Enhancing Tabletop Games with Relative Positioning Technology

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Abstract. Research in pervasive and ubiquitous computing has produced especially small and powerful technologies. In this paper we motivate the application of these new technologies in tabletop games that do not rely on special game boards, but are mainly played on custom made miniature landscapes created by the players. We propose the RELATE [1] platform for augmenting miniatures normally used as game pieces in these tabletop games. Thereby the RELATE platform augments tabletop miniatures with relative positioning, communication and computing power. We discuss how the gaming experience can benefit form this technology.

1 Introduction

Ubiquitous and pervasive computing technologies are perfectly suited to enhance gaming experience especially of hands-on tabletop games. These technologies are designed to unobtrusively fit into everyday objects and therefore build the perfect basis for augmenting classical tabletop games. By now, the first augmentation platforms for board games like STARS [2] are available. Even electronically augmented board games like "King Arthur" published by Ravensburger [3] are on the market since last year. We can basically distinguish between two methods of augmenting board games with computing technology. The first is to embed the technology into the board or use surrounding and supporting infrastructure like cameras, screen and external computers. Using cameras and overlay projection introduces some disadvantages. Before playing, the highly sophisticated infrastructural technology needs installation and maybe even calibration. The positioning of the camera must e.g. have a stable and robust stand annoying the players during the game. Using augmented game boards instead limits the possible games as they will always depend on the boards and their embedded functionality. Augmenting games with an enhanced game board is especially unsuited for classical cosim (conflict simulation) tabletop games. The success of this game genre is based on the high degree of freedom for the players. Most of these tabletop cosim games are played on an individually designed and built landscape setting. The players take time to set up challenging gaming environments by placing different terrains like grassland, mountains, hills or rivers,

that provide tactical challenges during the game play. Most of these games are played with metal or plastic miniatures representing different characters and forces. What we propose for the future of augmented tabletop games is using pervasive and ubiquitous computing technologies to be unobtrusively embedded into the miniatures themselves. Cosim tabletop games can be easily enhanced in both ease of play and gaming experience by using technologies like the RELATE platform [1] developed at Lancaster University and TecO, University of Karlsruhe.

2 Location Systems

The area of location systems is fast growing and has already produced a lot of different location technologies in the last few years. In most cases the technology design was influenced by energy consumption considerations and physical size of the devices. Early research projects such as the Active Badge System [4] or SpotOn [5] showed that location systems can be built and work in a reliable and user friendly way. Based on ultrasound or radio frequency transmission, those systems use the triangulation theory like the GPS systems does. In most cases, the location systems consist of two architectural parts: the infrastructure and mobile devices that need to be located or even tracked. The measurements are always based on the known infrastructure. This infrastructure provides e.g. reference points of a coordinate system. The measurements are taken between mobile objects and the infrastructure and then, multiple results are combined in a location information. The computation necessary for the location estimation is either done in the mobile devices, like in GPS or in the infrastructure like in the Active Badge system. Localizing the objects by the infrastructure is in many cases an inconvenient and time consuming task. It often includes the precise placement of reference beacons, adjustment and calibration of circuitry and the need of powerful backend computing equipment. Even though location system on the market have improved the effort of installation a lot, it is still important to mention that the functionality of locating object always depends on the presence of infrastructure. All applications that are meant to profit from location technology are limited to the spaces where the necessary infrastructure is installed. There are many application in the office area such as intelligent doorplates or document tracking systems, mobile buttons, variable displays [6] that are anyway in the need of a powerful backend systems to provide floor plans, document databases, user profiles etc. The centralized design of those applications does not suffer too much from the centralized and static structure of the location system.

Applications that do not normally operate in central systems and do not depend on information data bases but work mobile and in a peer to peer manner - like the tabletop games we investigate here - have to be freed from the constraints of infrastructure and therefore be based on relative positioning.

2.1 Relative Positioning

In this context the term relative positioning describes that objects gather information on their spatial relationship without using a pre-installed infrastructure. They only depend on technology that they carry themselves. All objects participating in the system must therefore be equipped with the necessary sensors to perform the location measurements. When an object determines the spatial relation to another object, it has to rely only on this partner object without any further support. The distributed and collaborative sensing between the objects brings up issues in scaling, ad-hoc behavior, redundancy and reliability. Those have been addressed and partly been solved in the RELATE project.

2.2 RELATE

In the RELATE project we have investigated technology for relative positioning in the specific context of tangible user interfaces. Relate addresses fine-grain location technology for 2D surfaces in close-range operation. During the project, different technologies have been implemented in prototypes and have been compared. Sample applications have been built that showed the capability of spontaneous and peer-to-peer relative positioning. The technologies that evolved into ready-to-run prototype devices were infrared light (figure 1) and ultrasound (figure 2).

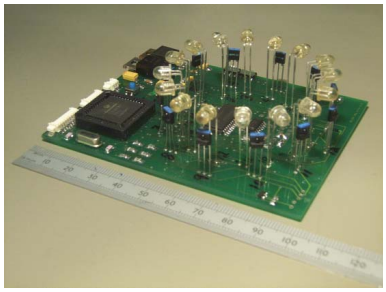

Fig. 1. Infrared light

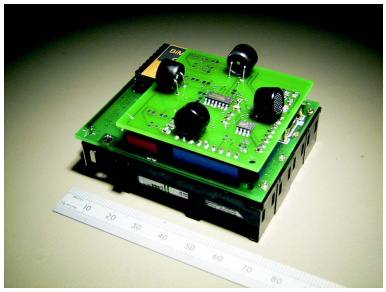

Fig. 2. Ultrasound

More than twenty objects have been built, and they have worked together in applications like location based sensor fusion. Relate objects consist of two parts: the respective sensing hardware with algorithms to produce measurements between objects as well as a Smart-Its [7] devices, covering computation and the wireless ad-hoc connection. Smart-Its carry a microprocessor with up to 5 MIPS, 150K of ROM and 4K of RAM and can be freely programmed with the desired application. RELATE objects localize each other without infrastructure or any other preparation in many environments. They can measure distances between each other with an accuracy of a few centimeters and their orientation angles

with an accuracy of at least 30 degree. This can be improved to millimeters with broadband techniques like used in other ultrasound systems, such as the broadband Active Badge [8] system. RELATE devices can achieve update rates under one second which is fast enough for most real-time applications.

3 Enhancing the Tabletop Game

RELATE technology can easily be integrated into the miniatures used in tabletop games as it is small is size and works independently of surrounding technology. The prototypes built during the RELATE project gives an idea of the functionality that is possible with today's off-the-shelf components. A goal-oriented development of specific hardware especially to be embedded in tabletop miniatures would result in an affordable, unobtrusive and nearly disappearing computer augmentation. We come to this conclusion through our many years experience with embedded technology during various research projects. The miniatures would carry small sensors and the necessary hardware equipment including batteries in their inside and user interfaces like buttons and displays or just colored LEDs would enhance them to pervasive and tangible artifacts. The actual process of gaming is in no way negatively influenced or disrupted through the pervasive technology. No special requirement for the creation of the game area are incorporated. No installations of infrastructure are necessary. The freedom of the design is not limited by the enhancement of the miniatures. Even recharging of the batteries of the miniatures could be done wirelessly by means of magnetic induction e.g. in the box of the game when stored at home and would therefore not cause any inconveniences.

The activity of the players is then completely focused on the game itself and the bothersome administrative things like measuring distance by hand are avoided. The players' concerns are reduced to placing their figures, moving them tactically and enjoying the game with the support of the pervasive computing technology.

3.1 Gain from Relative Positioning

The relative positioning capabilities enhance the table top games in various aspects. We see the improvement in convenience during the game as the major aspect. Miniatures can measure their distances and can e.g. decide whether they are in range for an attack by adversarial units. The fire arcs can rapidly be determined without the inconvenient usage of e.g. a tape measure. After pressing a button on one unit, the surrounding units could e.g. light up their red LEDs if they are in fighting distance. This is a very convenient and intuitive user interface.

RELATE technology depends on line of sight for reliable measurements. That brings an interesting feature into the usage of such technology in an imaginary battle field in the game. Miniatures that are covered by others or parts of the

environment like trees or mountains can not take advantage of reliable measurements. The line of sight is interrupted and therefore a measurement is physically not possible. That gives a vivid picture of the real world: Hidden or distant objects cannot be observed or recognized. The automatic measurement and determination of fight ranges and attack areas is combined with the knowledge of the character of the respective unit. With this, the miniatures at the same time act as an independent arbiter during the game. People playing together can rely on the impartial measurement of the objects. Arguments about millimeters during the game can be avoided through the trustworthy sensors.

3.2 Gain from Computing

With the integration of computing and communication technology into the miniatures of a game, the rules of the game played can be bailed into the gaming equipment itself. For augmenting cosim tabletop games this provides the opportunity to distribute the rules among the miniatures they apply to. That means that every unit knows its movement abilities, armor class and arming, fire arcs, weapon ranges and any other necessary property. When using RELATE technology it is even possible to reprogram the computing part of the device - a Smart-Its embedded computer - via a wireless connection. This enables a fully flexible adjustment of all game parameters, even enabling the reuse of miniatures for different tabletop game systems. By reprogramming the players can change the virtual character of their miniatures. However, the availability of computing power also permits new features that can be added to the gaming experience. Consider miniatures developing a personal character themselves. A unit would learn the skills and attributes of other miniatures met during battles and memorize their capabilities and properties. With this collected knowledge, the unit itself could support the player by e.g. indicating imminence caused by opponent units in range and alarm the player to tactically react. Additionally, if a unit is permanently learning during various games, this unit becomes more and more valuable to the player due to the helpful experience it has gathered in the past. In this way the computing power integrated in each individual miniature can enhance the gaming experience in classical tabletop games in a complete new way as well as provide the basis for totally new gaming concepts.

From our experience, using relative positioning technology seems to be a promising way to increase the pleasure of tabletop games since it can be unobtrusively embedded without negatively influencing the flow of the game. Players profit from the electronic replacement of the tape measure as it makes the gaming more convenient. The automatic supervision by the positioning system acts as an independent arbiter and avoids arguments during the game.

4 Authors

Albert Krohn has received his master degree from the University of Karlsruhe in 2003, focusing on communication theory and spectrum pooling, where he developed new concepts for simultaneously running concurrent wireless protocols. He

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