Augmented Reality Games for Upper and Lower Extremities Stroke Rehabilitation

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***Abstract*— Stroke is associated with impaired movement of the upper and lower extremities, and is a leading cause of disability. Traditional clinical stroke rehabilitation relies heavily on the presence of therapists, and patients often quit home-based rehabilitation programs, despite the importance of home-based rehabilitation in effective recovery. In this work, we propose scalable, engaging, augmented reality-based home-based exercise games for enjoyable yet effective stroke rehabilitation. To evaluate our exercise games, we recruit 12 healthy younger individuals, 10 healthy older individuals, and 2 stroke patients. Likert scale responses indicate that our exercise games are usable, enjoyable, and meaningful, as it relates to their perceived efficacy in stroke rehabilitation.**

I. Introduction

It is reported that stroke affects 795,000 adults in the United States of America every year [1]. It is estimated that 7 million Americans are victims of stroke [2]. Statistics suggest that up to 80 percent of stroke survivors get hemiparesis [3]. Physical therapy can help ameliorate the effects of stroke; yet the time spent with a therapist or rehabilitation specialist can be limited. Therefore, patients must practice at home, so that adequate progress can be made in the absence of the therapist or rehabilitation doctor. However, traditional home-based rehabilitation exercises have been reported to be repetitive, dull, and unengaging, causing some patients to discontinue their exercises [4]. While human rehabilitation specialists can actively engage patients in functional exercises, it is impractical to have a rehabilitation specialist physically present at all times, especially in home-based scenarios. Thus, there is a need for home-based rehabilitation that is engaging, interactive, and independent of a physically present rehabilitation specialist.

Prior solutions deploy video games as a viable alternative to make home-based rehabilitation more stimulating and appealing to complement a human specialist. A reason to implement video game solutions is that video games have been shown to enhance sensorimotor learning [5]. Hondori et al. made use of a projector and a webcam to monitor a users movement in drum, water pouring, and grasping games [6]. Although these games provided functional exercises, their user interface used relatively plain, simple graphics, such as monochromatic circles and black-and-white squares. It did not leverage the full power of augmented reality to create elaborate, detailed virtual environments. The lack of exciting, novel visual stimulation makes these games similar to traditional banal rehabilitation exercises. Burke et al. designed a framework of games to rehabilitate upper extremities [4]. However, this system was not subjected to a clinical trial. As such, they lack quantitative data regarding validity, reliability, and usability for real human users. Additionally, both of these systems lack exercises for the lower body, limiting the scope of their efficacy, since stroke affects both the lower and upper extremities.

In this work, we present a scalable, engaging system that uses smartphone cameras to facilitate fun, meaningful, home-based rehabilitation for upper and lower extremities. Particularly, we utilize augmented reality technologies to instantaneously recognize the users' movements as they play interactive exergames.

Our system presents multiple novelties which are not addressed by previous systems. It is designed to engage and motivate users at a level exceeding that of traditional home rehabilitation. Specifically, we gamified the functional exercises with immersive vivid graphics, arcade-style scorekeeping, atmospheric music, automatic audible positive encouragements, and built-in instructions. Additionally, in order to evaluate the validity and usability of our system, we conducted user trials on younger healthy, older healthy, and stroke cohorts. The results of our experiments show that performance on our system can distinguish the groups, indicating that performance on our exercises is a valid measure of physical ability. The users also gave generally favorable responses on the likert scale when asked about certain aspects of the game. This indicates that our system is user-friendly, with potential for further use. Finally, our system takes into account exercises for both upper and lower extremities, so as to rehabilitate a wider range of muscle groups affected by stroke, not just the upper extremities.

In summary, the contribution of our work is threefold:

- We introduce the design principles of scalability, user-centered activities, and efficacy of movements.
- We present a rehabilitation system, AR mRehab, which is a concrete prototype implementation of this model.
- We show through trials with users that AR mRehab fulfills our design principles, being user-friendly and having valid exercises.

II. Background and Related Works

Prior solutions deploy video games as a possible way to make home-based rehabilitation more stimulating and appealing. A reason to make video games for stroke rehabilitation, as opposed to other forms of media, is that

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video games, as a form of media, are designed to keep users engaged and interested through direct interaction for extended periods of time.

A. *Virtual Reality*

Some video game-based solutions deploy embedded sensors hardware in conjunction with virtual reality. Adamovich et al. developed a system employing virtual reality and a haptic glove to train finger motion in post-stroke patients [8]. Yet, this system has limited gamification, with the work making little mention of the enjoyability or entertaining aspects of the exercises from the perspectives of the users. Thus, this work has similar shortcomings to traditional exercises, in that it has limited engageability. Huang et al. created a similar system which also employed a smart glove to grasp virtual jewels in a game titled "Jewel Thief". In spite of its effective gamification, this work falls short in its strict hardware requirements, as a smart glove with embedded sensors can be cumbersome and unwieldy to use.

B. *Augmented Reality*

Other solutions make use of augmented reality. Hondori et al. made use of a projector and a webcam to monitor the users movement in drum, water pouring, and grasping games [6]. Although these games provided functional exercises, their user interface used relatively plain, simple graphics, such as monochromatic circles and black-and-white squares. It did not leverage the full power of augmented reality to create elaborate, detailed virtual environments. The lack of exciting, novel visual stimulation makes these games similar to traditional rehabilitation exercises, in that both are visually unappealing. In addition, no mention was made of automatic, audible, positive encouragements nor instructions. This means that when playing the games alone, there is no interactive guidance to help users remember and complete the tasks in the exercises. Additionally, the lack of audible positive verbal feedback means that the system may have a limited ability to motivate or encourage those users who are frustrated by the difficulty of the tasks, in the absence of a specialist. Burke et al. designed a framework with the games brick breaker and shelf stack [4]. However, this system was not subjected to a clinical trial. As such, they lack quantitative data regarding validity, reliability, and usability for real test subjects.

Moreover, most existing systems, whether they use virtual reality or augmented reality, are limited in their support for lower body exercises.

III. SYSTEM DESIGN GOALS

Our system was designed with the following goals in mind:

A. *Scalability*

We aim to ensure that our system can be accessible to stroke individuals. Thus, the hardware must be affordable and very commonly used.

B. *User-Centered Design*

Fun activities captivate more attention. Thus, our system is created to engage and motivate stroke patients to relearn movements at a level that exceeds that of traditional, mundane home rehabilitation. This can be achieved through interactive gamification and multi-sensory (visual, tactile, aural) stimulation. This is intended to incite interest in the exercises, resulting in higher adherence rates; multi-sense stimulation has been shown to facilitate stroke rehabilitation [9], [10]. Additionally, interactive games give users tangible and achievable goals to work towards, shifting the rehabilitation locus of control internally, meaning that they feel responsible for the success of their own rehabilitation. It is reported that an internal locus of control is associated with faster recovery from physical disability [11], [12]. While video games may not be the preferred form of entertainment for some people, adapting certain gamified aspects, such as audio and vivid graphics, into stroke rehabilitation exercises is more entertaining than incorporating no such features.

C. *Efficacy of Movements*

It is imperative for stroke victims to perform exercise movements that help their recoveries. Movements in traditional rehabilitation exercises, when performed correctly and consistently, can contribute to effective recovery from stroke. A main shortcoming of traditional home-based exercises is that they can become repetitive and monotonous to some patients. With this in mind, our system is designed to mirror the same variety of movements as are covered in traditional rehabilitation exercises, but in a gamified manner. This means that the actual muscle movements will be as effective for training, if not more effective, than traditional rehabilitation exercises, whilst incorporating the entertaining nature of a game. It is also important to train patients in the specific integrated motor skills and movements which are needed to live effectively and independently in the real world. Considering this, our system also includes exercises emulating ADLs (Activites of Daily Living). The exercises require the coordination of multiple muscle groups, as in everyday life.

IV. SYSTEM SETUP

In determining the setup of our system, our goal is to ensure that the user experience with the prototype is both convenient and comfortable.

A. *Hardware Setup*

We wanted a computer vision camera that is both easy to obtain and easy to use. To meet these mandates, we employ a regular Apple iPhone. The iPhone is widely available, and has an intuitive, user-friendly, ergonomic interface and design.

It is necessary to place the phone screen in a position that is comfortable for users to view. Thus, the phone screen is oriented at an angle parallel to the users' eyes, so as to not strain their necks. To accomplish this, we attach a reflective mirror to the smartphone camera lens, reflecting

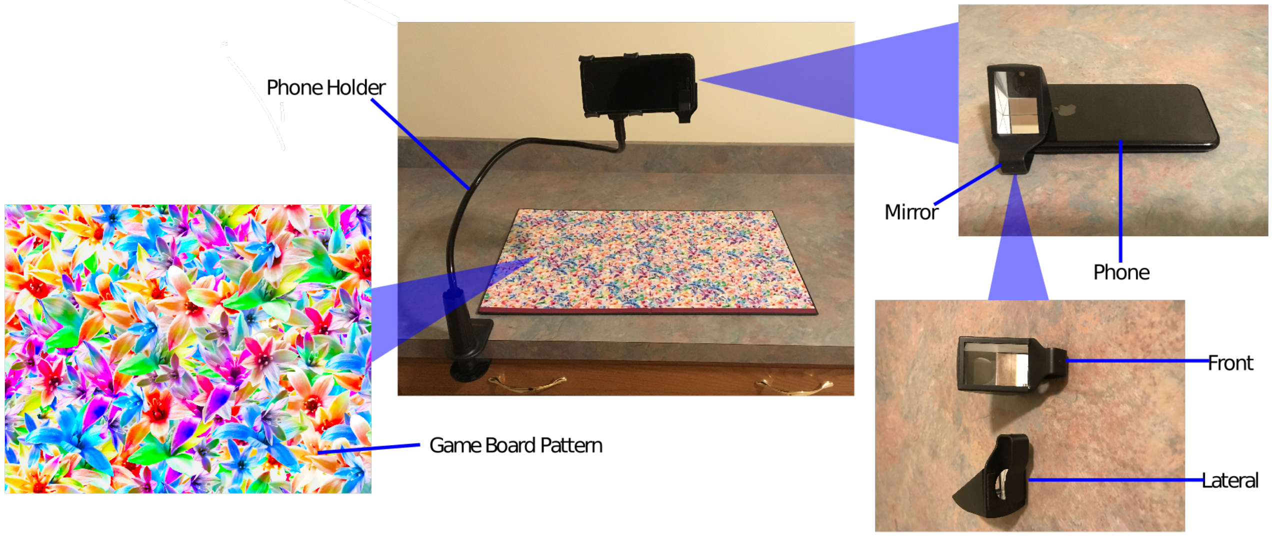


Fig. 1: Our hardware setup.

light at approximately a 90 degree angle. Without such a mirror, the phone screen would need to face the ceiling in order for the system to get camera input, causing users to bend their necks in uncomfortable positions.

It was also important that the users do not need to manually hold the phone by themselves, so that they can have greater freedom of movement. Therefore, we leveraged a goose-neck phone holder. This is specifically designed to hold the phone in its ergonomic, user-friendly position during the game. The system setup can be seen in Figure 1

B. Customized Rehabilitation-Specific Prototypes

The purpose of physical rehabilitation is to prepare users for ADL's (Activities of Daily Living). In real-world household tasks, people must interact with physical objects, like knives and mugs. Accordingly, we used computer aided design and 3D printing to create ergonomic plastic mugs and knives to be held in some games. These 3D printed objects are similar to their real-world counterparts, and are inexpensive to produce.

In order for the computer vision module to work, it was necessary to include patterns that were recognizable by the computer. As such, we used GIMP to make non-repetitive, detailed images for use in the functional exercise games. The patterns are optimized for image tracking [13].

V. Description of Exergames

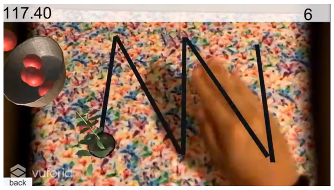
Our suite of exergames contains seven distinct games. These games exercise a variety of different motor tasks for both upper and lower extremities. We gamify all of these functional exercises with vivid graphics, arcade-style scorekeeping, atmospheric music, automatic audible positive encouragements, real-time quantitative progress monitoring, interactive feedback, and built-in instructions. This is intended to engage patients through multi-sensory stimulation.

A. Upper Extremity Exercises

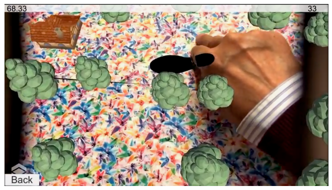
1) Pick a Plant: Without proper movement of the forearms, muscular ability and flexibility quickly deteriorate [14]. Accordingly, this game exercises forearm movement. In order to achieve this objective, virtual plants are spawned in an assortment of patterns (zig-zag, elliptical, straight line), which the user must trace in sequence. The score is denoted by the number of plants the user was able to trace. In order to follow such patterns, the users must be able to move their forearms in multiple, specific directions, as illustrated in Figure 2a.

2) Walk the Path: This game is similar in objective to Pick a Plant, focusing on coordinated forearm movement. In this game, the user traces a path through different terrains by following footprints, shown in Figure 2b. The score is measured by the number of footprints the user successfully followed. While this game has essentially the same purpose as *Pick a Plant*, forearm movement is important enough to warrant multiple games dedicated to its exercise. The addition of this game provides variety in graphics and game play, encouraging the users to continue to practise forearm motion, even when they have decided to complete playing *Pick a Plant*.

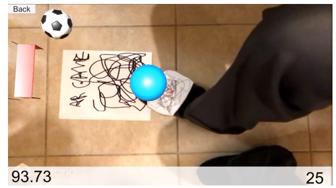
3) Handprints: Practical, real-world movements require the conjunctive cooperation of both hemispheres of the brain and body. In fulfillment of this need, this game is designed to improve coordination of the left and right hands. In this game, handprints are randomly generated on the board, dictating the positions the hands of the users are to be placed in, as displayed in Figure 2d. The users must first place their left hands upon the first handprint. The location marker for the right hand spawns only after the left hand is placed and held in the appropriate position. The score is denoted by the number of times the user has successfully placed both hands on the board. This impels the user to



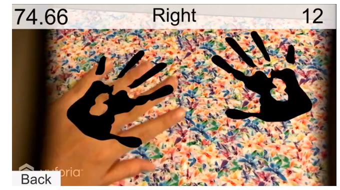
(a) *Pick a Plant*. The user grabs for the plant which has just spawned.



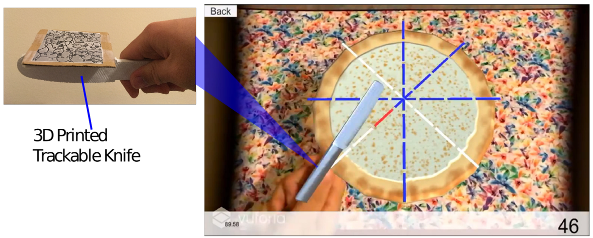
(b) *Walk the Path*. The user traces the footprints.



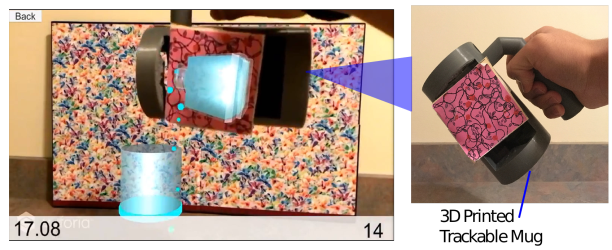
(c) *Soccer*. The user has kicked the soccer ball at the net.



(d) *Handprints*. The user has placed her hand on the left print, and is now prompted to place her right hand.



(e) *Pizza Cutter*. The user is cutting the pizza diagonally.



(f) *Slow Pour*. The user is successfully filling a cup.

Fig. 2: The exergames.

simultaneously employ both hemispheres of the brain and body for successful completion of the task.

B. Lower Extremity Exercises

Stroke affects both the lower and upper extremities. However, to our knowledge, few effective previous games exist that practise lower extremity rehabilitation. Yet, effective lower extremity rehabilitation is crucial to full recovery from stroke. As such, this game's focus is solely on lower body movement. To allow users to exercise their lower extremities, the setup is changed for this game, with patterned images both on the floor and on the user's foot; this allows the software to track the position of the user's foot in relation to the floor. In this game, virtual soccer goals are randomly generated for the user to kick the soccer ball into, as shown in Figure 2c. The score is recorded based on the number of times the user successfully kicked the ball and the number of goals that were scored. The primary movements exercised in this game are hip flexion, plantar flexion, hamstring stretching.

C. ADL Simulation

1) Pizza Cutter: A major objective of physical therapy is to allow patients to regain the skills needed for independent, self-sufficient living. Thus, the design consideration for this game was to practise real-world object manipulation, specifically, the cutting of food. In this game, the user is presented with a virtual pizza. The user is then prompted to use the customized knife to cut the pizza along the specified line segments, illustrated in Figure 2e. Points are accumulated based on the number of times the pizza has been cut. The pizza will only be cut if the knife is held at an appropriate angle that matches the line segments.

2) Slow Pour: Continuing the objective of practical, realistic interaction with physical objects, our suite also includes a game where water is poured into virtual cups. The user holds a 3D printed mug against the patterned background image, shown in Figure 2f. The virtual cups are randomly generated along the base of the background image, requiring the user to move his or her forearm to the specific locations of the cups in order to fill them, as conveyed in Figure 2f. In addition, the user is warned when water is poured outside of the cup or if the cup is being overfilled. The score is measured by the number of cups that were successfully filled without wasting excessive amounts of water. In order to fill the cups to the correct levels without spilling water, the users must use controlled, steady movements. These movements require the coordinated use of multiple muscle groups, as would be required in the real world.

VI. System Implementation

A. Rationale for Software Development Modules

We select the software development modules that best fit our philosophy of creating a scalable, user-friendly experience. As a means to this end, we leveraged the Unity Game Engine, C#, and Vuforia Augmented Reality.

It was necessary to create software that is easily deployable to stroke victims. In selecting a game engine, we looked for a platform that creates games that are universally supported by a variety of operating systems, so that a patient's ability to rehabilitate using our app would not be limited by the brand of phone used. Another criterion we had for a game engine was that it should have a low incidence of runtime errors and game crashes that could interrupt the functional exercises. The combination of these factors is why we chose Unity. Unity has support for both Android and iOS games, fulfilling the first requirement. Unity is also optimized for efficient runtime performance and graphical rendering, meeting the second goal.

Considering our choice of Unity for a game engine, we needed to select a programming language that is compatible with Unity. We select C# because it is the de facto scripting language of choice for the Unity Game Engine, ensuring that our program scripts can be compiled and used by the game engine.

For the augmented reality module, we require an augmented reality platform that has a wide variety of functions and features that are adaptable to exergames. Thus, Vuforia is used. Its libraries come with a plethora of functions and features that can easily be adapted to detect, track, and augment customized images from the physical environment in real-time. For instance, these libraries allow our software to superimpose specific interactive game objects over our customized physical images while the user performs the specially designed functional exercises. This adaptability ensures that the augmented reality module can be incorporated to meet the specifications of the functional rehabilitation exercises, as opposed to the functional rehabilitation exercises being designed to fit the limitations of the augmented reality module. Additionally, Vuforia's application programming interfaces are integrated with Unity and C#, meaning that it is easily incorporated into our other development modules.

B. Effective Image Recognition in Vuforia

Although Vuforia is a powerful augmented reality standard development kit, we initially faced difficulties with the image recognition module. In playing the *Slow Pour*, *Pizza Cutter*, and *Soccer* games, the tracked images are in motion. During game play of the *Pick a Plant*, *Walk the Path*, *Piano*, and *Handprint* games, parts of the game board are covered. In all of the games, the camera must be held at a reasonable distance from the target images. However, Vuforia was initially was not very robust nor effective in tracking moving images, partially covered images, and distant images.

As such, there were considerations that we made in order to further optimize image recognition. Specifically, we made the target images to contain sufficient contrast, have high detail, and be non-repetitive [13]. As shown in Figure 1, the game board we designed has a highly detailed, unique pattern which strictly adheres to these guidelines. With the designs of these images, our system was significantly more able to track moving, partially covered, and distant images.

VII. EVALUATION

A. Subject Recruitment

To validate the efficacy of our system, we recruited 24 participants in 3 cohorts. The subjects are categorized as follows:

- 12 healthy younger people ($Age_{avg.} = 22.8 \pm 7.8$),
- 10 healthy older people ($Age_{avg.} = 57.9 \pm 9.9$),
- 2 stroke patients ($Age_{avg.} = 67.0 \pm 8.5$)

We chose to compare healthy younger, older, and stroke participants to show that there is a difference in performance in the functional exercises between the younger people, whose bodies generally are not affected by motor impairments, and the older and stroke people, whose muscular and neural performance have typically declined. We specifically chose to test the system for younger people to clarify that our system is indeed conducive to the cohort that is more familiar with technology, as identified in the usability questionnaire. We tested older people, who are used as the baseline, to see how people in their age range would perceive the technology. As for stroke patients, we tested only two, because our exergames are in a prototype stage, and we were only looking to test their viability to obtain validated learning outcomes.

To the best of our knowledge, we verbally verified that our participants did not have cognitive impairments.

B. Cohort Performance

In collecting our user data, we took into consideration that participants would perform at sub-optimal levels when learning how to play the games for the first time [15]. For this reason, the participants played two trials of each of the games. A third trial was not done, as stroke patients tend to become fatigued by the third attempt, and we did not want participants' fatigue to interfere with genuine usability results [16].

Score in the games is measured by the number of times the participant was able to successfully complete the task required by the specific game. For each trial, we calculated the rate of scoring using the formula $rate = score / time$, where $score$ was the final score achieved, and $time$ was the time in seconds taken to achieve the score. There was a maximum time limit of 120 seconds, so as to likely not fatigue the participants.

For the younger and older healthy cohorts, $score$ and $time$ came from screen recordings of the phone game interface; for the stroke cohort, $score$ and $time$ were obtained through analysis of footage of the actual patients playing the games. We employed this strategy since footage of stroke patients would provide more insights into their efforts, as opposed to screen recording. We figured that screen recording alone would suffice for the healthy cohorts.

Figure 3 compares the average performances of the older, younger, and stroke cohorts. The data were normalized with the calculation $relative\ performance = rate_{cohort} / rate_{old}$, to provide a uniform standard of comparison across different games. We choose to use $rate_{old}$ as a benchmark, because their average age is similar to the average age of stroke patients, and they are also physically capable of performing the exercises correctly.

The young healthy cohort outperformed the old healthy cohort, which outperformed the stroke cohort, in all of the games, as expected. The stroke cohort's best performances came on *Walk Path*, *Pick Plants*, and *Hand Prints*; their worst were on *Cut Pizza*, *Pour Water*, and *Soccer*. This is because the stroke patients were generally able to perform gross forearm movements, as required in the first three games. However, they were unable to perform ADLs, as required in *Cut Pizza* and *Pour Water*, since these required precise motor coordination. As for *Soccer*, they seemed to have difficulties

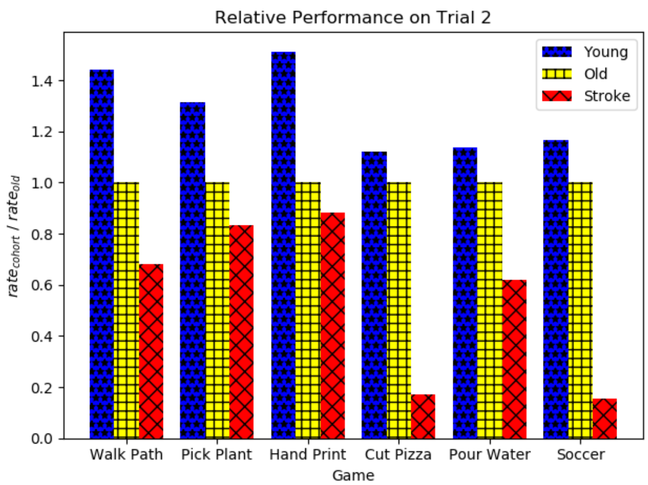


Fig. 3: Comparing the performance of the young and stroke cohorts to the old healthy cohort.

performing plantar flexion. Regarding the younger cohort, their best performances were in *Walk Path*, *Pick Plants*, and *Hand Print*. This is because these games rewarded speed, which the younger cohort was best in. The other games were more focused on precision and coordination, which were similar between healthy cohorts.

C. Likert Scale Results

Additionally, participants were requested to complete quantitative usability ratings on a 5-point Likert scale.

In general, the healthy participants responded with positive ratings for all four categories. Only one stroke patient responded, as the other patient did not have time. The one stroke patient that responded gave mixed ratings. During the clinical trial, this patient was observed to have difficulty using the 3D printed objects during the ADL simulations; the patient also had difficulty orienting the foot during the lower body exercise. This likely contributed to the low numerical ratings given. The data is summarized in Figure 4.

VIII. FUTURE WORKS

Overall, our system showed potential for future application for stroke rehabilitation. However, we wish to make further extensions of our framework.

First, the physical hardware and objects must be redesigned to be more conducive to the exercises. Particularly in the ADL simulations, participants had trouble holding the knife and mug in an orientation that was recognizable by the camera. We plan to use different algorithms to track these objects.

Secondly, fine motor training of the fingers and toes, in addition to gross motor training, is important for recovery from stroke. Currently, our system mainly addresses gross motor training of general areas such as the forearms. For the next iteration of our system, we plan to add exercises to train the finer motor movements of the fingers and toes. However, Vuforia's functions mostly relate to detection of static, unchanging patterns. It is not optimized to recognize the precise, real-time motion of the fingers and toes.

Thirdly, it is important to test a larger cohort of stroke patients. Our initial study involved two stroke patients. We plan to involve more participants with stroke in future studies, so that we can better optimize our system for the group for which it is designed.

IX. CONCLUSION

In this work, we propose an augmented reality system that provides scalable, engaging, functional stroke rehabilitation exercises. We use augmented reality technologies in conjunction with smartphones to display the exercise games in the user interface. The impact of our system is that it can increase adherence rates to home-based rehabilitation programs, ultimately increasing post-stroke quality of life.

APPENDIX

ACKNOWLEDGMENT

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Statement	Agreement (SD)		
Meaningfulness	**Younger**	**Older**	**Stroke**
1. Walk the Path	3.8 (1.0)	3.7 (1.2)	3.0 (0.0)
2. Pick a Plant	3.8 (0.9)	3.9 (1.0)	4.0 (0.0)
3. Handprints	3.8 (1.3)	4.2 (0.8)	3.0 (0.0)
4. Pizza Cutter	3.8 (0.8)	4.7 (0.5)	1.0 (0.0)
5. Slow Pour	4.3 (0.8)	4.8 (0.4)	1.0 (0.0)
6. Football	4.5 (0.5)	4.2 (0.8)	1.0 (0.0)
Systems Usability - Positive			
1. I think that I would like to use this system frequently	3.7 (1.0)	3.9 (1.2)	4.0 (0.0)
2. I thought the system was easy to use	4.3 (0.5)	4.2 (0.8)	2.0 (0.0)
3. I found the various functions in this system were well integrated	4.3 (0.6)	3.9 (1.1)	4.0 (0.0)
4. I would imagine that most people would learn to use this system very quickly	4.1 (0.9)	4.1 (0.6)	2.0 (0.0)
5. I felt very confident using the system	4.2 (1.0)	4.0 (0.9)	5.0 (0.0)
Systems Usability - Negative			
1. I found the system unnecessarily complex	2.4 (1.4)	1.7 (0.8)	3.0 (0.0)
2. I think that I would need the support of a technical person to be able to use this system	2.8 (1.4)	2.0 (1.3)	3.0 (0.0)
3. I thought there was too much inconsistency in this system	2.8 (0.9)	1.8 (1.0)	5.0 (0.0)
4. I found the system very cumbersome to use	2.3 (1.2)	1.9 (0.9)	4.0 (0.0)
5. I needed to learn a lot of things before I could get going with this system	2.2 (0.9)	1.5 (0.5)	5.0 (0.0)
Technology Acceptance			
1. Using the system would improve my performance	4.3 (1.0)	4.3 (1.3)	5.0 (0.0)
2. I felt that my interaction with this system was clear and understandable	4.5 (0.9)	4.4 (0.7)	3.0 (0.0)
3. Interaction with this system does not require a lot of mental effort	4.7 (0.7)	4.2 (1.0)	1.0 (0.0)
4. Learning to operate the system was easy for me	4.3 (1.0)	4.3 (0.7)	N/A
5. I found it easy to get the system to do what I want it to do	4.1 (1.0)	4.1 (1.0)	1.0 (0.0)
6. I like the idea of using the smartphone-based system	4.5 (0.9)	4.4 (1.0)	4.0 (0.0)
7. If I have continued access to the system, I want to use it as much as possible	4.0 (0.9)	3.7 (1.3)	4.0 (0.0)
8. If I heard about a new technology, I would look for ways to experiment with it	4.7 (0.5)	4.3 (0.7)	N/A
9. Among my peers, I am usually the first to try out new technology	4.2 (0.7)	3.3 (0.9)	N/A
10. In general, I am not hesitant to try out new technology	4.6 (0.7)	4.5 (0.5)	N/A
11. I believe that I have the necessary skills for using the smartphone-based system	4.8 (0.4)	4.6 (0.5)	5.0 (0.0)
12. These activities give me a sense of accomplishment	4.5 (0.8)	4.1 (1.0)	4.0 (0.0)
13. These activities give me pleasure	4.6 (0.9)	4.0 (1.2)	4.0 (0.0)
14. These activities give me a sense of satisfaction	4.5 (1.0)	4.1 (1.2)	4.0 (0.0)

Fig. 4: The results of the meaningfulness, usability, and technology acceptance scales. 1 indicates ”Strongly Disagree”, and 5 indicates ”Strongly Agree”. 23 subjects gave responses, with the exception of 1 stroke patient.