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INFLUENCE OF A PLATFORM GAME CONTROL METHOD ON A PLAYER'S EFFECTIVENESS

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Abstract. *The aim of this research is to check which of two devices the keyboard or the controller – has a positive effect on a player's game-play in a platform game. Four parameters are defined: death count, error count, game time, learning time. A custom game is designed and implemented specifically for the research. The conducted experiment is divided into thirty-minute sessions, during which one player participates in the game after getting acquainted with the game's mechanics. After completing the game, he/she fills out a survey in which he/she can express his/her level of satisfaction while using the assigned device. Each player has only one attempt. 16 players agree to participate. They are divided into two groups of 8 people each. Participants in the first group use the keyboard while those in the second group use the controller. In order to determine final results for the tested devices, the AHP method is used. The importance values for all pairs of measured parameters are determined in order to calculate their priorities. The priorities allow for distinguishing important from less important parameters. For this purpose, a survey of experienced players is conducted. They help to identify parameter importance. After trials and analysis of responses from the game-play satisfaction and parameter importance surveys, it turns out that players using the keyboard achieve better results, and the keyboard is more satisfying to use.*

Keywords: keyboard, controller, gameplay, interface, control

BADANIE WPŁYWU STEROWANIA GRĄ PLATFORMOWĄ NA EFEKTYWNOŚĆ ROZGRYWKI

Streszczenie. *Celem badań było sprawdzenie, które z dwóch urządzeń służących do sterowania postacią w zręcznościowej grze platformowej, klawiatura czy kontroler, wpływa pozytywnie na wyniki rozgrywki gracza. W tym celu zdefiniowane zostały cztery parametry: liczba śmierci, liczba błędów, czas gry, czas nauki. Badania polegały na ukończeniu gry zaprojektowanej i zaprogramowanej specjalnie na potrzeby badań. Badania zostały podzielone na trzydziestominutowe sesje, podczas których jeden gracz brał udział w rozgrywce po wcześniejszym zapoznaniu się z mechanikami gry. Po ukończeniu gry wypełniał ankietę, w której mógł wyrazić swój poziom satysfakcji z korzystania z przypisanego mu urządzenia. Na każdego gracza przypadała jedna próba wykorzystująca klawiaturę lub kontroler. Do badań zgłosiło się 16 osób, które zostały podzielone na dwie grupy badawcze po 8 osób. Uczestnicy z pierwszej grupy korzystali z klawiatury podczas badań, a osoby z drugiej – z kontrolera. Aby wyznaczyć wyniki końcowe dla badanych urządzeń, dzięki którym można było je ze sobą porównać, zastosowana została metoda AHP. Na potrzeby tej metody należało określić przewagi pomiędzy wszystkimi mierzonymi parametrami, aby obliczyć ich wagi. Wagi te przyczynić się miały do wyróżnienia parametrów ważnych od mniej ważnych. W tym celu utworzona została ankieta skierowana do doświadczonych graczy, którzy pomogli w określeniu tych przewag. Po przeprowadzeniu badań i analizie odpowiedzi z ankiet dotyczących satysfakcji z rozgrywki oraz przewag parametrów, okazało się, że gracze korzystający z klawiatury otrzymali lepsze wyniki, a klawiatura była bardziej satysfakcjonująca w użyciu.*

Słowa kluczowe: klawiatura, kontroler, rozgrywka, interfejs, sterowanie

Introduction

The method of controlling a video game character is an important aspect of designing a video game. A player's satisfaction depends upon how comfortable he/she feels while playing. Confusing keys or remembering a large number of key combinations may annoy the player or cause fatigue after only a few minutes of game playing. This can result in a sudden loss of interest in the game. It is also important what device the player uses to control the game. It can be a keyboard, alone or in conjunction with a mouse, or a special controller designed specifically for a given game.

Conducting research on players is necessary to identify the best or most convenient way of controlling what is happening in a video game. By surveying players, one can also learn what "intuitive" control is, i.e. what way of controlling the game is the easiest to remember and to learn. Players with experience in some game genres have specific reflexes that make it easier for them to adapt to a game from a new environment.

There is much discussion about which of the two game control devices – keyboard or controller – is best suited for specific game genres. The aim of this paper is to test a player's efficiency while playing an arcade platform game using these devices. Efficiency in this context can be understood in many ways and depends upon many different factors. However, by making specific assumptions based on our own experiences and the opinions of experts, one can try to calculate the efficiency factor.

Research presented in this paper addresses only one aspect of video games, but it can help to improve the quality of games overall by concentrating on this aspect. By comparing multiple game plays in which different devices are used, it is possible to draw conclusions that can help game developers make better decisions. Thanks to concrete results and strict analysis, the gaming industry can gain the additional knowledge it needs to create better products.

1. Literature review

This research is divided into the following problems:

1. Preparation of initial surveys for test participants and experts in the field of platform games.
2. Preparation of software (platform game) for conducting the research.
3. Conducting a final survey for test participants concerning the experiment.
4. Analyzing the results.

For each of these problems, a literature review is carried out, the conclusions of which are presented in subsections 1.1–1.3.

1.1. Literature overview on the preparation of initial surveys and an analysis of results

In [5] poker player bias was investigated. The authors separated research participant groups by experience. People who had played poker regularly and for at least a year were considered experienced poker players. The regularity of playing poker was defined as a minimum of once a week. Beginners, on the other hand, were defined as people who had had contact with the rules of poker but had no personal experience with the game.

In [2], drivers were divided into groups by experience. Experience was measured by the time during which a person had contact with driving a vehicle. The median experience of inexperienced drivers was 2.7 months, experienced drivers 7 years, and older drivers 38 years.

Taking into account the conclusions from the above works, the level of player experience can be determined by the time frame in which they had contact with games.

To clarify which games fall into the platform game category, game genres should be defined. [1] deals with the classification of video game genres, with "platform game" being considered a sub-genre extending the genres described in the aforementioned

study. Video games can be described by different categories, such as "action platformer" or "first-person shooter". Over the years, game genres have evolved, but platform games are always associated with 2D controls. This means that all game genres with this trait can be considered to be platform games.

In surveys prepared for the purpose of our research in this paper, examples of games of each genre (Adventure, RPG, Shooter, etc.) are taken into account when determining a player's experience. It is assumed that the game controller is limited to two directions of movement – horizontal and vertical. Additionally, titles from the arcade games category are also be preferred in this survey.

Thanks to a survey with well-defined questions, it is be possible to distinguish between experienced and inexperienced players. In order for the parameters tested during the experiment to be reflected in the real world, after defining them, they should be assigned weights that allow for distinguishing between important and less important parameters.

The method that enables such classification is called the AHP (analytic hierarchy process) method and is described in [9]. In the survey process, respondents, who are experienced players, determine which parameters they consider to be important. According to the aforementioned work, parameters will be compared to all other parameters in pairs. The respondent chooses an integer number between 1 and 9 to indicate how important a given parameter is compared to another. Thanks to this, the weight of the parameter can be calculated and converted into the final result. Thanks to this method, various parameters can be taken into account. The result of the analytical hierarchy process is one number denoting the result for the tested alternative.

1.2. Literature overview on software preparation

In [14], the authors created a platform action game in a short time using the four-step method: preproduction, production, testing and postproduction. The game was programmed in Unreal Engine. Finally, players testing the game were surveyed to answer three questions: "Is the game graphically attractive?", "Is the game playable?" and "Is the game satisfactory?". The survey results suggest that the game was missing some elements and appeared to be underdeveloped, but despite the fact that it was created in a short time, it looked attractive and was fun to play.

In order to properly design a game level, its most important elements should be defined. This was done in [11], which describes the following level elements: 1) a platform – an object on which the game character can walk/run, 2) an obstacle – an object or phenomenon that interferes with the player's achievement of a goal, 3) a movement aid – an object that helps the player to move from one point to another, such as a springboard, 4) a collectible item – an object to be collected by the player (to get extra points for example) and 5) a trigger – an object that changes the state of a level (for example a lever that opens a door). The skillful use of such elements will allow for creating a game level that is fun and intuitive for the player.

Deals with the topic of programming computer games from a practical standpoint in the Unity environment. It is addressed to programmers who don't have experience with the Unity engine and C# language. It describes the basics of game development, C# programming, project export and principles of operation of objects available in this engine [6].

In [8] the importance of correct key assignments and design of the game interface are outlined. The authors state that the player should not be forced to think how to perform a given action, but instead should focus on the problem presented in the game (e.g. on a puzzle to be solved). The unintuitive interface can frustrate a player when performing basic activities. This confirms the importance of the problem researched in this paper.

The topic of interface intuitiveness was discussed in [13], in which the author defined what the spectrum of a user's knowledge is. For the interface to be intuitive, it should be designed in such a way that the user can perform the operation he/she wants without outside help. The spectrum of knowledge should include a so-called current knowledge point and target knowledge point. These points indicate at what level of knowledge the user of the system may be. Between these points, there are levels of knowledge of a future user which must be considered when designing the interface. Usually, the interface designer focuses on the current knowledge point in order to fully adapt the interface for use by the least knowledgeable users.

In [3] an experiment was carried out in which two players and two computers with artificial intelligence play a platform game similar to "Infinite Mario Bros" (a platform game). The following parameters were selected to determine the effectiveness of the players' gameplay: completion time, last life game play duration, percentage of time spent running left, percentage of time spent running, number of jumps, number of unsuccessful jumps, number of collected coins, number of kicked shells, number of deaths caused by falling into a hole, number of deaths caused by enemies, number of killed enemies, number of enemies killed by a kicked shell.

While testing the satisfaction of players in using game controllers in a video game developed for the purpose of [15], members of the research group were asked to play a given game for 15 minutes. They had the option of extending this time by 10 minutes. 70% of the surveyed players showed a willingness to extend the game time. This may mean that this type of experiment should take from 20 to 30 minutes.

In [7], researchers created a game that adjusts its difficulty level to the player's level of focus and performance. The very low difficulty level of the game causes low player interest, and the high difficulty level can be frustrating and cause him/her to quit playing. From the results of the experiment it can be concluded that, with five levels for a player to complete where consecutive levels become more and more difficult, the greatest level of focus and performance of a player was achieved on the second level. This means that the game should be easy but also present a moderate challenge to the player.

1.3. Literature review on preparing the final survey and results analysis

In order to obtain significant results of the final survey on user satisfaction, it is necessary to carefully prepare the questions and possible answers for the players to choose from. This topic was discussed in [10], which describes the way in which the users can assess a tested solution. Satisfaction with transparency, efficiency and similar traits can be described using one of seven options to choose from. The first three options define a given element in a negative way, with the first option being extremely negative. They can be specified as -3, -2, and -1. The fourth option, specified as 0, means that the user does not think about the tested solution either in a negative or a positive way. The last three options, specified as 1, 2 and 3, express a user's positive opinion of the tested solution with the last option being extremely positive. The questions asked of the user should concern:

1. appeal (general impression of the product);
2. clarity (is it easy to learn to use the product?);
3. efficiency (can the user use the product without much effort?);
4. reliability (does the user fully control interaction with the product?);
5. stimulation (is the use of the product satisfactory?).

Quoting the introduction to [12] "A recent trend in the video game industry is toward a more complex controller. Devices such as the Dual Shock 2 controller, made popular with the Playstation 2, are designed to satisfy the needs of the avid gamer but can be intimidating for nongamers to adopt". This means that people who do not have experience with video games may be more inclined to play with the keyboard they are already familiar with from working on a computer, as opposed to a controller which is intended only for playing video games.

In [4] experiments were carried out to prove that controllers with Oculus Touch motion sensors are more intuitive than an Xbox game console controller in the case of VR games. A strategy game and an FPS (first-person shooter) game were used in the

experiment. It turned out that, according to obtained results, the intuitiveness of the controllers, the sense of presence and the player experience for both controllers differed only slightly, thereby negating the initial thesis. Despite the different results for both controllers, they were not significant enough to prove a thesis that initially seemed correct.

2. Research methods

The AHP (Analytic Hierarchy Process) method mentioned in subsection 2.1 was used to calculate the final results for the tested alternatives (keyboard and controller). For this purpose, it was necessary to define criteria by which these alternatives could be described. The criteria (also referred to as parameters) are defined as follows:

- Death Count (DC) – the number of deaths of the player's character during the game.
- Mistake Count (MC) – the number of times the player pressed an incorrect button (button not assigned to any action in the game).
- Game Time (GT) – the time in which the player completed the game.
- Learn Time (LT) – the time during which the player familiarized himself/herself with the rules of the game and learned how to control the game's character.

In all of the above mentioned criteria, lower values are better.

In addition, for all possible pairs of criteria, the advantage of one criterion over the other had to be determined. For this purpose, a survey was prepared for people experienced in the video game industry, in which they could assess the importance/advantages of all criteria. In addition, to determine the respondents' experience, the survey included questions about the time spent playing video games in general and which platform games they specifically played.

In order to test the effectiveness of gameplay when using a keyboard and a controller, it was necessary to prepare software that allows for measuring specified parameters. The piece of software has the form of an arcade platform game, measuring the above-defined parameters. The game was created in the Unity engine version 2020.3.2f1. The graphics and the game mechanics have been created to conform to assumptions about platform games. In the game, the parameters enumerated above are measured. When the game is finished, the results are displayed on the final screen.

The LT parameter is measured in seconds as the player learns about character controls and game rules. The GT parameter is also measured in seconds during the game, and timing ends when the player completes the game. The DC and MC parameters are incremented respectively when the player's character dies and when the player presses any button that has not been assigned to character control.

The game has been tested and problems found during testing have been fixed. A screenshot from the game is presented in Fig. 1.

Along with the software, an application form was prepared for people willing to take part in the research. The form contained personal information, such as age and sex, and was used for statistical purposes. Other information was used to organize the tests. In addition, the form contained three questions that helped to assess a person's level of experience with platform games.

Participants in the research were asked to come to prepared rooms at the Lublin University of Technology. A computer with the game installed and two tested control devices were prepared.

Each participant took part in one session of the game in which he/she had to finish the prepared game. Once he/she completed the game the participant was asked to fill out a survey on user satisfaction. In the survey the player assessed his/her experience with the keyboard or controller (depending on which device he/she was using). The time of each game session was limited to 30 minutes.

Fig. 1. Screenshot of the game prepared for the purpose of research

All safety measures related to the prevailing SARS-CoV-2 virus pandemic were taken. The control devices were disinfected after each game session. The participants were required to wear masks covering the mouth and nose at all times. Rooms used were continuously ventilated. Only one room was used at any given time while the other room was thoroughly ventilated.

16 participants signed up for the study. They were divided into two groups of 8 people. People from the first research group used the keyboard while the people from the second group used the controller. The participants' characteristics used for statistical purposes, together with information on whether a given person was considered an experienced player, are presented in table 1.

Table 1. Research groups and participants assigned to them

Groups	Keyboard			Controller		
Participants	Sex	Age	Exp.?	Sex	Age	Exp.?
	M	24	Yes	M	26	Yes
	M	23	Yes	M	24	Yes
	M	23	Yes	M	24	Yes
	M	21	Yes	M	24	Yes
	M	24	No	M	24	No
	F	24	No	M	24	No
	F	24	No	M	24	No
	F	23	No	F	26	No

12 men and 4 women, all 16 aged 21 to 26, participated in this study. Due to the low number of participants caused by the pandemic, they were not divided into additional groups by experience. However, their experience was taken into account in observations presented at the end of the paper.

3. Results

The survey on the importance of studied parameters was addressed to people with experience in the field of video games. It received 57 responses, of which 18 were rejected due to inconsistent answers. Each question had 9 possible answers ranging from 1 to 9, where the number 1 denoted that the first parameter is very important and the second parameter completely unimportant, and 9 denoted the opposite situation. For each pair of assessed parameters, a mean was calculated from respondents' answers. The calculated means needed to be converted into a number corresponding to the importance values for the purpose of the AHP ($\bar{x}_2$) method (that is into a number from the following set {(1/5),(1/4),(1/3),(1/2),1,2,3,4,5}). In order to do that the non-integer part of the mean was left out and the following formula was used:

$$\bar{x}_2 = \begin{cases} \frac{-1}{\bar{x}-6} & ,\bar{x}-4<1 \\ \bar{x}-4 & ,\bar{x}-4\geq 1 \end{cases}$$

where $\bar{x}$ – is the average value of the answers for each of the questions (each pair of parameters). The reciprocal of this number was also calculated. It was needed to fill in the matrix, which was then used to calculate the parameter weights using the AHP method. The means of the responses for each pair of parameters, the transformed values expressing the importance values and their reciprocals are presented in table 2. For each pair of parameters,

the value of $\bar{x}_2$ below 1 means that the left parameter is more important than the right one, and the value above 1 means that the right parameter is more important than the left.

Table 2. Transformed parameter importance survey results – average, importance value, reciprocal

Parameter pairs	LT:DC	LT:MC	LT:GT	DC:MC	DC:GT	MC:GT
$\bar{x}$	4.79	4.26	5.38	4.95	5.23	5.64
$\bar{x}_2$	0.83	0.57	1.38	0.95	1.23	1.64
$\bar{x}_2^{-1}$	1.20	1.75	0.72	1.05	0.81	0.61

The transformed importance values for all pairs of parameters were placed in the matrix presented in the form of a table (table 3).

Table 3. Matrix of parameters with importance values

Parameters	DC	MC	GT	LT
DC	1	1.05	0.81	0.83
MC	0.95	1	0.61	0.57
GT	1.23	1.64	1	1.38
LT	1.20	1.75	0.72	1

After calculating the geometric mean of the rows in the matrix, weights for each parameter were calculated. The weights were used in an analysis of the results of the research with the participants. Geometric means of the rows are shown in table 4. The parameter weights have been rounded to the second decimal place.

Table 4. Geometric mean of the AHP matrix rows, computed priorities and their sums

Parameter	Geometric average	Weight
DC	0.916617412	0.22
MC	0.758109736	0.19
GT	1.291686175	0.32
LT	1.108888674	0.27
Sum	4.075301997	1

To make sure that the weights were correctly calculated, the CR coefficient was also calculated. It defines the logical consistency of the assigned weights. The coefficient value was 0.13. Its value slightly exceeded the typical threshold (0.1), but it was assumed to be sufficiently close (due to the number of received answers).

Then the research with participants described in section 3 was carried out. Results are presented below on the values of the measured parameters and responses to the survey on participants' satisfaction with using a given control device. Table 5 shows the results for the participants using the keyboard and table 6 for participants using the controller.

Table 5. Test results for the group using the keyboard

KEYBOARD									
Parameters				Survey					Exp.?
DC	MC	GT [s]	LT [s]	1	2	3	4	5	
55	0	547	14.28	2	3	2	3	2	Yes
157	23	1269.35	31.49	2	1	1	2	3	Yes
94	1	1163.12	26.49	1	1	1	1	1	No
24	0	396.82	18.08	1	2	1	2	1	Yes
145	17	1678.28	22.26	2	1	2	4	2	No
91	6	997.61	29.99	2	1	1	1	1	Yes
82	15	1098.94	31.03	1	1	2	2	1	No
99	2	1243.62	27.24	1	2	2	2	1	No

Table 6. Test results for the group using the controller

CONTROLLER									
Parameters				Survey					Exp.?
DC	MC	GT [s]	LT [s]	1	2	3	4	5	
107	30	1051.90	13.03	3	3	4	3	3	Yes
384	26	3095.85	30.34	3	3	3	3	2	No
113	10	876.49	17.21	1	3	3	2	2	No
106	2	738.38	13.11	2	2	1	1	1	Yes
105	6	809.57	48.74	2	2	3	2	2	No
239	519	2061.62	30.19	2	3	3	2	2	Yes
82	4	824.93	47.54	3	2	3	2	2	Yes
80	26	1444.44	19.86	7	6	7	5	7	No

4. Results analysis

The results of this research with participants described in Chapter 4 are presented in box graphs (Fig. 2). The graphs show the priority of the keyboard over the controller in the case of DC and MC parameters and the priority of the controller over the keyboard in the case of GT and LT parameters. Due to high variations in the results, a decision was made to use the median instead of the mean of values measured during the tests. Median parameters for both tested devices were determined.

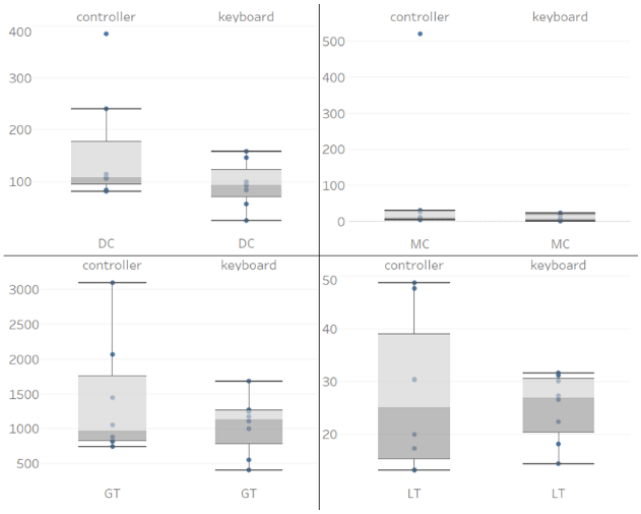

Fig. 2. Box graphs showing the values of all parameters for both tested alternatives (GT and LT are expressed in seconds)

Using the AHP method, two final results were calculated for the tested alternatives. The results are presented in table 7.

Table 7. Test results for both alternatives for median parameter values

	Keyboard	Controller
DC	92.50	106.50
MC	4.00	18.00
GT	1131.03	964.20
LT	26.87	25.03
Result	0.93	0.82

According to the results in table 7, of both compared devices, the keyboard turned out to achieve better results while playing arcade platform games. The parameter values indicate that it was easier to learn to control the character using the controller device, but fewer mistakes were made when using the keyboard.

In addition, the results of the survey regarding the satisfaction of using a given device show that the vast majority of participants using the keyboard assessed their experience with the device as "Very Positive" or "Extremely Positive", and the vast majority of participants using the controller – between "Positive" and "Very Positive". Among the responses of participants using the controller, there was also one very negative answer.

4.1. Additional observations

Without taking into account the variation in test results and calculating the final score for the keyboard and controller using mean values instead of medians, the keyboard had the smallest values for all parameters. This means that the end result for the keyboard was 1 (the highest possible) and the controller's score was 0.65.

Given the low number of participants and the study results, discarding the outliers proved pointless. For each of the alternatives, only four results remained and the final results of the AHP method of the two alternatives were evened out. This happened, however, because in most cases results making the final result lower were rejected for the controller, and results making the final result higher were rejected for the keyboard tests.

When looking at the results of only one group (the participants who were considered experienced or inexperienced), the final results also show the advantage of the keyboard over the controller, in spite of the low number of participants.

In addition, participants using the controller had an opportunity to choose which way of moving the character they wanted to use – the left knob or arrows. During the research, it was noted who used which method. It turned out that half of the participants (4 out of 8) used the knob and the other half used the arrows. This may mean that the ability to choose how to control the character affects the comfort of the player's gameplay.

5. Conclusions

After analyzing the results, it can be concluded that the keyboard is a device more accessible to users when playing arcade platform games. The results of surveys completed by participants at the end of each game session only confirm that using a keyboard is more satisfying than using a controller while playing this type of game.

Research may be repeated in the future with more participants to confirm or negate the above results. In addition, with a higher number of participants, it would be possible to divide participants into additional groups by experience to further investigate differences between control devices.

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