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Interface Design Requirements For Playing Pong With A Single Switch Device

J. Gilligan, B. Mac Namee and P. Smith

***Abstract*— Motivated by a desire for increased accessibility in digital games, in this paper we consider the design requirements for an interface to a variation of the game Pong for single-switch users. We consider the issues in the design of accessible interfaces for games and propose a set of interface configurations for playing Pong, using this as a proof of concept for more elaborate games.**

***Index Terms*—Games, interface design, accessibility, assistive technology, switch access, selection grids, scanning**

I. Introduction

As the world market for computer games expands, increasing attention is being focussed on games accessibility. In its mission statement the Game Accessibility special interest group (GA-SIG) of the International Game Developers Association state that it intends to "*develop methods of making all games genres universally accessible*" [8]. This reflects other world wide accessibility initiatives such as the Web Access Initiative (www.w3.org/WAI) [9], and the Universal Design philosophy [12].

Thus, motivated by this desire for increased accessibility, and as a proof of concept for more elaborate games, we consider the design requirements for an interface to a variation of the Pong electronic game for single switch users. Switch devices are one of the major alternative input technologies to computers for people with disability.

This paper will begin by briefly introducing the game of Pong. This will be followed by an in-depth discussion of switch technologies. Following on from this design configurations required both to make switch access suitable to Pong and to make the Pong interface suitable to switch control. Finally, we will propose a scheme through which Pong could be made available to single-switch users, and extrapolate on what is required to make other games available to switch users.

II. Pong

Although there is some argument as to who first created a ball and paddle video game, we can be certain that the electronic game Pong was released in 1972 by the ATARI corporation, at the time headed by Nolan Bushell. A screenshot of an early version of Pong is shown in figure 1. Pong was released both as a coin-operated arcade machine and as a home system and became one of the first games to reach a mass audience. The success of Pong is largely attributed to its simplicity [7].

The concept of Pong is simple. A small ball moves across the screen, bouncing off the top and bottom edges. In the two player version, each player controls a paddle which can move up and down. The objective is to position the paddle so it hits the ball and returns it to the other side. The opposing player must then anticipate the likely position of the ball and try to hit it back to the other participant. A score is awarded when the opposing player misses.

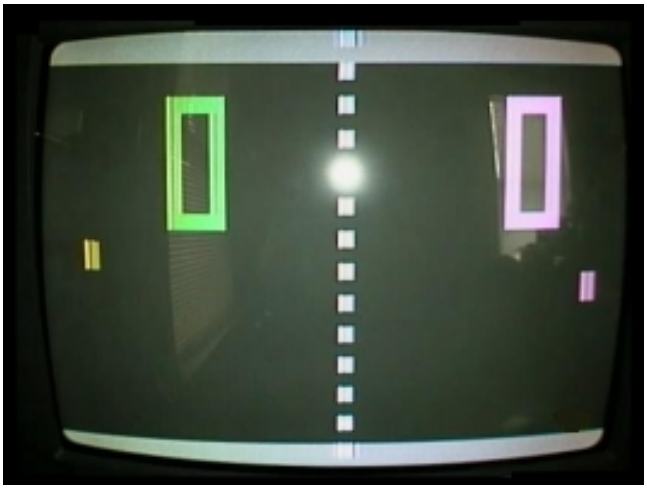

Figure 1: A screenshot of an early version of Pong

Over the years there have been many clones of Pong. There In this report we will consider a single player version in which 'the court' is enclosed by top, left and right walls off which the ball can bounce. The player controls a paddle at the bottom of the screen which can be moved from left to right and the object of the game is to keep the ball in play, with scores being awarded for each successful hit. A diagram showing the layout of this version of Pong is shown in figure 2.

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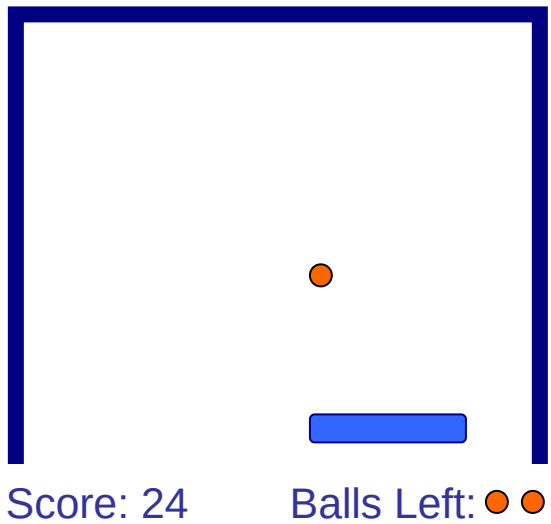


Figure 2: A simple illustration of the proposed single player Pong clone

While Pong may seem an unusual choice to work with - there are countless more sophisticated games currently available - it has a number of compelling advantages. Firstly, although Pong is relatively straightforward, with its relatively fast pace it does offer enough complication to allow exploration of the important issues surrounding accessible games. Furthermore, the ubiquity of Pong style games means that even those unfamiliar with modern digital games will not feel out of their depth with a Pong clone. In fact, there is also a growing body of thought that suggests that simple, or *casual*, games offer the greatest potential for growth of the digital games industry [13]. And finally, as our work will focus on single switch control, we require a game with simple control requirements.

III. Switch Access

A switch is simply a make-or-break electrical circuit used by those disabled people who are incapable of using conventional computer input devices such as the keyboard and mouse [6, 11]. The switch is placed on or near the muscle group over which the user has most control, in some cases just an eyebrow. Figure 3 shows an image of the Jelly Beamer™ wireless switch.

Many types of switch are available from the standard hand-controlled switch to sip/puff switches which involve a tube connected to a switch which is activated by a change in air-pressure caused by sipping or blowing. Switches can be activated by most muscle movements, with newer ones even controlled by thought alone [4]!

Switch access as a means of input to a computer works in association with on screen grids of items to be selected. This collection is known as the *selection set.* This is placed in a separate window and can comprise text and graphic items. The window can be positioned anywhere on the screen and always appears on top of any other application windows.

Figure 3: The Jelly Beamer™ wireless switch

Switch access works by selecting appropriate items on the grid through a process known as *scanning*. Each item in the selection set is highlighted in sequence. The length of time for which an item is highlighted is known as *scan delay*. A press of the switch will select the currently highlighted item. Scanning is characterised by the switch configuration used, the manner and order in which the highlighter moves through the items in the selection set (*scan movement*) and by how items on the computer screen are sequentially highlighted - one after the other, until the user chooses one by pressing the switch (*scan method*). Figure 4 shows a sample selection grid used to enter text into a word processor.

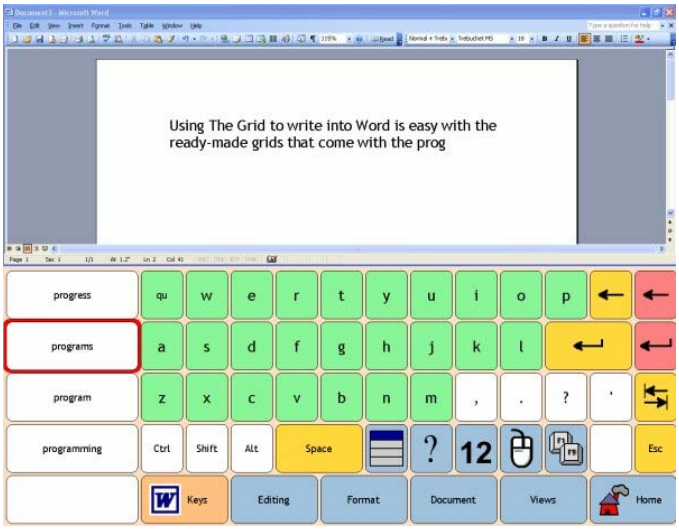


Figure 4: A selection grid being used to input into a word processor

The following section will describe the considerations which must be kept in mind in order to allow switch control of a Pong clone.

IV. Pong and Switch Access Design Configurations.

The game Pong places a number of functional requirements on the user. The most important of these are as follows:

- The player must be able to control the paddle through an input device.
- The player must be able to react quickly enough to effect paddle movement in the time interval in which the ball is within the playing area.
- The player must possess enough spatial awareness to

understand the relative positions of the ball and paddle to each other.

- The player must anticipate the likely position at which the ball will arrive at the paddle plane of movement and move the paddle there beforehand - this involves projecting the path of the ball as it bounces through the angles of the playing area.

Using a switch device also places a further set of functional requirements on the user. To use a scanning system, a switch user must be able to [5]:

- Make a choice from a field of options.
- Watch/listen and wait until the choice is highlighted by the scanning box or advance through choices until they arrive at the choice.
- Activate a switch to select their choice.

Successful switch use involves issues such as volitional and reliable movement, anxiety control, and cognition [2, 5, 11].

How the switch system is configured can significantly affect performance. For example, the choice of scanning method demands different abilities [1] which individual users may have to varying degrees.

The design of the grid significantly impacts on performance. Decisions must be made as to the grid layout, item size, shape, colour, spacing, presentation and so on [5, 11].

In the next section we will look at how some of these switch design choices can impact on the accessibility of Pong.

V. Switch Interface Design Issues for Pong

Most accessible design philosophies place the user at the centre of development. The choice of switch is determined by the functional limitations of the user and can impact on the consequent usability of the game. So, there are a number of important considerations which must be made in determining an appropriate control scheme for the game of Pong.

For example, a standard Pong player requires reasonable function of sensing size, form and contour using both eyes for objects close to the eye. If an eyelash switch were used it may interfere with the user's view of the playing area and the ball and paddle. This in turn could reduce the user's effectiveness in assessing the relative position of the ball in space in relation to the paddle. Similar considerations for other switch locations for which, for example, the user may have to turn their head away from the screen.

Maybe most importantly switch access is slow. Even for less complex grid traversals, the accumulation of scan delays amounts to a slow selection process [1]. This must be accounted for when setting the speed of the ball, as the ball should not move so fast as to reach the paddle line quicker than the time it takes to make the required number of paddle moves.

Also, switch systems involve a selection grid. This adds another element to the screen layout of the game. While the game is playing the switch user is forced to change their focus from the path of the ball to the selection grid while making a paddle move. Again this introduces another layer of complexity and both the speed of the ball and the design of the selection grid should account for this.

The presentation of items in the selection grid is an important area in which switch access can be facilitated. The larger the item size the easier the item is to target and select. However, this increases the size of the grid which in turn encroaches onto the space allowed for the playing area. By reducing the size of the playing area it can leave the ball with a shorter path to travel. This might leave the user with less time to move the paddles to the required positions.

Scan methods (i.e. how the item is selected) also affect user performance. Nisbet and Poon [11] outlines the functional demands that different scan methods (such as Autoscan and Userscan [3]) place on the user. Some of these may be in conflict with the requirements of Pong.

For example, in Autoscan the highlighter moves automatically between items. This places the onus on the user to wait until the required grid item is highlighted. Pong also requires the user focus attention on the playing area and its constituent objects at the same time. Thus, the user is required to shift attention between the grid and the playing area and at the same time carry out the multiple tasks of controlling grid selection and the Pong paddle. Switch users may not have sufficient capacity to carry out multiple tasks simultaneously or to divide attention between differently sited stimuli. These difficulties may result in increased stress and anxiety on the part of the user.

Another consequence of the dual focus imposed on switch users of games is that there may not be correlation between the direction of grid traversal and the direction of the paddle. It is an added burden on the player to control a paddle moving up and down in a vertical plane through grid selection involving left to right traversal in the horizontal plane. This involves complex control and coordination of counter intuitive voluntary movements. Grid traversal and paddle movement should be similar in so far as is possible.

Following on from these issues the next section will suggest a number of possible solutions for making Pong more accessible to single switch users.

VI. Proposed Solutions

Based on all of the considerations discussed in the previous sections we now propose a number set-ups for single switch controlled Pong. There are three different configurations, two of which use a selection grid which appears in a separate window to the actual Pong game, and one of which uses a selection grid which integrated into the game itself.

A screenshot of the first proposed configuration is shown in figure 3. In this scenario the Pong window is positioned above a smaller window which contains the selection grid for switch control. Here the selection grid has only two options – to move the paddle left or to move the paddle right. When a user selects either one of these options the paddle would move a pre-determined amount in the appropriate direction. This

configuration would use an Autoscan-based scan method in which the arrows are continually highlighted one after another allowing the player make repeated selections.

Figure 5: Accessible Pong configuration 1

The obvious concern over this configuration is that it would take an unacceptable amount of time for the user to successfully move the paddle as they must make repeated choices. This difficulty inspires the second proposed configuration.

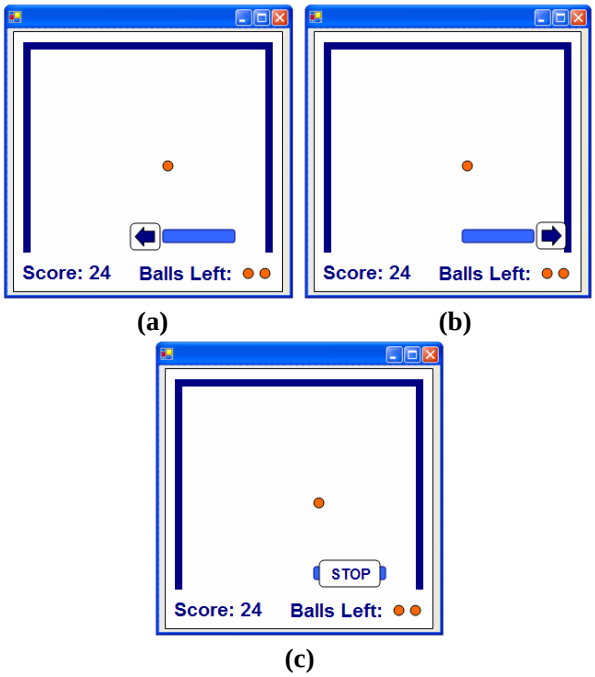
In the second proposed configuration a third choice is added to the selection grid used by the player. This time the selection grid offers choices to go left, go right and stop, as shown in figure 4. In this configuration the left and right choices are alternately highlighted until the user makes a selection. However, this time once a selection is made the paddle moves continuously in that direction. While the paddle is moving the selection grid changes to only offer the stop option, which when selected stops the paddle. At this point the selection grid reverts to alternately offering the left and right choices.

The advantage of this proposal over the previous offering is that it will allow the player move the paddle more fluently, making the game more playable. However, there is still the difficulty that the player must shift their attention between the selection grid window and the game window. The final proposed configuration addresses this problem.

Figure 6: Accessible Pong configuration 2

The final proposed configuration does not use a selection grid in a separate window, but rather integrates the selection grid into the play area itself. This configuration is illustrated in figure 5. This time two options are initially offered to the player by right and left arrows which flash alternately at either side of the paddle (shown in figure 5(a) and 5(b)). Once the player selects a direction the paddle moves continuously in that direction until the player chooses the newly offered stop option (figure 5(c)) which stops the paddle.

This configuration has the advantages that movement selection should be relatively fast and that the player's attention does not need to shift between two different windows. However, the major drawback is that the selection mechanism has to be built directly into the game. Ongoing work is exploring a number ideas to solve this problem. For example, it is proposed that a game could offer an accessibility layer which would allow external programs overlay graphics onto the game window to facilitate accessible control, assuming that the game exposed enough information to allow sensible positioning of the control graphics. This would allow games be built without major consideration for accessible control, while allowing any number of accessible control schemes be built onto the game after release.



(a) **(b)**

(c)

Figure 7: Accessible Pong configuration 3

VII. Conclusions & Future work

In this paper we have reviewed some of the issues surrounding single switch access to computer games, particularly focusing on how the game Pong would be implemented for single switch users. It is clear from the above that switch access is a complex issue with considerations arising both for the design of the switch control and the design of games themselves. We have proposed a set of configurations for switch control of Pong that attempt to address these. It is clear from this initial review that very flexible designs are required.

Within the domain of switch access there are many other variations and considerations, for example set-ups for younger players, multi-switch configurations and different selection grid layouts and these form the basis of our plan for future work. As is accepted best practice [10] it is also intended to perform an extensive set of tests of the proposed configurations with switch users.

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