Using AR to Enhance Exercise Experiences through Games

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ABSTRACT

Various computer technologies are coming faster and faster into our lives in many different areas. It is hard to find a part of an industry that has not been computerized at all. With this paper we will try to suggest a new approach of sporting and take it to a higher level thus contributing to the computerization in everyday life (social computing)[1]. The new idea is to make sporting as fun as possible. And something that is usually connected to fun is games. This paper suggests how to use sporting equipment, namely a treadmill, to game with, giving a complete game scenario. Also, we will suggest some interesting ideas for the future development.

INTRODUCTION

Augmented reality tries to merge electronic and computer systems into the physical world and does not attempt to change it as virtual reality[2]. The most important thing is to let one feel natural in her or his surroundings but at the same time relate it to the digital world. The main approach taken in this document is augmenting the physical object with a little taste of augmenting the user itself[3]. The future work interpretation may lead to stronger notion of user augmentation.

The main purpose of this paper is to give an approach of how augmented reality can make the boring process of exercising to a more entertaining activity converting it to a game. To do that, there are many issues to discuss and there is a possibility to take different approaches for actual implementation. To make the person doing sports feel like being a part of the game, all three augmentation styles can be chosen: augmenting the user, the exercise devise or the environment itself. All three approaches have advantages and disadvantages with respect to what actually can be done with all the inventions in electronics we have so far and how easy the desired result can be achieved.

The hardest path to take would be augmenting the environment. That would mean having a lot of video cameras looking at the person in different angles and trying to capture the movements in the real time. That would be the wrong way to do this because of several reasons. First of all, it would be too expensive to install many cameras so just one ordinary user can enjoy the game at home, it would be hard to calibrate everything in a way so that all the motions would be captured in real time and the precision is not guaranteed. The question is how much precision do we need? Basically not too much. It is supposed to be just a sporting game, these kinds of technologies are more appropriate for movie makers.

The next approach would be to augment the user. In that case, a person would have to wear electronic things from head to toes. That would start with head-mounted devices, gloves, boots, a whole body costume, a backpack with hardware and various sensors all over[4]. Sticking only to this kind of approach is not yet reasonable. A person, equipped with everything mentioned above, may lose the feeling of free movement and it may be tiring to carry everything. But it would not be clever to refuse this approach at all. All the techniques are becoming lighter and more comfortable every day. Furthermore, we will use this approach a little bit.

The final approach is to augment the physical object. This means that all the sensors and electronic parts have to be added to the equipment used, without bothering the user. This is the simplest solution so far and the cheapest of all. This approach would limit the expression of the whole, as not too many fancy solutions can be done. That part we are leaving for the future works, and concentrating on the basic idea. Let's make sporting more fun.

SURVEY: IT IN SPORTS

The main purpose of this paper is to propose an idea of actual gaming while doing sports. We will concentrate on one out of many possible solutions. Despite of the fact that there exist similar examples of fitness games, the new idea is to augment the equipment in a way that would guarantee the player full scale of movements. What it means is that player's avatar in the game would not have to run straight through some predefined route but he/she could actually decide which way to run or how fast to run. In the example that will be soon presented, the exercise equipment chosen to augment, as one could have understood already, is a treadmill. The game is all about the running but it also includes some tactics and some luck. After all, the main goal is to have fun and to do some work out.

Game implementation

This chapter explains the gaming process in detail without any equipment interaction. This part will be explained in the following chapter.

The game is meant to fit for various target groups, so it would be used by different people with different capabilities. To adjust the game to that, before the game starts, the user is allowed to choose one of the five levels of difficulty. The higher difficulty it is, the more speed would be required from the player and the routes would be more complicated. After the difficulty of the game is selected, the player is shown the route he or she will have to overpass. Routes for the player are randomly generated. The route plan can be seen in the figure 1.

Figure 1. Route for the player to run around.

The green cross in the figure shows the player where he or she will start, the blue line shows the route plan and red dots are stations along the route where player will be allowed to rest for a while. Basically the challenge for the player is to run around the route in some limited time. In this case, the player will have a chance to rest four times. The elapsed time is calculated just in between the rest stations. In the rest station the player is allowed to rest for some limited time (from 1 to 5 minutes, accordingly with the selected difficulty of the game). What is more, before every run, the player is allowed to choose a game character from the list.

Now, the actual game is where all the fun starts. The running route goes through various environments: forests, cities, swamps, etc. The surroundings are approximately of natural size with respect of the game character. And the character itself is seen from some distance of the backside. Now, when the game starts, the player is not given the whole route that he or she could peek a little at the start, instead, part of the map is given. It is up to the player to figure out the right paths. So it would be not too much confusing, a helper arrow shows the direction of the next rest point. The part of the map and the helper arrow are shown in figures 2 and 3 respectively. In the map there is a little yellow arrow so the player would exactly know where he or she is at the moment according to the map. Neither finish point, nor rest stations are placed on the map, so it would be more interesting for the player to find the right path.

Figure 2. Orientation map for runner.

Figure 3. Direction arrow for runner.

The trick here is if the player takes a wrong turn in the crossroad, sooner or later that part of the road will be blocked somehow. The runner will have to turn around, return to the crossroad and try another path. This takes time but also makes the game more interesting. The points the player scores are summed at every rest section and the finish line. The score is given accordingly how fast the player is running. But it is not the case if he or she runs terribly fast, gets terribly high score. Instead, there is given an amount of time for the player to make from one resting point to another. The time given is approximate time for a healthy person to make such a distance. While running, the given time tics down. If the player makes it until the clock reaches "00:00:00", gets the maximum amount of points for that part of the route. If it is not the case, after reaching "all zeros", the clock starts to count penalty seconds. The more seconds have passed after the player should have reached the resting point (or the finish line), the more score points are taken away. In the screen it is given "Your score: " indicating the score the player actually has and "You can get: " indicating the score the player can get after reaching one of the points, figure 4.

Figure 4. Score counting.

Apart from the scores, the player can see on the screen how much time there is left to run to the next stop, how fast he or she is running and approximately how much calories were burnt from the moment the game started, figure 5.

Figure 5. Some gaming parameters seen on the screen.

The parameter "To: " says to which stop the runner is supposed to go. There is one more thing worth mentioning about the game. Whenever the rest point is reached, cheering people will throw flowers at the runner, and if the score is not maximum, as a little punishment, the game character is showered by water. The prototype gaming window is shown in figure 6.

Figure 6. Prototype game window.

Finally, after the finish is reached, score window is opened, so the player would know, how well he or she did this time, figure 7. The score in red is the current score.

PLACE	DATE	SCORE	AVERAGE SPEED
1.	08.08.2008	6783	38,8
2.	08.08.2008	6001	30,2
3.	08.08.2008	5003	20,9
4.	08.08.2008	4987	10,2
5.	08.08.2008	3865	22,9
6.	08.08.2008	3233	19,2
7.	08.08.2008	2234	12,2
8.	08.08.2008	2222	10,2
9.	08.08.2008	1098	8,1
10.	08.08.2008	56	12,1

Figure 8. Score table of the game.

Augmented equipment

Now that we clearly understand how the game looks like, let us talk about the equipment for the game. As was mentioned before, a treadmill is taken to be augmented and it is the key tool for this game to work. A treadmill is an exercising tool for running, figure 9.

Figure 9. An example of a treadmill.

Figure 10. A treadmill with an LCD monitor

Apart from having the equipment, the game itself has to be seen somehow. This problem could be solved in various ways: it can be placed on TV screen, computer screen, projected or even the game can be played using head-worn displays (HWD)[5]. As much as it would be tempting to use the latter one, one could find it difficult to have something on the head while running. To avoid this, the proposal from us is to use an LCD monitor attached to the treadmill, as that in fact can be easily done and is comfortable to use (and does in fact exist, as can be seen in figure 10). One more thing about the monitor is that it should be either touch sensitive or it has to be connected to the shield of the treadmill. That is because some parameters have to be chosen before the game starts.

Now we have come to the part where we actually augment the treadmill with sensors to control the game. The game console itself should be attached to the shield of the treadmill. In order for the game to be fully enjoyable, many things have to be done. The key issues related to the game – treadmill interactions are shown in figure 11.

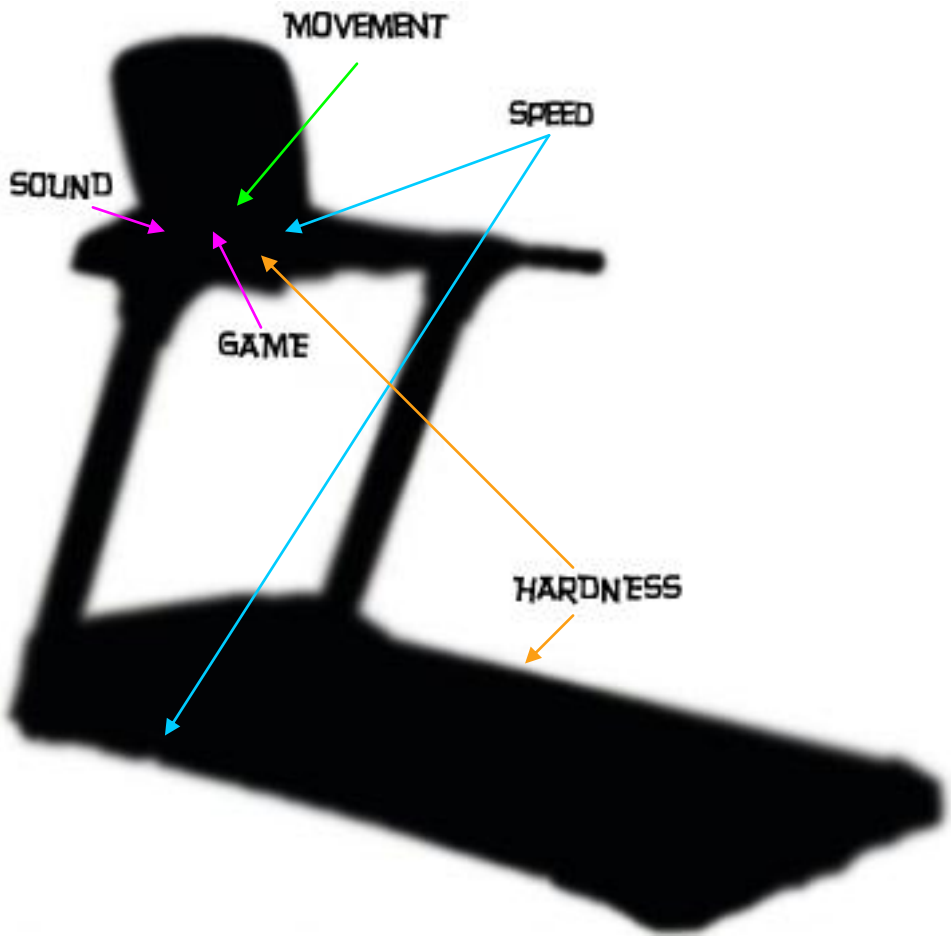

Figure 11. Key issues of the game – treadmill interactions.

The most important issue of the game is for the game character to run. And for that to happen, the player has to run. How good one is at running is usually expressed in speed. Usually sporting equipment, like treadmills or bikes, is actually measuring speed or distance. In this case speed is all we need. So this measurement has to be taken from the treadmill shield directly, or a sensor has to be attached that would do that.

If we want to make the running more real-like, we should take into account how hard or easy it is to run in actual life. In case the game character is running uphill, it has to be much harder to run then it is on a straight road. And on contrary, if the runner is running downhill, it should be easier. This can be done in two ways. Either electronically the game would give parameters of hardness to the shield of the treadmill, but in that case the treadmill itself should be supporting such service, or air-driven pistons should be attached at the bottom part of the equipment that would do that.

We are at a very important part now. The big question still lacks an answer: how to control the game character itself, the direction he/she runs? To push buttons that would force the character to turn left or right would be too distracting and would put the runner away form the real running experience. Instead, some more sensors have to be added to the treadmill. To make the character turn, it should be enough for the runner to stretch a hand in the right direction. If the stretched hand is right – turn right, if it is left – turn left. Ordinary computer games often go by the parole that the longer an arrow of the keyboard is pushed, the more the character turns. Accordingly, the longer the hand is over the shield, the more the character turns in our game. For that purpose, Radio Frequency Identifier (RFID) tags could be used. RFID tag reader should be implemented to the treadmill shield. Now RFID tags should be attached to the sporting gloves. One tag should indicate that it is “left” and the other one that it is

"right". The RFID tag reader has to distinguish which one of the tags is near and track down how long it can be sensed. As the longer it is sensed, the more game character has to turn in the game. Of course, we have to make sure that the runner can use his or hers hands normally without turning, so the amount the arm has to be lifted to turn, would have to be quite big[6].

The last thing to talk about is the sound. The game has to have the full sound arrangement: forest sounds, city sounds, cheering people etc. One of the options is game console with sound output in general or there can be implemented place where to plug ordinary headphones.

RELATED WORK

Although there are not many research papers concerning sporting and computer interaction in general, some work has been done and one can find some interesting examples.

Concerning the control of the sporting process, handheld devices are becoming popular[7]. PDAs are now mainstream technology, and users can input relevant data, have workout schedules and access email. And some other special gadgets that actually track one's physical activity where later it is analyzed and the user gets an email or notice with recommendations for the next day's activity and diet.

The role of the computer in the sporting environment is also becoming increasingly important. That gives the comfort to use computerized data collectors, which contributes to member retention, communications, and exercise planning as well as long-term focus on health related activities.

More than ten years ago a game bike was introduced. By that time it was too fancy and expensive thing to last long. The bike was mounted with a monitor in front, a pair of front mounted fans blew air at a rate in proportion to the speed a user was moving, a pair of stereo speakers projected related sounds and it had increasing resistance when moving uphill. All things used to build this game bike are common and not that expensive nowadays, and some approaches we are borrowing from this invention. But the thing is that one can feel more satisfaction while riding an actual bike in the real environment with real sounds and wind. The outdoor experience is simply transferred indoors. What our research suggests is that more actual human-computer interaction where one can make solutions and decisions makes it more fun for the users.

Another game bike, the Cateye GameBike, was introduced in 2004[8]. This was neither any big success. Our guess is that was still too expensive (about 400 $) because one had to buy the whole bike, and not just some extra equipment to put on your already existing exercising tool. Furthermore, the only functionality in the bike, was that you could use it in already existing games where speed is an issue. This makes the individual value of the bike smaller. Our proposal is to make a game that you can only play if you exercise, not an equipment that you can use if you feel like it. We also take as a starting point the exercise tools that the user already has, making this a way of using the existing tools more fun and straightforward.

One more related example, that was more successful, is suggested by NetAthlon. This is again an outdoor simulator. The program gives 3D view for running, riding and rowing. One can select different surroundings and that is all the decision-making there is. What is good about that is that one person can compete against another in LAN. Of course, it is just a tiny peak of what can actually be done. The bigger approach to this issue is discussed in future work section.

FUTURE WORK

The future approach would be to let the user use many kinds of training equipment in the game, not only one. Furthermore, exercising should not involve only big sporting tools, but smaller equipment, like boxing gloves, training mats and weights as well.

The game itself should be dynamical in a sense of one's wishes and needs. That means that one has to be able to select in advance the equipment he or she wants to use while playing, on a condition that one has the necessary equipment and it is prepared for the game. Fox example, to walk stairs in the game, you have to use a stepping machine if you have one, but if you don't, you will have to lift your legs a little bit higher. Crossing lakes will only be included in case you have a rowing machine. The person playing should be wearing special gloves and shoes. The gloves and shoes contain sensors, making it possible to track movements. The augmented sporting equipment could be seen with help of projection or optical see-through glasses[9] could be used. The arms and legs of the game character should move according to the sensors placed on player's gloves and shoes.

The sporting tools have to be equipped with sensors in a way, so that the game would "feel" which tool is chosen by a user and that the game would "feel" how properly those tools are used, in order to count the points.

Another thing worth considering is sensors on user's body and actual gym in the game. Say, as a part of the game one ends up in a game gym, where a game trainer comes and shows how exactly to lift dumbbells or make pushups. In this case, sensors on the person along with sensors on all the relevant equipment would help to estimate how well the user makes those exercises. Alternatively, this part of the game can be used independently of the other parts. The approach of doing exercises correctly can be borrowed from the idea of how head-mounted display helps basketball players to practice the correct aim[10].

Another area with great improvement possibilities is the networking part. For future versions, it should be possible for the users to compete against each other over a network. This is a way that makes computer games in general much more popular than non-networked games – take the example of World of Warcraft which immediately became a huge success when they networked it[11]. Since our suggestion is both a computer game and a kind of sport, it suggests that the computer game part of it could be popular on the internet. People could get global highscores, race each other and win prizes.

CONCLUSION

The area of exercising tools is a part of the real life that fits perfectly to the idea of being augmented. There is some functionality that can be added by a computer that one cannot have without the computer, and we allow the user to "interact with the real world in natural ways and at the same time, benefit from enhanced capabilities from the computer"[12]. This should mean that our idea of enhancing exercising equipment is good.

The theory is that this way of augmenting exercising tools could help people exercise more and thereby becoming healthier. We have not developed a prototype of the model yet, and therefore it is impossible to tell if this will actually happen. But studies show that the more fun users think that some kind of exercising is, the more they will use it. The general tip from experts is "The key to staying active is choosing activities that are fun to do"[13]. In 2000, 35% of Americans mentioned computer and video games as being one of the most fun activities they could think of.[14] The success of the game consol Wii[15] suggests that augmented exercising tools might become popular in the future, if it is possible to develop them to a reasonable cost. All these findings combined, suggests that our suggested sporting game might become a popular device in the future. The price of a Wii and a GameBike is approximately the same, so the magical border between success and failure should be somewhere about 400 dollars. The main point why Wii became so much more popular than the GameBike, was that you can do so many more things with a Wii. This is why, for future work, our game should be possible to use with a diversity of different exercising tools.

More research is needed in the area of combining the different technologies used. Want[16] showed that it was possible to combine RFID tags, RF networking, infrared beacons, and portable computing – which suggests that it would also be possible to combine RFID tags, movement sensors, and a game console. The Wii have many of these features, which suggests that it is in fact possible to create our

idea with the current technology without it being too expensive to become popular. A prototype of our system is needed though, before we can conclude that it is in fact a feasible solution of making exercise more fun.

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