nodes move into the space between them and allow transfer of information from one island to the other. The group behavior of the users can therefore be mapped to an outcome of the story. For example it in Figure 1 when a path exists between two islands, a character from the red island can move to the green island. The group behavior can also be used to demonstrate health principles. For example the behavior of the group can be mapped to the spread of an epidemic to emphasize how individual or collective behavior has health implications. In this case the epidemic would spread from island 1 to island 2 under certain group behavior conditions.

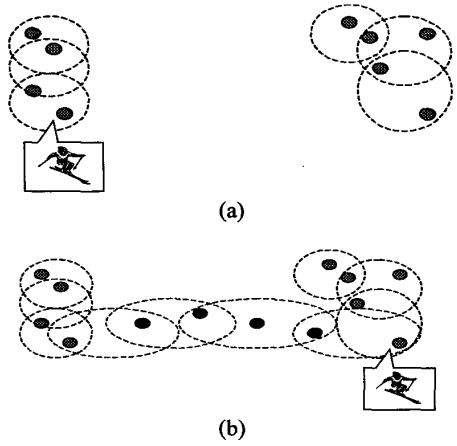

Figure 1(a): No connection between islands. 1(b): Islands connected via ad-hoc nodes appearing in the space – Character has Moved to Green Area

2.3 Context-Aware Features

The third main reason that ad-hoc networks are suited to this new story form is that can very easily be made context-aware both by using external information or by manipulating the inherent characteristics of the network.

In terms of gathering external information, as is well known ad-hoc networks are very suited to applications involving distributed sensors. Sensors can be an essential part of context-aware systems as the output of a sensor can be used to influence the story element. For example a set of distributed moisture sensors (associated with mobile users) could determine real weather conditions and this information could be used to influence the progression of the story. It can be viewed as *inverse pathetic fallacy* where the mood of the characters in the story reflects the weather elements rather than the weather reflects the mood of the characters.

Ad-hoc networks also have the capabilities of being context-aware in an inherent manner and do not have to only depend on external inputs to gather the contextual information. The routing protocols of the ad-hoc network can actually reveal a large amount about the dynamics of the users of the network. The manner in which the ad-hoc network routing protocol deals with sending messages from node to node reflects the way the nodes (i.e. the people) are behaving and therefore any observation of the flow of messages around the network tells the 'story' of the people moving in the space who are using the network. Information such as number of nodes visible to a given node, number of possible routes (list of nodes between a source and destination) to a given destination, length of routes, speed at which routes are being changed, details of which routes are being used, details of routes that have no traffic, general details of traffic on the network etc can be used to make the node context-aware of the behavior of the users. Thus inbuilt in an ad-hoc network by virtue of the fact an ad-hoc routing protocol must exist is a means of getting information about the context of the users of the network.

2.4 Communication Features

Finally the ad-hoc network can facilitate communication between users themselves and allow subsets of viewers to exchange stories with each other and propagate the story to further fields.

3. THE WIRELESS AD-HOC PLATFORM

To illustrate the power of ad-hoc networking for enabling mobile context-aware stories, an ad-hoc story system was created and a story was designed for test on that system

The ad-hoc networking infrastructure used was designed and part of a large research project on 4th Generation Communication Systems [5], [6]. The core of the system consists of a 'generic layer' interface that allows the dynamic assembly of a network communication stack consisting of the relevant hardware and software elements. Components of the communication system environment are implemented as standalone *layers* each realized by a single *thread*. The inter-layer interface is very simple, consisting of primitives to send information upwards or downwards through the stack and to attach a list of *name/value* pairs to each request that can be used by any layer through which the data passes. This modular system is used to create an ad-hoc network communication stack that typically consists of an application layer, an ad-hoc routing protocol layer and a physical layer to communicate with whatever wireless hardware is chosen. With this system we have ad-hoc networks that run over 802.11, IrDA and proprietary UHF radios. Figure 2(a) shows a sample stack configuration for the proprietary radio case. The application layer in Figure 2(a) is responsible for presenting the story segments associated with the node. The ad-hoc routing is facilitated by a Dynamic Source Routing (DSR) [7] layer. A wide range of other ad-hoc routing protocols can be substituted for DSR in the stack if so desired. The media access layer (MAC) is necessary for correct wireless communication. Relevant information (such as the presence of a user or multiple users or the arrival of a 'character') is received by the radio and fed up the stack to the application layer to trigger the story segment.

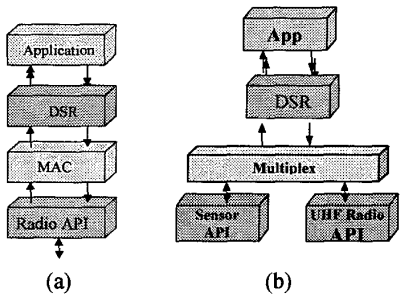

Figure 2: Generic Communication Stack

In terms of facilitating the gathering of contextual information, the communication stack can also interact with a wide range of sensors (such as proximity sensors, touch sensors, temperature sensors, light sensors, moisture sensors etc.) To facilitate input from multiple sensors and radio communication the generic layer structure can be configured to take inputs from more than one communication device. Any number of sensors, can be connected to the node by inserting a multiplexing layer above the selection of sensor and radio APIs. Figure 2(b) shows an example of this. In this case the story element can be trigger by a combination of input from the radio and the sensor. For example the presence of a user and the daytime temperature could determine what story sequence is presented to the user.

As described in section 2.3 the ad-hoc network has an inherent means of being context-aware by using information from the routing layer to deduce patterns of behavior of the users. The ad-hoc network story system described here has exploited this feature of the ad-hoc network. As mentioned above the generic stack system allows a list of name/value pairs to be attached to each request that passes up and down the stack that is accessible to all layers. This mechanism facilitates the gathering of the information required to make some contextual deductions. For example the routing layer can pass information on the number of nodes in the vicinity and the

rate at which routes are changing to the application layer. This information can be used to determine the group activity (movement) of the nodes in the vicinity. In other words, information that is used by layers, such as the routing layer, can be used to make contextual deductions from anything from number of nodes to how sociable a node is (i.e. whether it is in communication with others or not).

The implementation described here runs on any Windows platform including WinCE.

4. SAMPLE STORY IMPLEMENTATION

The prototype story is a historic story based on a group of people who worked in a beer hop store and is called HOPSTORY[1]. It focuses on the events of one particular day in their lives. The ad-hoc network in this case consists of fixed story-provider nodes embedded in the building at locations where the events of the day took place and the mobile viewers of the story. As users move through the building elements of the story (audio, video etc) come to them based on contextual information. For example if the viewer arrives at a story-provider node at a particular time then the viewer will see what happened at that time on the day in question. The physical presence near one of the fixed nodes triggers the story segment of interest. The viewer collects the story segment of a personal device. The collected story has been designed to make sense no matter what order the story-provider nodes are visited.

Some of the mobile nodes are characters in the story that can move to and from the fixed nodes once a path exists to do so and thus influence the story element on that node. This means that the collective behavior of the viewers in the building also has an influence on the story. If there are not enough mobile users then the 'mobile characters' cannot reach the fixed story nodes and influence the story.

The building also contains a 'playback area' that allows individual users to playback the stories they captured for other users to view.

6. CONCLUSIONS

The story described in section 4 was designed to give a sense of the history of an old building and a sense of fun to a group of visitors. It marks the beginning of a new story form that is mobile, context-aware and sensitive to group dynamics. The playback area was very successful and had the effect of creating dialogue between different viewers, who did not know each other, as the watched each others collected stories. It also had the effect of encouraging viewers to revisit the story nodes multiple times to collect new experiences.

At the core of the system is an ad-hoc network. The ad-hoc network provides a distributed infrastructure that can be context-aware sensitive and that is ideal for adapting to the natural creating and recreating of small and large networks as viewers move through the space and hence influence the evolving the story. The users can be more or less aware of their effect individually and collectively on the outcome.

This story form has huge potential for making a story real, for exploiting cause and effect in a learning environment, for emphasizing the implication of actions taken alone or with others and for providing an alternative entertainment experience. While the emphasis of this paper has been in the artistic domain it is clear that a context-aware ad-hoc network has much to offer in more mundane and practical fields in terms of bringing individuals information when they want it and where they want it or in the world of distributed games.

In the world of mobile communications mobile context-aware stories based on ad-hoc networks provide a great opportunity for further advancing interactive multimedia applications.

6. REFERENCES

[1] J. Murray, *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*, MIT Press, Cambridge MA, 1997.

[2] G. Landow, *HyperText 2.0: The Convergence of Contemporary Critical Theory and Technology*, The Johns Hopkins University Press, Baltimore, 1997.

[3] F. Sparacino, G. Davenport, A. Pentland , "Media Actors, Characters in Search of an Author," IEEE Multimedia Systems '99, International Conference on Multimedia Computing and Systems (IEEE ICMCS'99), Centro Affari, Firenze, Italy, June 1999.

[4] Perkins, C., Ad hoc Networks, Addison Wesley, Upper Saddlewood, NJ, 2001

[5] D. O' Mahony, D. & L. Doyle, An Adaptable Node Architecture for Future Wireless Networks, in Mobile Computing: Implementing Pervasive Information and Communication Technologies, Kluwer series in Interfaces in OR/CS, Kluwer Publishing, August 2001

[6] T.Forde, L.E. Doyle, D. O'Mahony, "An Evaluation System for Wireless Ad-Hoc Network Protocols", Irish Signals & Systems Conference, UCD, pp A-B, June 2000.

[7] D.B. Johnson and D.A. Maltz, Dynamic Source Routing in Ad Hoc Wireless Networks, in Mobile Computing, Chapter 5, pp153-181, Kluwer Publishing, 1996

1. Thanks to Valentina Nisi and Alison Woods for their work on designing Hopstory