The Evolution of Game Controllers and Control Schemes and their Effect on their games

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ABSTRACT

Video and computer games controls and controllers have gone through a large amount of change recently. The introduction of new, more immersive control technologies such as motion sensing and touchscreens into the commercial games market has and will change the design of games. This paper looks at how games have spurred on the development of controllers fitted to their needs and how some games adapt themselves to the controller technology already present.

Keywords
Games, Controllers, HCI, input, Computer Vision, Gestures, joystick, gamepad

1. INTRODUCTION

The video and computer game industry is one of the largest entertainment industries in the world. The two main sections of the games market are that of computer and video games. Computer games are games that are played on Personal Computers (PCs) whilst video games are played using a television and a games console (a cheap mass produced computer). There are typically only a few consoles every few years and games are built around a standard platform and controller.

An interesting aspect of the change in the industry is the way that games are controlled by the players. Early designs used simple mechanisms, whilst the latest consoles have state of the art motion sensing controls. Some of the most substantial changes in the control schemes of games came about during the transition from 2D to 3D games. That is the change from flat 2 dimensional games to fully 3 dimensional environments. Lately there has also been a change to more immersive control schemes.

This paper will look at the evolution of the game controller and control schemes and examine what effect the design of a controller can have on games, and also the effect that the design of a game can have on controllers.

2. BACKGROUND

Video and computer games have been around since before the start of the digital age. The distinction between the two is generally considered to be that video games require specialised hardware and plug into a television and computer games run on a regular home computer (usually a PC) with a computer monitor. They all involve a player interacting with the action on the screen through some input device, which changes depending on the platform on which the game is being played. Generally computer games use a mouse and keyboard and video games use a joystick or a joypad/gamepad, but there are other controllers. Joysticks and joypads are specialised input devices designed mostly for games and will be explained later when they are fully discussed. There are many other unique control devices that will be fully discussed and described in the course of the paper.

2.1 Related Work

There has been a limited amount of research into the area of regular games controllers, especially gamepads and joypads. The development of the game controller precedes the majority of Human-Computer interaction (HCI) research. There is some research into computer vision based interfaces such as Eisenstein and Mackay's evaluation of computer vision[10]. Other more recent developments in the area of HCI have also recieved attention. Spatial 3D Gestures (such as those found in the Wii, section 7.2) have also been studied[30] and found that gestures have the potential to be an intuitive interaction mechanism.

There has also been considerable research into the use of devices, often game controllers such as joysticks or paddles in accessibility for the disabled[29] and other uses for devices unrelated to games such as mobile phone text entry with a joystick [8]. Finally, there is research in HCI aspects that are many years away from being used in games such as using biological and physiological sensors to recieve input from the body[4].

3. EARLY CONTROLS

The very first action based computer games had no special hardware designed for them. They ran on whatever was available at the institution where they were developed (usually computers or oscilloscopes), and used digital switches or knobs attached to variable resistors for input.

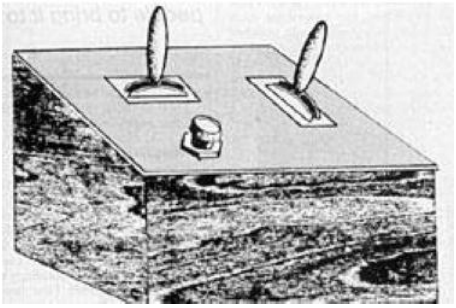

Figure 1: A sketch of the control box for *Spacewar!*. Copyright 1981 Creative Computing

3.1 Spacewar!

The first well known action based computer game was *Spacewar!* (1961) on the DEC PDP-1[11]. As were all computers of its age, the PDP-1 was designed for processing for the university or company that bought them, hence the only controls available on the PDP-1 were simple toggle switches on the front of the console. This is the first example of the controls that are available affecting the games that were developed and also of a game causing the development of a new controller. The programmers of *Spacewar!* needed to develop a game that would show off the capabilities of the PDP-1, and be action based, whilst taking into account the limitations of the system. The game involved two spaceships flying around a sun trying to shoot torpedoes at each other with the ability to use a hyperspace function to randomly move around the playing field and escape attacks (this is similar to the more popular game *Asteroids*). The controls involved 5 switches controlling left and right rotation, thrust, firing torpedoes and hyperspace. The designers found the switches to be clumsy (the system could be reset by accident) and if two players were playing one of them had an impaired view of the screen. They developed a control box [Fig. 1] to make play of the game easier. It took the 5 switches that were needed and moved them to 2 two way switches and a single button placed on box. They were connected to the main machine by a wire and were one of the first examples of a wired remote game controller.

3.2 Pong and the Paddle

Technically, the first computer game was *Tennis for Two* (1958)[1] developed by Willy Higinbotham. It was a simple game of tennis from a side-on perspective[Fig. 2] on an oscilloscope and custom made circuit board. Control was through a knob and button on a control box attached to the computer by a wire, which would later be known as a paddle. This simple device allowed one dimensional input to be provided by the user. Players rotated the knob and in the game adjusted the angle at which the ball was returned. The paddle could not be turned past a certain point either way. Pressing the button returned the ball across the net. This game was only a demonstration to make tours of Brookhaven National Laboratory (where it was developed) more interesting. This basic design, whilst constrained by the limited resources available to the developers and of limited versatility, was well designed for its use and is an example of a game causing the creation of a controller, whilst the limitations of the technology at the time were considered during the design of the game. The paddle was used as the main controller for the first video games console, the *Magnavox Odyssey*(1972), and later for Atari's Pong(1975). All these games were similar in design to Tennis for Two and there was no evolution in the control scheme with them.

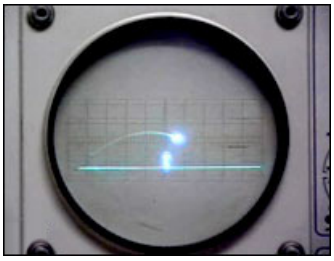

Figure 2: Tennis for two being played

3.3 Atari and the first multi-game consoles

Between the early 1970s and early 1980s dozens of games consoles were developed, and with each of these came new games, and new controllers. The Odyssey used a paddle, but it also had a light gun. The *Atari 2600* (1977) had joysticks[Fig. 3] and driving controllers, the *Atari 5200* (1982) added mice, trackballs, and keyboards whilst the *Atari 7800* (1986) added gamepads. The controller best associated with the Atari consoles was the joystick and was included with all versions of the hardware. A joystick is an indirect input device[9] based on the design of an aircraft's control system. The Atari joystick had a square base with a single cylindrical stick pointing up and a button on the base. Pushing the stick in a direction or pressing the button sent an input to the console. This is clearly a simple design, and this was necessary, as most people who played with it had never played a home console game previously. An important factor in a controllers design is its ability to be used with many different types of games. A gun gives perfect control for a game in a target range, but is useless for almost everything else. The joystick was adaptable to many situations and easy to learn how it adapted to different games. Games on the Atari consoles were all simple 2D games with basic graphics and gameplay, and it was rare that it was required for players to do anything more than move and fire. The joystick is one of the first examples of a truly generic controller, one which could be used to play hundreds of completely different games. Nearly all games on the Atari consoles therefore had to adapt their gameplay to work with the joystick. With the invention of the gamepad, use of the joystick was reduced, but it is still regularly used for PC flight simulations and its function is replicated in the analogue thumbsticks of modern controllers. The Atari consoles had other, more specialized controllers available to be used. The driving controller[Fig. 4] (1977) was a paddle that could be turned round over and over again, simulating a steering wheel. The only one game that ever actually used this controller was *Indy 500*, but it can be seen as a step towards the full steering wheels of later years. It is also one of the first attempts at taking a real device (a steering wheel in a vehicle) and adapting it to simulate the experience in a game.

Figure 3: Atari 2600 Joystick (Wikimedia)

Figure 4: Atari Driving Controller (Wikimedia)

3.4 The D-Pad and first gamepad

The first gamepad (also known as a joypad) arrived with the Atari 7800, but it was with the *Nintendo Entertainment System* (NES,1983,1985) that it was used to its full potential. The NES controller[Fig. 5] consisted of a *D-Pad* and 2 buttons on a base attached to the console by a wire. The evolution of the standard game control scheme from joystick to joypad was necessary for a variety of reasons. One of the major advantages of a joystick (and the reason they are used in aircraft) is the sensitivity to small movements due to their anologue nature[17]. The joysticks of games consoles of this age were not analogue however, only digital, and hence could only tell what direction they were pushed in, not how much. Also, games of this age did not require any sort of extra analogue control. For example, in the game Donkey Kong[21], players move their character left and right, or jump to avoid oncoming barrels. Players can only move left or right at a single speed, and can only jump a single height, making any sort of analogue control irrelevant. The joypad is superior to the joystick in digital control as it requires smaller movements to register different directions, can be more flexible for use in different types of games and is more accurate[17]. The D-pad is the plus shaped button that can be seen on Figure 5. It tilts in 8 direction (up, down, left, right and diagonals) and has more in common in its input mechanism to a button than to a joystick. The D-pad was a perfect design for 2D platform games such as Super Mario Bros.[22]. These, like Donkey Kong, only needed simple movement controls. Left and right moved the characters left and right, down ducked, up climbed ladders and entered doors, one button jumped

Figure 5: Nes Controller (Wikimedia)

and another one used some sort of attack. The small movements needed to move the D-Pad around enable quick and accurate control of the player, essential in Super Mario Bros. to avoid enemies.

4. PC CONTROLS

Parallel to the home console game development was the PC game. The PC game did not truly separate itself from the console game until the early 1990s with its 3 strongest game types: First-Person Shooters(FPS), Real Time Strategy(RTS) and Flight Simulations. Flight Simulations use an analogue joystick in an example of copying the real life controls as closely as possible. First-Person Shooters and Real Time Strategy games have developed their own style of control due to their unique concept and the limits of technology.

4.1 2D First-Person Shooters

A First-Person Shooter is a game where the player takes the role of a character and sees his world from a first person perspective (through their eyes). They generally involve walking around 3D areas and using ranged weaponry to kill enemies. The first FPSs were developed in the early 1970s using simple vector graphics and Battlezone[2] is an example of this type of game. True FPSs emerged in the early 1990s with id Software when PCs were beginning to have the power to render true 3D environments [31]. The control schemes for these games had to be developed parallel to the games themselves. Unlike driving games and flight simulations there is no natural control scheme to simulate walking and so a mapping had to be made to some input device. A possibility was Virtual Reality technology, but the expense and immaturity of the technology made this unfeasible. PC First-Person shooters all settled for a combination of mouse and keyboard controls, the only controls that were available to all PC users.

The first modern FPS is widely considered[5] to be Wolfenstein 3D[14]. In this game, the player played an American soldier and explored a Nazi base killing soldiers and other enemies. The game's default controls used the keyboard and were simple. The arrow keys moved the character forward, backward and turned left and right. Another key fired and the number keys changed the current weapon. As with

most PC games, these controls were customizable, but most players would have kept the default controls as they had likely never played a game like this before, and hence had no other preference for specific controls. These controls were adequate for the pseudo-3D world of Wolfenstein. Missing from the control scheme is the ability to look up and down, but this wasn't a problem as the levels in the game were flat.

id Software's next FPS game, Doom[15], was even more popular than Wolfenstein 3D and was the next step towards true 3D environments. All areas of all levels in Wolfenstein 3D were at the same altitude, but Doom added the ability for different sections of levels to have different altitudes. This enabled ramps and stairs, and necessitated a new control ability, looking up and down. Doom implemented vertical viewing angle changes with buttons (Page Up, and Page Down), but this was not very successful. Most players only fought enemies on the same level as them, as looking up or down was inaccurate and slow. It was not until the first true 3D FPSs that the problem was solved.

4.2 Quake and 3D First Person Shooters

The last great evolution in the First-Person shooter control scheme, and still in use today, was brought about with id Software's Quake[16] (although it was not the default control system until its sequel, Quake 2). Quake added a control option known as *Mouselook*. This is the ability to use the mouse to control where the player is looking at in the game, rather than using keyboard buttons for this function. A side effect of this was that the now redundant turn left and turn right buttons became strafe (sidestep) left and strafe right. This control system was superior to using the keyboard to look due to the ability to change the vertical angle, increased accuracy, and increased speed. In the 10 years since the release of Quake, the only significant change in control system has been the translation of the movement controls from the keyboard arrow keys to the W,A,S and D keys. This configuration enables quicker switching of weapons (which are generally assigned to the number keys) and access to more buttons for other functions (jumping, sprinting, crouching). Whilst there are first-person shooters on games consoles, they are less popular than they are on the PC. The only reason for this is the control scheme, as although the gamepad is a better control device for most games, it lacks the accuracy and acceleration of a mouse for high speed reaction based first person shooters[18].

4.3 Real Time Strategy

Real Time Strategy (RTS) games are those that put the player in the shoes of a commander of some military force. These games are often exclusive to the PC due to the control scheme that was developed in the early 1990s for games like Command and Conquer[34]. The controls for nearly all RTS games are similar to these. The player uses the mouse for selecting units, and giving them orders (usually attack, build or move), whilst the keyboard is used for shortcuts for more complicated orders. This interface is very simple and works well with all RTS games, and hence has been left unchanged for the last decade. There have been attempts at new peripherals to simplify these controls, but none have been successful. This is an example of a control scheme that works and all games in the genre are made to use it and work around it.

Figure 6: N64 Controller (Wikimedia)

5. 3D AND ANALOGUE

When the first 3D home consoles were released (the Sony Playstation and the Sega Saturn) their initial controllers were very much copied from the earlier 2D consoles. They both added digital shoulder buttons, and increased the number of buttons upto 8 as well as the D-pad.

5.1 D-Pads and 3D games

A major problem with this is that the D-pad does not work well in a 3D environment, especially from a third-person perspective. If we look at the game Resident Evil[7] some of the problems can be seen. In Resident Evil the player is trying to escape from a zombie infested city by solving puzzles defeating enemies. Had this been done in a 2D environment it is easy to imagine a simple control scheme with players moving left and right and aiming up and down with the D-pad whilst using other buttons to control weaponry and other basic functions. In the 3D environment in which the game was set however, a new control scheme had to be developed to cope with the extra dimension. In the game, players now used up and down on the D-pad to move forward and backwards, and left and right to rotate the character on the spot. This was clumsy and slow, and it felt more like driving a tank than controlling a person. It was clear that in order to have good 3D control, players needed to be able to move more freely and in more directions.

5.2 The Analogue stick

The first console to provide analogue control was the Nintendo 64(N64). The controller included an analogue stick (centre, Fig. 6, 1996), a small joystick like device that enables the user to provide a vector as directional input. The stick can be pushed in any direction and does not have to be pushed all the way out (hence providing a size of the movement). The N64 controller has an eccentric design, and is meant to be able to be held in 3 different ways (left and centre, left and right and centre and right handles held) but in fact only centre and right was regularly used. The controller was developed with the aim of providing good 3D control, especially with the N64's flagship game, Mario 64[23]. During the development of this game, the hardware and software developers worked together to discover what was necessary from a controller for a 3D platform game. Prior to the start of Mario 64's development there had been few 3D and no 3D platform games. Two main changes were found to be necessary: A more accurate way of control a character in a 3D environment and a form of camera control.

In 2D platform games the character can only move forward and back however, in 3D platform games, the player can also move sideways. Using a d-pad would mean that the player could only move in one of the four directions (or at diagonals if the design of the d-pad allowed it) which is frustrating and slow for the player. The addition of the analogue stick provides players with the ability to move in any direction, solving the problem entirely. Another advantage of the analogue stick is that players can have degrees of direction by only pushing it halfway out. Mario 64 (and many other games) took advantage of this by allowing different speeds of movement. This was previously done by holding down another button to indicate that the player wanted to run (or walk).

The other major problem with 3D platform games is control of the camera. In 2D platform games the camera is perpendicular to the player's movement and there can be no scenery or obstacles in front of the player. The camera is usually fixed to follow the player and so the player can always see what they need to see to play the game whereas in a 3D environment the camera has to avoid other obstacles and give the player a clear view of his character. This is very hard to do automatically (even 10 years after the first 3D platformers most games still struggle with this) and so it is easier to allow the player to have some degree of control over the camera. Up until the 3D generation game controllers had upto 6 buttons but the 3D consoles had upwards of 8 buttons. The extra buttons allowed for control of the camera. The N64 had 4 'C' buttons for controlling the camera (4 yellow buttons, Fig. 6). These allowed the camera to be adjusted by the player for the best view. The Playstation Dual Analogue controller added 2 analogue sticks to the original Playstation controller, giving it the analogue capability of the N64 and a means to control the camera in games more accurately.

5.3 Haptic Feedback and more analogue Controls

There have only been 2 further developments in the development of the standard gamepad (apart from motion control, Section 7.2). The first was the addition of haptic feedback to the controller. Haptic feedback is more often referred to as force feedback when discussed with games. It is some physical output exerted on the user, in games usually the controller shaking (rumbling).Haptic feedback has been a part of virtual reality research for a long time[6] but it was not until the late 1990s that it became common in games. The Nintendo 64 was the first to implement haptic feedback with its accessory known as the "'Rumble Pak"' *[sic]*(1997) and the game Starfox 64[24]. In the game players played as a member of a space fighter unit. When players crashed or were hit, the controller shook violently. This, whilst crude, provided players with another dimension in their play. Force feedback is now common to most console game controllers.

After the development of analogue directional control, analogue buttons followed. These were buttons that could sense how hard the user pressed down on them, provide different input to the game. The most common form is in an *analogue trigger*. This is a button, shaped similar to a gun trigger that the player can depress upto approximately a centimetre. On the Playstation 2 controller all buttons had analogue sensitivity however it was very hard to use them accurately as there was less than a millimetre between the fully up and fully down positions. Generally, the analogue nature of the triggers is only used in racing games to provide a variable amount of acceleration to the player's vehicle.

6. ARCADE AND NOVELTY

Apart from the mainstream console controllers and control schemes there are dozens of unique novelty controllers. Most are designed for use with a specific game in an arcade setting, and the successful ones see sequels and console releases.

6.1 Light Guns

The first light guns were developed in the 1930s[35], but the first light gun video game came with the Magnavox Odyssey. Light guns work by seeing what the end of the gun sees and returning the information to the game so it can be interpreted as a hit or miss. The Odyssey gun games were simple shooting galleries. Targets appeared and the player had to aim and shoot. Ultimately all light gun games consist of this formula, however more recent ones have human targets that shoot back. The light gun is an example of a device that exists and is used in reality and was essentially copied and transferred to interact with a virtual world. Several games consoles have had light gun peripherals as alternative controllers to their normal joystick or gamepad, the first being the Colecovision, but popularised by NES Zapper and SNES Super scope.

6.2 Rhythm Games

Rhythm (or music) games are games where players have to simulate some aspect of music or dance such as strumming a simplified guitar. Due to the unique nature of these games they often have a novel controller designed along with the game.

The first popular rhythm game was Parappa the Rapper[33]. During play icons representing the buttons on the Playstation control would appear and players were required to press the correct button when it reached the centre of the screen. Players are scored on the accuracy of their timing. The player's performance was reflected by the musical ability of the main character, PaRappa. If the player played poorly notes would be out of tune, if not it would sound good. The game created a unique, yet simple, control scheme for this brand new type of game that did everything required of it. The next rhythm games would take the simple control scheme of Parappa and add a new input mechanism to add to the enjoyment of playing the game.

Dance Dance Revolution[19](known as Dancing Stage in Europe) is a game similar to Parappa the Rapper in design, but added considerably to the genre of rhythm games due to its controller. In the game, players have to hit a direction as an arrow passes the top of the screen. To hit a direction they had to stand on a floor pad (Fig. 7, 1998), which is split into up, down, left and right sections. Dance Dance Revolution takes quite a complicated and free action and attempts to simplify it to a level that a computer can generate instructions and assess performance. Interestingly, the Dance Dance Revolution community has added the completeness of real dance back into the game through freestyling [12]. In

Figure 7: Dance Dance Revolution pad (Wikimedia)

this players must still hit the correct arrows at the correct time but they also dance freely in between, return to the complex nature of real dance from the simplified version.

There are many dozens of other music games involving things such as guitars, drums, keyboards and even maracas. All these were developed on the principle of taking a complex musical task and simplifying it to a level that is assessable by a computer.

6.3 Computer Vision and interactivity

One of the ultimate aims for game interfaces is the ability to do something normally and have your action reflected in the game by your character. One way to achieve this is to use computer vision technology to analyse images of the player's movements and translate it into movement in the game. Due to the continued inaccuracy of computer vision techniques [10] there have been few attempts at this, but the most successful is the Sony EyeToy®[32]. The Eyetoy is a small camera that connects to the Playstation 2, and Eyetoy:Play was the first game available with it. Eyetoy:Play is made up of many smaller games (minigames) that use the camera in some novel way. In each minigame players have to perform an action, usually repetitively. Examples of games involve running to make the character run, or window washing. The output of the camera is displayed as the background to the current game so players can see where the system is perceiving their movements to be. A major advantage of this type of control system is how simple it is for people who may not be regular gamers such as young children[13] and the elderly to understand what they have to do and be able to do it. Whilst Eyetoy is a fun game to play the technology behind it is still poor. Actions are often ignored or misinterpreted despite their simplicity. It is for this reason that this type of computer vision will not be a larger part of a system's control scheme for a long time.

7. NEW IMMERSION

Recently two technologies have been implemented into games console design; touchscreens and motion sensing. They have been present in other forms for many years but only recently have become cheap enough and easy enough to process that they can be implemented in a commercial games console.

Figure 8: Nintendo DS Lite and Stylus(Wikimedia)

7.1 Touch Screens

The Nintendo DS(Fig. 8 is a DS Lite, a redesigned DS, 2004) is a handheld games console that uses a touch screen as one of its controllers. The console has two screens although only the bottom screen is a touchscreen. The console also has the regular d-pad and button interface reminiscent of a Super NES gamepad, and also has a microphone. Interaction with the touchscreen is done through a finger, a stylus or a special thumbpad depending on what level of accuracy is required. Some games use the touch screen as another button, but there are games that are designed around the touchscreen and wouldn't be playable without this. There are two common ways for interaction with the touchscreen to be used as a pointer, or in some sort of gesture recognition.

Trauma Center[3] is game where the player takes the role of a surgeon performing various surgical procedures on patients. It is designed solely around using the touchscreen interface with a stylus to simulate a surgeon using his hands with surgical instruments such as scalpels and forceps. Players are presented with a patient's torso and use the stylus to cut them open or stitch them back up. The stylus can take the place of many of these instruments and give players the feeling of actually using real versions of their virtual tools. This game would not be possible without an interface like this to allow players accurate, realistic control. This game also uses some gesture recognition, such as when players stitch up a patient.

Brain Age[25] is described as a "'Brain Training"' game. It consists of small mental challenges that players are meant to practice repeatedly. It is unique to the Nintendo DS for two reasons. Firstly, in some games players are required to answer simple mathematical problems by writing their answer on the screen. Most games consoles do not have any method of quickly entering textual information, but by using gesture recognition Brain Training can identify what number is being written down and allow the game to proceed at a fast pace. The game also takes advantage of the DS' inbuilt microphone. One game requires players to say the colour of word out loud, even though the word may be a different colour. Whilst many of these challenges could be done with a different control system, they could not be done with the speed and ease of use that allows the game to be effective and also gives the game a wide audience (it is very popular with the elderly in Japan[20])

Figure 9: Nintendo Wii Remote and Nunchuk(Wikimedia)

7.2 Motion Control

The latest development in commercial video game console controller design is the addition of motion control. Both the Nintendo Wii and the Sony Playstation 3 have added this functionality, but this paper will concentrate on the Wii as it is the basis for the philosophy of the console. The Wii controller is a radical departure from all previous controllers. Unlike nearly all other console controllers, it is not considered to be a gamepad (although it can have this functionality). The main Wii controller is known as the Wii Remote and is shaped liked a television remote control (Fig. 9, right, 2006). The Wii remote has multiple accelerometers inside it giving it the ability to sense what motions the player is putting it through. The remote can also interact with a sensor bar above the screen that the game appears on to enable accurate pointer functionality, so the remote can be used in a similar way to a mouse. There are two attachments available to the Wii remote, the classic controller and the nunchuk (Fig. 9, left). The classic controller is a normal gamepad that plugs into the remote but the nunchuk is a motion sensing controller with an analogue stick and a trigger button. These accessories are designed to increase the functionality of the Wii remote, which without them would not to be able to play games that didn't use the motion sensing abilities. Development of the Wii remote was accompanied by the development of games designed to use it (much like what was done with Mario 64). In order to develop the basic concept and functionality of the controller, Nintendo developed simple games such as Wii Sports. Nintendo then adapted the already developed Nintendo Gamecube game Legend of Zelda: Twilight Princess to use the motion controls of the Wii.

Wii Sports [28] is a simple set of five games designed to aid the development and to demonstrate the concept of motion control to other developers and the public. The games all present similar aspects of the Wii remote's design and so the focus shall be on one of them, Wii Tennis. Wii Tennis is a simplified game of Tennis, where players swing the Wii remote like a tennis racket to hit the ball. The game is less complex than a normal tennis game as the characters on the screen move automatically, players only need to worry about hitting the ball. By developing this game, other developers can see how to translate their ideas onto the Wii. There is already a version of Trauma Center being developed due to the similarity to the Nintendo DS stylus of the interface that the Wii Remote provides. Another game that is using the increased amount of control provided by the Wii is Excitetruck[26]. In this racing game players use the remote as a steering wheel, but can also tilt it to adjust the angle of the landing of their vehicle. These games all take advantage of the more intuitive controls provided by gesture recognition [30].

The Legend of Zelda: Twilight Princess[27] was originally developed for the Nintendo Gamecube using a stand gamepad. With the creation of the Wii and its motion controls the game was adapted to work with the new control system. By adapting a control scheme for a regular game Nintendo shows that multiplatform games can be made to work on the Wii despite the unique control system. In the Gamecube version of the game, control is achieved through use of buttons and the analogue stick. The Wii version still uses the analogue stick for movement, but uses the Wii Remote's pointer functionality to aim weapons and gesture recognition to perform sword attacks.

8. CONCLUSIONS

The evolution of the game controller over the last 45 years has taken it from the simplest knobs and buttons to computer vision, touch and motion control. The first controllers were made of whatever was available to the scientists in their electronics labs and the games were equally simple. Highly simplified versions of sporting activities such as table tennis, shooting galleries and space shooters. With the creation of the gamepad games became more complicated. Games didn't have to be simple concepts, although the gameplay was still limited by the computing power of the era. 2D platform games took players on long journeys with them in control of simple movement of their characters. With 3D came the analogue stick, providing players with a way to guide their characters around their new 3D environment. The latest consoles let players perform the actions that they want their characters to perform and they can become part of the game more than ever before.

Alongside the main console developments dozens of novelty controller ideas have been created and tested and the most successful ones were integrated into mainstream consoles (light guns into the Wii remote). Even those less successful have still made their mark, although for most they will only ever be used for the type of game that they were initially designed for.

Finally there is the purely functional purpose of the PC control schemes. Whilst reflecting little on the actual actions taken in the game, the simple control schemes can become second nature to players, to give them a feeling of immersion on par with the best novelty controller. Despite this it can be seen that there has been minimal development on new types of games on the PC, these control schemes work, and so these games are the only ones that will be played.

The future of game controllers is unknown. If the Nintendo Wii is as successful as the Nintendo DS, then gesture recognition and pointer techology could be the future of all game control. If the Wii fails, then players will continue using regular gamepads until a new, cheap, more immersive technology arrives.

It can be seen that controls and games can affect each other equally. The earliest games had to work with whatever limited technology was available, whilst some of the more recent games can push development of a controller down a specific path, that usually ends up helping all games like it.

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