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Complete Motion Control of a Serious Game Against Obesity in Children

Simon Scarle and Ian Dunwell
Serious Games Institute
Coventry University
Coventry, UK.
E-mail: s.scarle@coventry.ac.uk

Thomas Bashford-Rogers,
Elmedin Selmanovic,
Kurt Debattista and Alan Chalmers
IDL, University of Warwick
Coventry, UK.

John Powell and Wendy Robertson
University of Warwick
Coventry, UK.

***Abstract*—Childhood obesity is a major problem in most developed countries, with significant negative impacts on children's health. A suggested method for reducing obesity, especially for children, are serious games. These could promote healthy eating and increased physical activity. Ideally, they should also increase energy expenditure during play, and not be a sedentary experience. In the preliminary work described here, we produced a demonstration serious game designed to combat childhood obesity. All user interaction for the game was supplied via movement using re-appropriated Wii input devices to maximize physical activity whilst playing. We describe the problems of implementing such an interface, in particular that of over-learning.**

I. Introduction

Childhood obesity in advanced countries is an increasing problem: 17% of children in the UK [1], 16% in the US [2] and 12% in Australia [3]. Obesity can have negative effects on a child's health (e.g. diabetes, cardiovascular disease) and negative psychosocial impact such as low self esteem [4], [5], and childhood obesity often persists into adulthood with continuing health risks and socio-economic problems [6]. Indepth causes of childhood obesity are complex, but broadly relate to unhealthy eating patterns and an inactive lifestyle. The later is often linked to time spent watching television and playing video games [4]. A basic response is to reduce screen time, but children do not relinquish it easily [7]. A more subtle answer is to convert sedentary screen time into a more active form, which could be accomplished using a serious game. We discussed in prior work [8] the broad design process of a demonstration version of such a game. This could tackle childhood obesity, by presenting relevant educational content on healthy eating and exercise, whilst ensuring that all user interaction required physical movement. In our case via the standard input devices of the Wii games consoles: Wii-mote/-fit. Here we concentrate on the development process of our completely motion based control system.

II. Game design

An overall discussion of the design of our serious game entitled Tito Bico can be found in our previously work [8], here we concentrate on the motion control user interface. To conform to the idea of boosting physical activity all input was carried out through movement. The devices chosen to capture motion were the Wii-mote controller and Wii-fit balance board, as they are cheap, easily obtainable, have easily obtainable supporting software and, given their popularity, a potential user might already own them. They were used to control both the character and the graphical user interface. Although physical activity was increased it was acknowledged that this was not an exercise substitute, but a supplement. A game with all player interaction carried out via movement at the time of development was still novel. We are only aware of one entertainment game, not overtly sports or exercise based, which uses the Wii-fit in a similar way [9]. The player character was a young sorcerer, based on a pedagogical decision of non-violence. The wizard's wand being a good option for a non-violent interaction device; the swish and flick movements made by a wand maps well to a Wii-mote, making control natural and helping increase immersion. The character's vehicle was a coracle, fitting well into the lake setting and allowed us to create an interesting and novel mixed Wii-fit and Wii-mote control mechanic. The Wii-mote being used for a rowing action which propelled the coracle forward, while direction was altered by leaning left and right on the Wii-fit. This leaning mechanic to control the player, increasing physical activity, was used in subsequent mini-games, *i.e.* when the player travels between lakes down a river full of obstacles and collectable bonuses. Healthy eating messages were incorporated subtly, so not to distract from main gameplay. Either by relevant text tips on loading screens between sub-games. As it is usual for Wii games to display safety messages at this point, it was thought this would least break immersion. The second concept defined the story of the game. As a young sorcerer, the player was required to deliver food packages to the famine struck islanders of the land Tito Bico, whilst the game's villains were for nefarious reasons slipping in unhealthy food. The main sub-game variant that was developed around this concept was of the Match-3 genre made novel by being presented as a 3-D puzzle (Figure 1). The player was required to stack blocks of incoming food on an island on the lake, matching three blocks of *healthy* food delivered it to the waiting islanders whilst matching 3 blocks of *unhealthy* food throws the food into a waiting bin. At the same time the enemies were clearing boxes vice-versa; *healthy* - bin, *unhealthy* - islanders. The range of movement/control

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Fig. 1. Match-3 game

mechanisms were as follows: menu navigation by *stepping* on the Wii-fit, navigating the lake by leaning on the Wii-fit to steer and *paddling* with the Wii-mote, island sub-games with navigation around the blocks by leaning whilst selection and depositing the blocks was by swish and flick Wii-mote gestures.

III. Game Interface Design

Creating a game's user interface even for standard controllers is a highly specialized skill, leading to particular posts in the games industry such as Gameplay Programmer. The code must go beyond the naive *if button A then do action Q*, so as to give the required *feel* of the control system, leading to the production of response-force-time profiles, *e.g.* the turn rate of a character increases both with how far a joystick is pushed but also how long, with a *dead zone* where the motion is ignored. This leads to a physical mechanics metaphore, with not only a *value* under user control but also its rate of change and *acceleration*. Note this can apply not just to moving objects, but also to more abstract concepts; camera zoom, menu navigation. With a motion control device this mapping to a physical model is more literal. The coder must interpret device data the player's intentions based on a model of the required movement. The data can be surprisingly minimal, *i.e.* Wii-fit 4 pressure sensor values, Wii-mote 3 rates of acceleration of rotation. The mapping of minimal data to movement model can lead to over-learning. This is a metaphorical and occasionally used term from AI and Genetic Algorithms (GAs), where an undeserving case achieves a high rating by exploiting a flaw in the rating system. The metaphore being that "it" has learnt too much about the system. In the GA case this is equated with the population explosion of an invasive species. In motion controlled games we use the term to describe the near instinctive way that players *over-learn* the control system in order to use minimum effort. This effect has been known anecodatally for some time, *i.e.* at the EyeToy launch a Ninja Attack game was demonstrated. The demonstrators used high speed karate chops, whilst video games journalists stood very still making slight flicking gestures and scoring far higher scores. A recent study [10] has evidence of over-learning, this showed using a Wii gave slightly elevated exercise levels as compared to sedentary game play, but still far lower than actual exercise. Further the elevation decreased after the starting sessions, which can be interpreted as the children over-learning the control system. There is an unpleasant feedback between learning and over-learning. To make a game accessible and enjoyable requires the control system to be intuitive and easy to learn and so highly susceptible to over-learning. Reversely, if one more rigidly requires a particular motion, *i.e.* an exercise serious game with large or rapid movements to increase exercise levels, then the control system becomes harder to learn and impossible or at least frustrating for the first time player. We faced this problem with the lake movement paddle gesture, our first physical model required a rapid sweeping arc and correlated rate of propulsion with speed. However, this was reined in to how quickly the Wii-mote rotated as it proved near impossible for anyone other than the developer who produced the control to actually activate it without excessive practice. This is the most insidious form of over-learning: developmental over-learning, were the person implementing the control system over-learns their system and tweaks it match what they have already learnt. The result is a perfect bespoke control system only the developer can use. The standard games industry way to avoid this problem is to have regular play-tests of the game preferably by people completely outside of the development process, and so obtain feedback on the design and implementation of the control system and wider game.

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