

Developing Exergame, Choo-Choo, Utilizing the Stepper

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Abstract

The widely spread exergames advertise in providing health benefits through entertainment. However the effectiveness of those in essence is questionable. This paper aims to observe muscular strength amongst others, which if proven effective, or otherwise, it will set out to identify factors associated with it, and to design more effective exergames for muscular strength in the extent to which basic criteria and factors must be met and considered. Lastly, it aims to develop exergames based on the design considered.

Keywords: *Serious Game, Motion-based game, Physical Game, Full-body-experience video game, motion sensing game*

1. Introduction

A game that is specially designed for a specific purpose, not of entertainment, with interactive entertaining factors is known as serious games. The idea was first described in the book ‘Serious games’ by a social scientist, Clark C. Abt, in 1977 [1].

A game that is designed to help relax and rehabilitate weak functions is known as game-aided rehabilitation, and is also called ‘serious game.’ [2].

Arguably, serious games that undertake functional role have extremely high growth possibility, especially when controversial social dysfunction is prevalent from induced excessive use of games including excessive immersion phenomenon, violence, gambling, inflaming, and others. This is due to huge increase in potential of serious games utilization from national level of support, and on various attempts with regards to developing functional factors and serious games.

A video gaming website Game Spot has viewed that according to a recent report released by research firm Gartner Inc., total worldwide video game sales for 2013 will reach \$93 billion, and is expected to rise further to \$111 billion by 2015 where video game market will continue to grow, in its article “Worldwide industry sales to reach \$93 billion in 2013” released on October 29, 2013 [3].

Comparable to such continued growth, number of motion sensing console-based games are being released, *i.e.*, exergames. Research showed that video game console devices such as Nintendo’s Wii, Microsoft’s Xbox Kinect, and Sony’s PlayStation®Move were most popular. Therefore it provided ample opportunities to observe the workings of the devices from playing motion sensing games. In order to evidence the effect of these exergames, a study was conducted by researchers at Baylor College of Medicine in Houston, Texas. The study selected 78 children between the ages of 9 to 12 where half of them were assigned to a group playing exergames (Wii Sports or Dance Dance Revolution, for instance), and other half assigned to playing games that did not require activity (Super Mario Galaxy, for instance)

over a 13-week period. The study concluded that there was no evidence to suggest that there is a difference in physical activity between the two groups, and this complete lack of difference shocked researchers, Tom Baranowski, Ph.D. among them [4].

Accordingly, this paper sets out to propose a model deemed most effective, albeit limited to muscular strength, in designing the exergame, and to develop an exergame utilizing the stepper based on such foundation.

2. Subject Matter

2.1 Previous Studies

Number of users continues to be caught in a vicious circle of playing exergames; getting disappointed with lack of results, getting frustrated over strenuous exercise and readily giving up, which many attempt to try taking in advertisements of various motion sensing games.

In other words, it is required to be designed so that the practical effect is given. With what certain factors should it be designed is observed next. First, the essence of game is fun. A game designer and science fiction writer Greg Costikyan defines game as “a form of art in which participants, termed players, make decisions in order to manage resources through game tokens in the pursuit of a goal” in his article <I have no words & I must design> [5].

Game is a means to active participation and selection, resource management, and carrying out decisions, which game tokens and game objectives are the key elements. Second, a step-by-step plan is required in order to apply muscular exercise. It is essential to progress with step-by-step applicable exercise plans.

A step-by-step plan that is easily adaptable to prevent and/or recover musculoskeletal disorders from warm-up to, and through, progressively advancing stages is required. (Keng-Sik Yan 2011) [6] Third, In-Young Seo (2012) [7] experimented and witnessed improvements in health and daily performance, and decrease in depression of institutionalized elderly women from a 10-week lower extremity strengthening exercise program. Accordingly, she states that to elders who are psychologically withered and whose health deteriorating, such exercise program could be suggested as a nursing intervention program that increases quality of life, for example, preventing disorders or improving functions, helping to increase physical activity and to participate in social activity, and giving emotional stability. Fourth and tafinal, Dong Hee Lee (2011) concluded in his experiment that there is no significant correlation between the flexibility and the lower limb strength where he was observing the extent of the correlation of the two [8].

In so evaluating the game design, arguably, continued effect in exergames is only achievable if the most important factor of a game, fun, is present. First, it needs to be designed so that a user is able to actively participate and select in game, able to utilize items, and accomplish a sense of achievement on both means and objectives, and this may be done by gaining insight into the relationship between human needs and games. Second, it needs to be designed so that a user is able to continuously play while not having been overstrained by the process, and this may be done by adjusting game levels so that it advances gradually. Third, designing exergames of strengthening lower limb strength needs to take priority in the continued participation in games, as strengthening lower limb strength can improve health and daily performance, and decrease depression, which all of the effects have been experimented and proven, not to mention the extensive study materials available. Lastly, evidence suggests that the reason for existing motion sensing games to be not as effective is with the lack of focus in goal and for which part that it needs to be designed. Correspondingly if an exergame is to have a purpose in strengthening muscular strength it is advised that it needs to be designed to fit the purpose in order to obtain desired effects.

We come up with problems of the functional game by case analysis and we bring up a new functional game that amends the defects. (Jeon Chang Young 2009) [9]

A tangible game is a motion-based game in which a player should move his/her body in person to make a motion in the game (Young-Sung Ga, 2014) [10]

(Ock-Hyun Yun 2011) his study indicates that MSVG (i.e. Nintendo Wii Sports) may positively influence gross motor skill and attitudes for students with intellectual disability [11]. Physical activity through physically interactive video games (Nintendo Wii) is an effective method for improving object-manipulation ability and balance of intellectually challenged students. (Yoon, Jun-Woong 2011) [12]

the game system can be utilized more widely in rehabilitation training with development and verification of game contents for muscle strengthening and cognitive learning (KO, YU MIN 2014) [13] Motion-based games make Mote controller to throw a ball at bowling, complex interface games are chiasme by crossing the physical game playing space, the real world sign of players' body, and the virtual world on the screen. The hybrid of the chiasme, which has heterogeneous elements of two worlds, works as an intrinsic mechanism of motion-based games. (Kim Eun Jung 2013) [14]

By clicking a specific button of Nintendo Wii e motion-based games with a controller as a representation system (Kim Eun Jung 2013) [14]

At present, Somatic Game has a good market; this novel approach makes many games bring a lot of different game effect. This positive development will make the game exudes the charm of diversity. The emergence of converged game will expand the game scope. A lot of games, through the integration of new games and new game types, have brought more colorful and more varied play fun (Li Xuanxi, 2012) [15]

Basing on these factors and references, two modes have been developed to fit individual capability: a speed mode where whoever comes in first wins and a timing mode where whoever correctly delivers minerals win. First mode is devised to help strengthen quick muscular strengths. Second mode is devised so that without putting too much pressure on legs player can achieve goals in a given time. Therefore even though the race is on a competitive environment, it should help players as adequately.

For instance, with the speed mode, player can gain speed only if stepper is stepped on more when climbing, and vice versa when climbing down to meet the objective. Similar concept is applied for the timing mode where player can load maximum amount of minerals if it reaches the station at exact time. Difficulty in level is posed for strengthening muscular strength to a minimum of 20 minutes where other levels and/or difficulties are adjusted accordingly.

3. Game Concept

3.1 Concept

“ Choo-Choo” comes from a motif of traditional Korean folklore of the rabbit and the turtle, and is developed in the form of exergame that is operated by player's impetus through connecting actual stepper to a casual racing game. A PC-based networking game that is played with a keyboard and a mouse normally provides entertainment but not much else. Whereas, the type of game this paper proposes with “Choo-Choo,” is designed so that by controlling and operating the game with player's physical movement, it contributes to increasing physical strength, muscular strength, and concentration. Moreover it hopes to contribute to the issue of existing online games with excessive immersion that it may be prevented from the lack of player's stamina.

Considering that the existing commercialized version of exergames have high entrance requirement that led to insubstantial usage, “Choo-Choo” should provide entertainment of casual gaming quality and at the same time exercising using stepper with reasonably affordable price.

3.2 Game Play

Racing is done by calculating each step taken on a stepper, which moves the train relative to the value translated. The game is played by running the executable file, and selecting map and a character, which then the objective is to reach the end point. The game requires the usage of stepper, and is designed for adults. The current prototype was developed with networking in mind.

Figure 1 presents the outlook of the stepper.

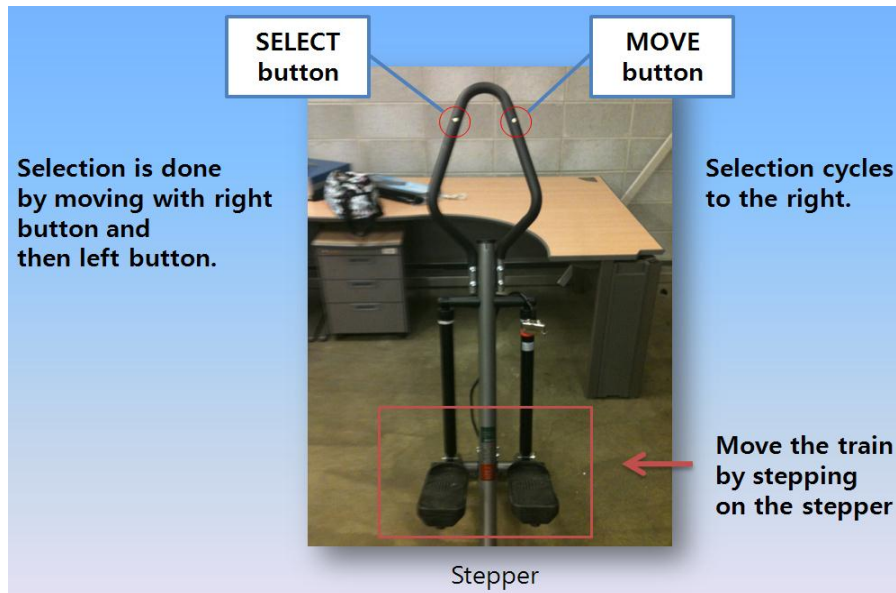


Figure 1. Stepper

3.3 Game Specification

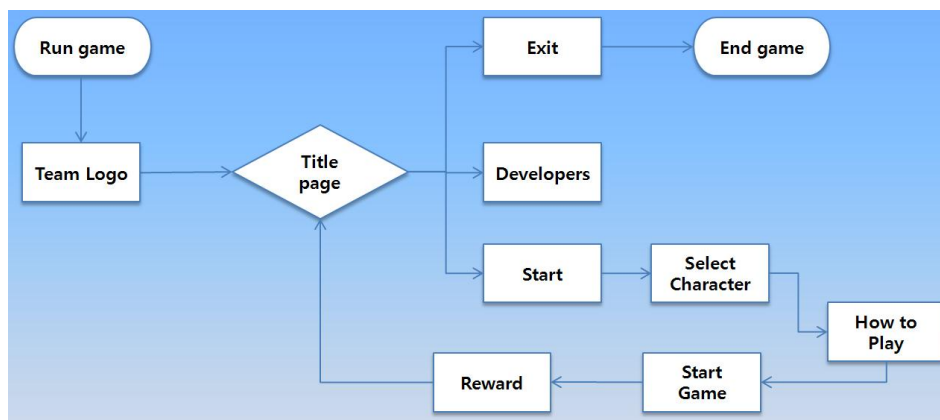


Figure 2. Flow Chart



Racing is done by calculating each step taken on a stepper, which moves the train relative to the value translated. The game is played by running the executable file, and selecting map and a character, which then the objective is to reach the end point. The game requires the usage of stepper, and is designed for adults. The current prototype was developed with networking in mind.



Figure 3. Game Screen



Figure 4. Graphic Resource Screen

3.4 Game Hardware Composition and Circuit Diagram

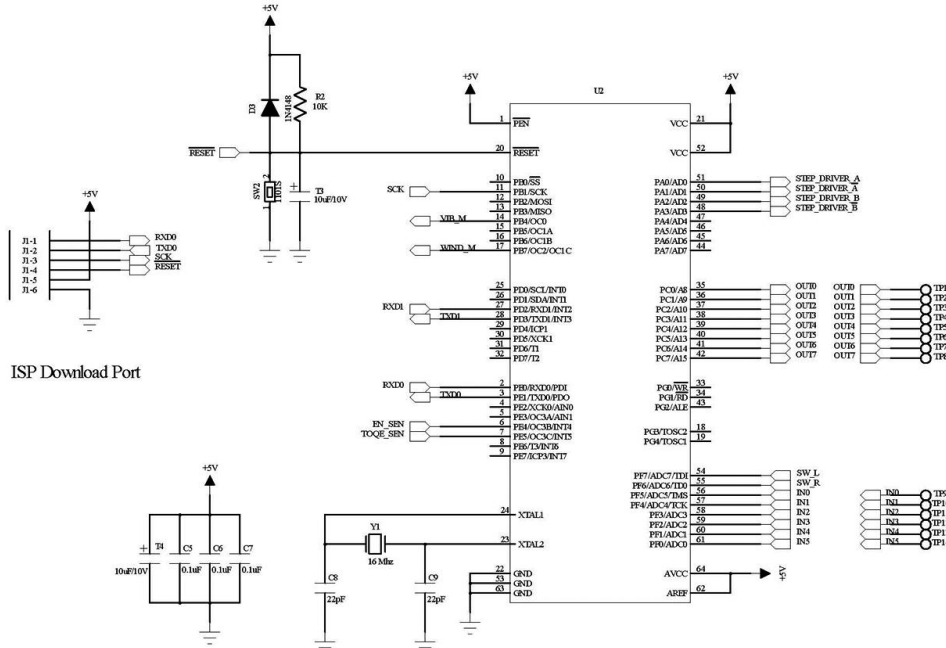
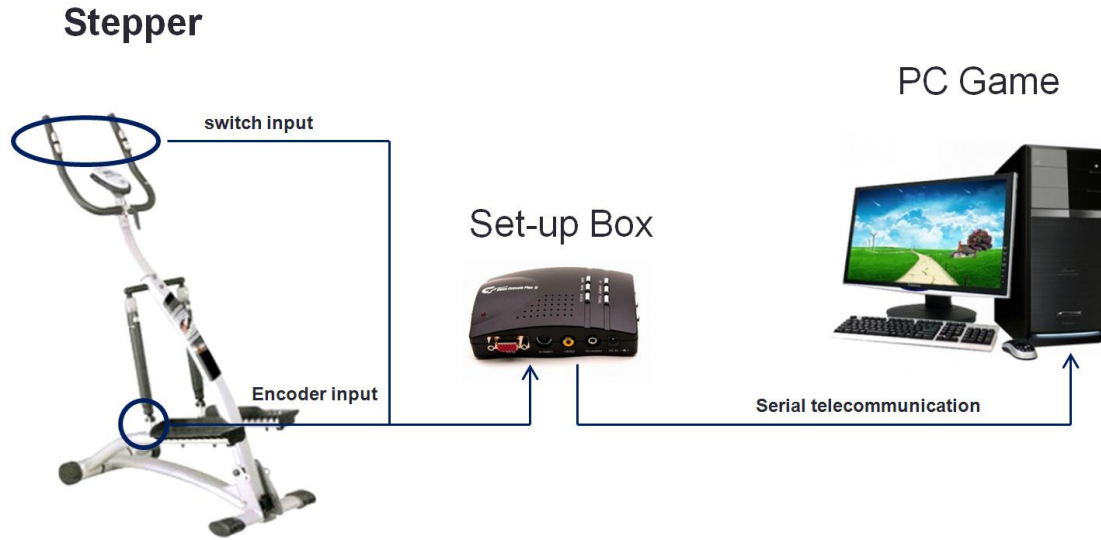


Figure 6. System Concept Diagram



[Fig. 5] Playing “Choo-Choo”

Game hardware Spec

- MCU : ATMEGA 128
- High-performance, Low-power 8-bit Microcontroller
- Up to 16 MIPS Throughput at 16 MHz
- 128K Bytes of In-System Self-programmable Flash program memory

Figure 7. Controlling Means

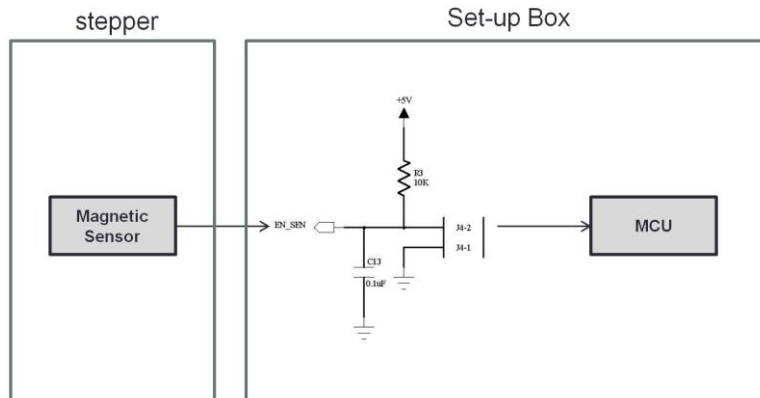


Figure 8. Input/ Output: Encoder Circuit

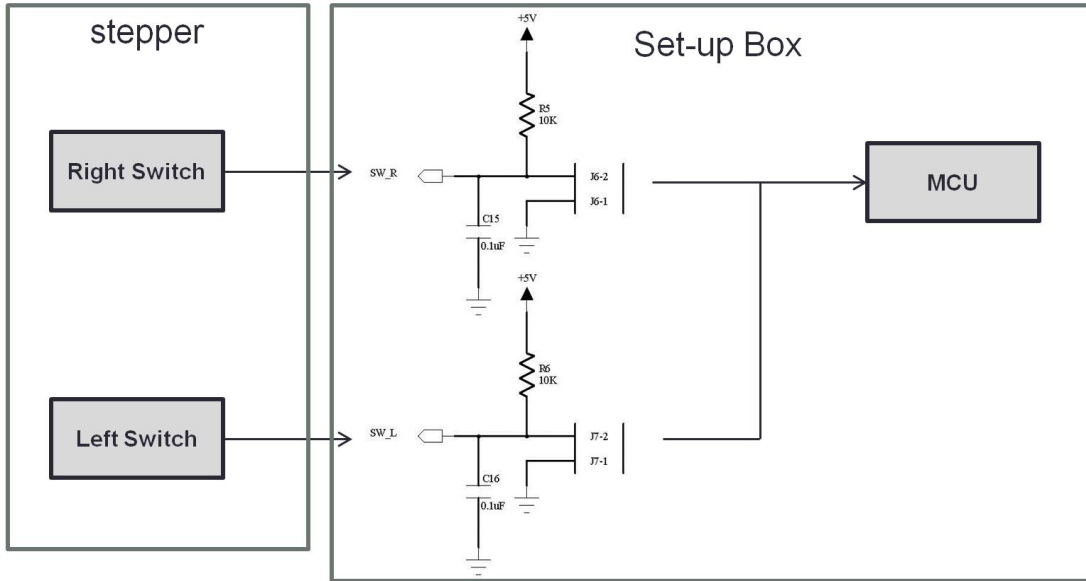


Figure 9. Input/ Output: Switch Circuit

Baud Rate(signaling speed) : 19600bps

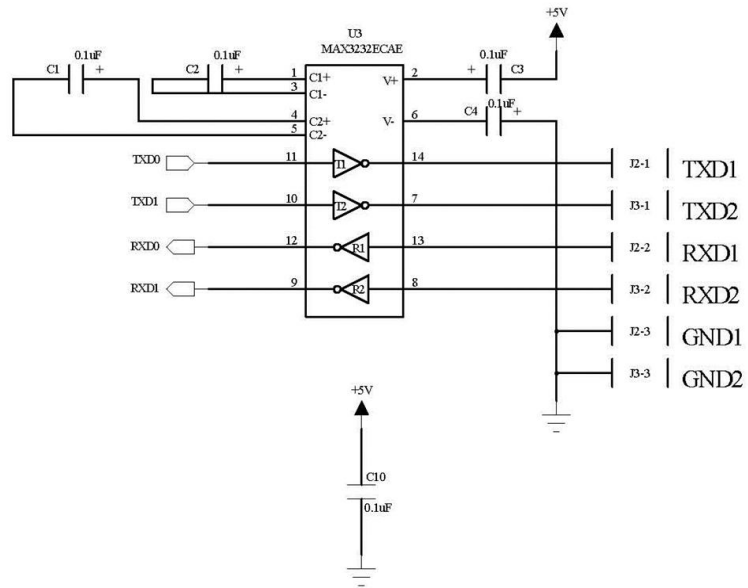


Figure 10. Serial Signaling

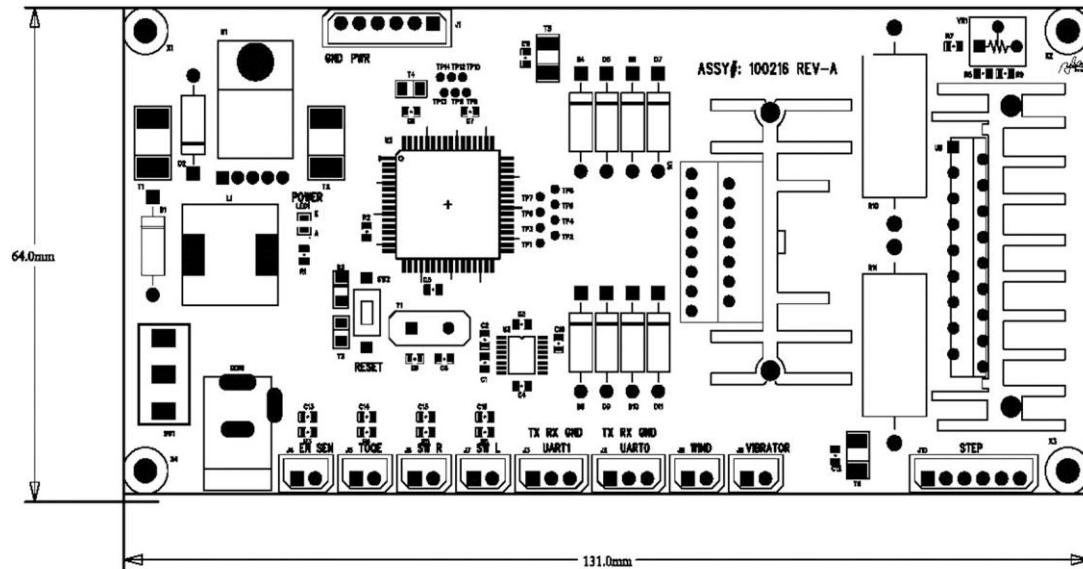


Figure 13. Circuit Board

4. Conclusion

This study recognized the need for designing exergames that is based on systemic research and basis, where ineffective exergames are prevalent in the present commercial market. It is with this background the paper researches developing games that may be enjoyed by young and old, men and women.

This paper case studies exergame that is easily accessible with using inexpensive stepper purchasable at a market, setup box, and a PC. Exergame is developed to have an effect of increased muscular strength and concentration, and is hoped to gain other positive effects such as eradicating depression from walking.

It is designed so that the feeling of achievement and accomplishment may be obtained in playing the racing game of competitiveness in nature, and level is set so not to put unreasonable pressure into playing the game. It is also devised to allow strengthening of muscular strength as well as increase in concentration by setting up a minimum running time of 20 minutes.

An exergame “Choo-Choo” that integrates software and hardware in the design as described above, is prototyped as a single mode. It however, embeds network function to aim for future development and deployment of network-connected game play. It is intended to further the research and yield proof of effectiveness in order to develop the most effective mode from testing young and old, men and women.

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