Smart Artifacts as a Key Component of Pervasive Games

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Abstract. In this paper we present how smart artifacts can become a crucial element in pervasive games. In our vision, 'magical' artifacts play two roles: first, they are very attractive game gadgets (such as magic wands), second, they are able to handle the game (implementing the main game logic). We claim that in some cases no infrastructure would be needed to play a game. Artifacts, as we present here, are carried by players (or lying somewhere in the game area) and communicating through a wireless network. The vision has been inspired by a number of ideas and ongoing projects on smart devices and middleware platforms.

1 Introduction

In recent years, *pervasive games*, i.e. computer-augmented games to be played in physical environments, have become an interest of many researchers dealing with ubiquitous/pervasive computing. Some novel ideas have been published [1] and a few initial projects have been started [2]. Pervasive games might be considered as a good 'laboratory' for where 'serious applications' might be safely tried and developed.

But researchers are not the only enthusiasts about the vision. We saw that there is a tremendous interest among potential players: the author's presentation at Polcon 2003[1] entitled *How to make a magic wand from accelerometer, microcontroller and a piece of wood* collected a number of people from various communities (RPG/LARP players, computers gamers as well as technology passionates).

What are pervasive games then? If we defined them as games satisfying the 'pervasive computing' paradigm, the definition would cover many possibilities ranging from card games [3] to sport games [4] to proximity-triggered games [2] to MUD-like games [5]. We would like to narrow the definition, focusing here at a subset of such games. To quote Gerd Kortuem, a parvasive game is "a LARP game that is augmented with computing and communications technology in a way that combines the physical and digital space together" [6]. Our vision has been influenced by two types of games: live action role-playing (LARP) games (played in 'normal' physical environments, not augmented with computers) and multi-user dungeon computer games (MUDs).

[1] The biggest fantasy/sci-fi convention in Poland

Since the terminology for pervasive games is not mature enough[2], we could suggest calling the games we describe here *ubicomp MUDs* (other possibilities could be *pervasive MUDs*, *ubicomp LARPs* or *pervasive LARPs*).

2 Getting rid of the infrastructure

We can split *ubicomp MUDs* into two groups. One group would be a LARP game played in a sensor-rich environment (e.g. a building consisting of several rooms). The system (the game main logic), located in a central server, could easily know the game state and thus control the game and determine the current game state as well as checking win/loose conditions. A proper infrastructure, e.g. access points and inter-access-point communications would allow all the artifacts to communicate. It would also provide some kind of localization. But such an approach would also have disadvantages as follows: firstly, it could be played indoors only (the environment must be appropriately prepared in advance); secondly, in some very attractive places (museums, historical places, castles) the sensor-rich environments simply could not be set up due to various restrictions. Finally, there are high costs of making the game ready - especially when it was going to be played only once or a few times.

Another group would be also a LARP game but not necessarily to be played in a 'pervasive environment' (e.g. an outdoor games being played in rural area). In such a game, players could start playing in virtually any environment in virtually any moment. The main drawback of not having an infrastructure, however, could be localization problems and communications among devices.

While discussing the games[3], we noticed that people playing a LARP game are usually grouped in one on more communities (communities may be competing or cooperating or changing the sides according to the game situation). Moreover, in case of MUDs, players often carry and make use of game artifacts. Most commonly, the artifacts are used to influence players (to supply the owner with some new skill, to affect other players or their artifacts, ..). So if artifacts are present on the 'game board' all the time, why not to place the game logic into the artifacts? Why not to build a new game architecture - *an artifact-based pervasive game*? Naturally, since not all devices can communicate all the time, the game logic should spread among multiple devices. Therefore, a problem of game management and synchronization arises here. One of the possible solutions would be introducing a special kind of devices: *personal artifacts* (**PAs**). They would be devices carried by every player in the game. Certainly, they will not be the 'real' artifacts. They should operate in a seamless way and be hidden from the player's eyes (for instance placed in the clothing or fastened to the players' belt).

The PA's functionality might be as follows:

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[2] There have been some approaches to classify pervasive games, e.g. Søren Aamand Jørgensen in his page http://www.mip.sdu.dk/~sorenj/index.html divides pervasive games (which he calls 'ubiquitous games') into four categories: virtual reality, augmented and mixed reality games; context-aware games; location-aware games; pervasive games. Ubicomp MUD idea covers in some extent all of them.

[3] Special thanks to my friend Stanisław Sawa with whom I had never-ending discussions about various scenarios of pervasive games

– carrying the game; checking if win/loose conditions are met
– monitoring the environment, for instance being aware of other device's presence in the proximity
– being a player's representative: holding the player's statistics (hit points/mana left, experience); holding the user current status ("player is influenced with white aura")

3 Artifacts: appearance

It is obvious that an attractive game must seem possibly natural - the player must not see any supporting devices that make the game running. The devices, such as VR/AR goggles, laptops, PDAs should be either removed from the game entirely or converted into domain devices. In conversion we mean changing their appearance to suit the game environment. For instance, if the game is situated in a fantasy world, the devices should probably look like magic sticks/wands, necklaces or be embedded into clothes: cloaks, caps, hoods, boots, etc. AR googles may be easily converted into, say, anti-matter detector but in a fantasy world such a detector might look a bit awkward - maybe changing the form into some kind of a glowing magical orb could help.

In certain game scenarios/genres some artifacts may be applied more naturally than others. For example, *space operas* look more promising than *fantasy* games. This is because it is easier to develop a new 'future hi-tech gadget' then to try to adapt electronic devices to look and behave like 'magical' ones. We do not focus here on the artifacts' appearance since they are domain-specific.

4 Artifacts: technological background

Artifacts, as presented above, are going to be pretty complicated computing devices. Choosing an appropriate technologies, developing or adapting a common platform for them would be a very important task here. Now, let us focus on specific problems.

4.1 Wireless communication

Radio-frequency communications seems to be the most suitable for the devices. Where applicable, popular standards should be employed. IEEE 802.11 in ad-hoc mode and Bluetooth look most promising. Most probably, PAa should take the responsibility of being master devices in such networks. In case of Bluetooth, a personal artifact might be a master while all the player's artifacts should be slaves. Also, in the IEEE 802.11 case the PA-centric approach should be taken. If a ZigBee standard was to be employed, a PA should be a network coordinator (full function device, FFD) while other artifacts, especially the simplest ones (rings, bracelets), might be even reduced function devices (RFDs). In such a case, some hierarchical architectures (in contrast to the flat ones) have to be employed.

We see that in some cases more than one way of communications might be implemented into a single device. For instance, due to its relatively high range, IEEE 802.11 might be used to make different PAs communicate and ZigBee to make the communication between the PA and other artifacts (which have to be cheap and simple).

We also see some scenarios where non-RF communications could be of use. IrDA, for instance, could be applied to those artifacts which would require some direction-awareness, e.g. a magic wand or some kind of magic weapon. The IR communications might also be used to 'affect' some selected artifacts (e.g., sorcerer blesses some weaponry before the battle). Naturally, the same standard (IrDA in this case) must be supported by both artifacts.

4.2 Middleware platform and programmability

Middleware platforms issues are the focus of many research activities about intelligent and autonomous devices nowadays. There are quite many platforms/architectures quite suitable for artifacts so it will not be necessary to be built one from scratch. Most of platforms usually appear in the context of home appliances, (like the Extrovert Gadget project [7] or the Semantic Gadget vision [8]) and wearable computing (the PROEM platform [9]). However, changing their domain seems not to be an impossible work .

Middleware would be most useful to handle all low-level communication issues and give the artifact application an abstract, service-based interface regardless the underlying wireless technology layer. Very probably, also a higher-layer-middleware might be helpful to supply the application programmer with top-level, abstract programming interface (scripting maybe), policy setting and semantic understanding support.

It is obvious that artifacts should be programmable. The PA application should differ from the 'ordinary' artifact application: in a infrastructure-less environment PAs will handle whole the game. They should have and open and extrovert attitude towards other devices. Special PA-PA protocols should be developed (e.g. to enable game state synchronization). For an ordinary artifact, in turn, it could be not obligatory to have all the PA's functionality implemented. Such an artifact would rather use some 'selfish' algorithms. Game-theoretical approach could be of any use ("How can I achieve the best results?"). We may think of an (adaptable?) artifact behavior policy: in some cases/configurations artifacts can be 'aggressive' (to 'attack' other artifacts quickly), in other cases maybe 'passive' or even 'social' behavior could be rather applied.

4.3 Ontology

Ontologies will allow communication and common understanding among devices that have never seen before nor even never heard of. Thus, new artifacts may be introduced to the game at any moment and be accepted by the already-playing ones. By using ontologies one can define object properties and also hierarchical service interfaces (for artifact communications). Ontology-aided design may also be helpful at the game planning stage to design whole the game universe (the artifact-related classes and the artifacts themselves). Developed ontologies might then be very easily incorporated into physical devices.

To give an overview of a simple ontology, we can say that *magic wand* belongs to the class of *wands* which are both *affectable* and *can affect*. *Affectable* means that another artifact may change the wand's properties (for a while or even constantly). Using this, a mighty sorcerer can *curse* an opponent's artifact - shortening its range or simply blocking it. 'Good' affections (such as *blessing* or *recharging*) could also be possible

using the approach. *Can affect* would mean that the artifact can influence other artifacts. With ontologies we can make use of such complex hierarchies and relationships in a simple way.

It is very likely that multiple ontologies must be developed for to support various game genres. Maybe there is a set of common, higher level concepts, which might become a 'versatile game ontology for smart artifacts'. Such an ontology should be, in turn, based on already-developed well-known service ontologies such as DAML-S [10] or DReggie [11].

5 Conclusions and Further Research

In the paper an artifact-based pervasive game has been presented. It is likely that powerful artifacts, as shown here, will become a common element of pervasive games. New advances in middleware systems and ontology-based systems supply designers and developers with powerful tools, very helpful in creating complex systems such as smart artifacts for pervasive games.

There are many issues to be further investigated here. The first and the most important one is what kind of games might be based on artifacts and which of them could attract players. The next issue is to design a number of artifacts and decide what properties they should have. A very interesting task here will be defining an ontology (or a set of ontologies for the artifacts). Another issue will be to pick the most suitable middleware platform to be small enough to be fit into a small device and also powerful enough to communicate in ad-hoc manner and be able to semantically understand other devices. Last, but not least, a most appropriate wireless technologies have to be chosen for the devices.

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6 Expectations Towards the Workshop

Everyone interested in ubiquitous computing-based entertainment knows that the Workshop on Gaming at Pervasive 2004 is not the first such an initiative, just to mention *Designing Ubiquitous Computing Games Workshop* at Ubicomp 2001 and a special issue of *Personal and Ubiquitous Communications* in 2002. One can see a 'pervasive game spirit' flying all over the world.

In the workshop I see opportunities to meet people who deal with similar things and are very enthusiastic about the vision. It will be a great exchange of experiences and ideas about pervasive games. Also, it can possibly cause some form of cooperation that could be started (or, for instance, an open-source project). This workshop can gather a 'critical mass' for such initiatives.

Hopefully, commercial companies will also be present - maybe the workshop participants can inspire them to enroll some project.

Finally, taking part in the workshop will be a great fun!

7 About the Author

The author is a PhD student at Warsaw University of Technology. He is a member of Mobile and Embedded Applications Group (http://meag.tele.pw.edu.pl), which focuses on pervasive computing applications (more specifically - we investigate systems consisting of smart nodes based on MANETs). Our research interests are middleware systems with high capacity constraints. The author's main interests are service models to be employed in such systems.

The author is experianced in analysing and developing complex IT systems (BSc thesis was an implementation VoIP H.323 terminal; in MSc thesis author focused on middleware for service creation in telecommunications, namely OSA/Parlay). The author is also very keen on developing ubicomp MUD-like games. As a former MUD player, he 'feels the taste' of such games and thinks that there are great potentials in the area.