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A NOVELGAME APPLICATION ON AUGMENTED REALITY FOR PEOPLE WITH DISABILITIES

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ABSTRACT

This article focuses on game development using Magic Leap One's Augmented Reality technology, the Lab and Unity Engine, in a fruit-grabbing game. The application helps People with Disabilities (PWD) exercise through participation in a game. It gives caregivers choices for assessing body mobility and limb biomechanics through collection of quantitative outcomes. Collecting fruits in augmented reality (AR) is made into a game to keep PWD interested while conducting balance and solder joint Range of Motion (ROM) exercises. As a PWD advances from starting location to destination, a Mixed Reality (MR) application of Augmented Reality (AR) technology deploys a computational reasoning process based on four layers. Under a care provider's supervision, the game's complexity increases with more obstacles in each level. It gives healthcare practitioners a numerical value of the time and an achievable aim. The game attempted to boost learning effectiveness while the PWD participates in a game designed to invoke enthusiastic participation and the care provider was able to assesse the improvement using the application statistics. The goal is to leverage MR technology to improve convergence in computing education and the deployment of computational thinking (CT) within application creation to help players strengthen their thinking process and self-confidence through game play. Experts evaluated the test afterward. Overall, game assessment focuses on fruit-grabbing skill relative to project objectives. Users rated it 77.8% and experts 88.6%. Assessments proposed adding educator or trainer workshop guidelines. This strategy contributes to healthcare research by integrating cutting-edge technology as an optional teaching tool in fruit-grabbing game for elementary students.

Keywords: Magic Leap Goggles, Sensors, Healthcare, Augmented Reality, Biomechanics

I. INTRODUCTION

Augmented Reality (AR) is a reality-based technology that allows the integration of virtual objects into the real world environment [1]. This game, developed on AR, exhibits a new user interactive experience for the exercise and the results were further observed and accessed by the therapist. Magic Leap and Microsoft are currently the only two companies with a wearable AR device for consumer use [2]. Each wearable AR device contains a hardware similarity: a unique head-mounted display (HMD), a wired CPU unit, and a handheld remote [3]. Specific to Magic Leap's (ML1) device, each hardware device bears a specific name: the unique HMD is known as light wear, the wired CPU unit is known as light pack, and the handheld remote is known as the control. Furthermore, proper setup for light wear requires placement on the crown of the end-user's head, allowing the goggles to wrap around and sit comfortably over the end-user's eyes. When the ML1 device is powered on and operated by the end user, the light wear generates a visible field of view that contains predetermined images and other digital objects by projecting light through the lenses of the light wear and into the eyes of the end user, allowing digital objects to be processed the same as natural light [4-5].

AR devices and their functionality are used in various fields; however, they are primarily used for medical, military, and educational purposes [6]. Specifically, the skill-based training of personnel to properly handle field-specific situations and simulations [7]. These devices have certain attractive features for end-users in tasks-oriented roles and positions. Characteristically, AR devices are compact, portable, and do not take up significant space on the end-user's appendages [8]. Additionally, AR devices are also easy to use and hands-free, since the visual component can recognize hand gestures. Currently, these devices do not interfere with physical maneuvers or task-specific objectives completed in the real world while wearing a device. Thus, other wearable technologies can be used in unison with ML1 to improve the end user experience and allow movement performance while performing task-specific objectives in the real world [9].

An Attitude and Hearing Reference System (AHRS) is a sensor that contains a three-axis gyroscope, a three-axis accelerometer, and a three-axis magnetometer that together make up an internal component within the AHRS device called an Inertial Measurement Unit (IMU). The AHRS IMU sensor allows data collection on the three-dimensional assessment and analysis of an object's movement in real-time [10]. Specifically, linear and angular acceleration, velocity, and position are assessable measurements while wearing an AHRS IMU sensor [10]. Wit Motion is a company that has designed an AHRS IMU sensor with Bluetooth capability for use in various fields, including engineering and movement sciences. When paired with multiple other AHRS IMU devices, this device can assess movement about a joint and its biomechanical interaction with other joints during exercise activity with respect to human movement [11].

During exercise and human movement, motor control is how an individual can perform concise and controlled movements. An essential contributor to motor control is proprioception, an individual's ability to assess joint position and motion during movement. Specialized training protocols are designed for use in populations experiencing balance abnormalities or poor proprioceptive capacities [12]. This proprioceptive training involves both static and dynamic balance and postural stability and is theorized to be beneficial for patients with balance-related functional impairments. However, with aging and the associated sensory impairments and cognitive decline [Humes & Whitson], the elderly are at increased risk of falling while performing basic activities of daily living (ADLs).

Thus, we developed a visual content with capturing different objects in Unity 3D as visual stimuli and investigate the effect with and without visual stimuli. Our approach and pilot study can be a basis to develop VR-based effective rehabilitation for the shoulder movement test using Unity 3D. The methodology, adopted within this study, involved the development of an optimized theoretical design for an activity-based rehabilitative AR application and an analysis of simulated movements performed using data collected from Wit Motion sensors.

The primary goals of the exploratory phase were to construct a theoretical foundation for why the ML1 device was intended to be used, what benefits AR can provide the target population, and design a conceptual framework explaining the technical foundations behind application development. To understand the function of the ML1 AR device, we observed the device's use and practiced operating the technology using the various available applications. Upon learning to use the device, the proposed use of this technology was considered within the fields of exercise science and rehabilitation due to its controllable and modifiable interactive capacity. Due to the multifunctional potential of ML1 and the supportive tools provided between Unity and the Magic Leap Developer Portal, developers can meet a critical goal within product development; specifically, the developer can create and design an application to fit the needs of the end-user [12].

Currently, during the completion of the needs analysis, certain aspects of it can answer key questions that also assist developers in creating variables regarding the interactable objects. This is where the modified portion occurred and was used to assist developers in understanding how the application can remain relevant for practical use within an elderly population. The purpose of this modification was to control the amount of exercise the end-user performed and attempted to ensure voluntary participation and safety throughout the end-user experience. Specifically, in the case for this theoretical application design, the researchers found the two most important questions regarding variable assessment were: "How much walking will the subject perform?" and "How many pivots will the subject be performing while walking?". These questions were translated to developers as 'How far can we place each object?' and 'How many objects can we place?', respectively. Thus, understanding the target population can assist developers in accurately designing applications for the benefit of the target population and in accurately focusing on the purpose of a designed application.

Currently, these devices are used primarily for educational purposes in the medical and educational fields [13]. Therefore, the purpose of this development of application and its usage was to provide a foundation for a product that can support, guide, and evaluate the elderly during exercise.

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II. PROPOSED METHOD

A. Machine Learning (ML) Application Development

Magic Leap is a wearable head-mounted AR system that transmits an immersive holographic three-dimensional (3D) concept into a real-world environment. The three-part headset system features a Light wear, Light pack, and hand-held Controller, called "a spatial computer" by its creators. It allows the user to monitor their location with freedom of movement, without the need to install additional sensors. Magic Leap device, upon loading an AR application, involves some degree of activity, the setup and function of a motion-based sensor system, and an experiment to evaluate potential movements performed within an AVG AR application.

B. Machine Learning Application Testing

In the proposed research, a Machine Learning (ML) application for the elderly patients was developed. ML application was used for diverse types of exercise and body movement measurement. The Unity platform was utilized with High Computation Power for the ML application development.

In the present research, a ML catch fruit (100 fruits) application was specifically developed using Unity platform for ML game development and uploaded to App Store. ML App Store was selected, as an example to provide of what is currently available for individuals to use as an interactive application. Figure-1 shows the Magic Leap menu where the 100 fruits application was downloaded.

Figure 1: ML home menu when the device is powered on.

In 100 fruits game, we have proposed different types of fruits like apples, bananas, mangos, pineapples, strawberries and many more. As shown in Figure-2, the 100 fruits application was imported onto the application list through the Magic Leap device bridge (MLDB).

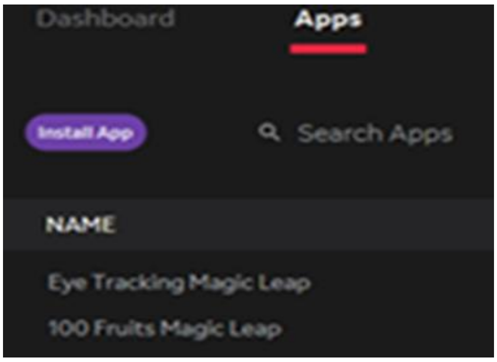

Figure 2: 100 fruits app shown in the list of searchable device bridge apps.

Concurrently Figure-3 is a visual representation of the upper body movement of an end-user and hand gesture and movements. The example illustrates the pinching, performed to interact with the in-game objects that appear within the application during a given instance.

Figure 3: Applications can function using hand gestures like pinching.

The proposed ML application goal was as how many fruits catch in different time duration as 30s, 45s, and 60s could be made. The specific time duration was extremely helpful for the selection of the diverse levels of speed to fruit catching. The ML device was connected to the mobile and the computer/laptop via Bluetooth and USB-C type cable. The Magic Leap mobile application allowed others to visually observe what the end-userwas looking for through the mobile application.

The ML device was connected to the mobile and the computer/laptop via Bluetooth and USB-C type cable. Again, the Magic Leap mobile application allowed others to visually observe what the end-user was looking for through the mobile application. Figure-4 shows illustrates an example using the 100 fruits application.

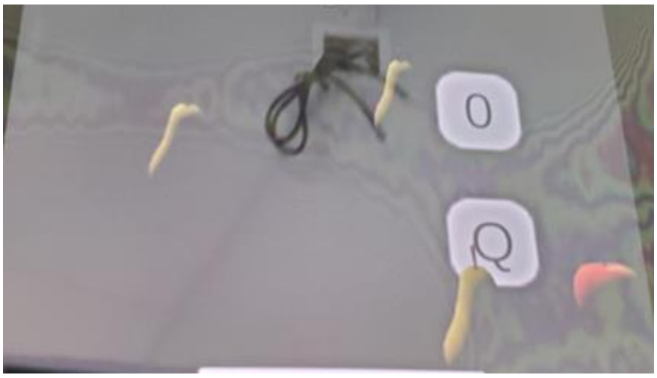

Figure 4: End-user point of view showing objects that appear.

III. RESULTS AND DISCUSSION

Figure-5 shows that a proposed Wit-Motion hardware integrates validated biomechanical joint of any part of the body. Wit-Motion device works on the axial coordinates. The Wit Motion BWT901CL Bluetooth 2.0 9-axis IMU sensor was implemented with an inclinometer, gyroscope, accelerometer, and magnetometer. The sensor was positioned on the shoulder of the athlete using a Velcro. The data was monitored and transferred to a computer for storage and processing through a Bluetooth 2.0 wireless serial connection for real-time data measurement, risk factor labeling, and activity visualization.

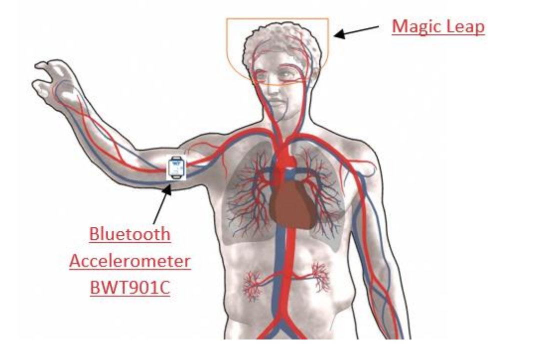

Figure 5: Placement of Wit motion Sensor and magic leap goggles on the Body

From the computed bone position angle and angular velocity of the solder and hand joints were evaluated at each point of the movement, achieved by calculating the relative orientation between the pelvis and femur (or femur and tibia), using two local coordinate systems [5], which were established based on the definitions suggested by the International Society of Biomechanics.

The ML1 device tracked eye movement, hand gestures, and placeed the virtual objects into the real-world environment for the end-user'sinteraction, according to a designed application's parameters. Wit-Motion sensors collected real-time data,delivered by Bluetooth to a downloadable mobile application on the end-user's mobile. In addition, there existed a concern over the accuracy of data collected from a similar sensor-based movement system, which was utilized.

IV. CONCLUSION

In this paper, we have presented an AR based application for exercise along with visualization of joint movements. The development of this application was accompanied by an experienced orthopedic surgeon, who could assist in different medical scenarios, such as physical examination, with evaluation of the passive and active joint during standard clinical movements, which can help the clinician visualize abnormal functional joint behaviors and physical rehabilitation, with periodic sessions for observation. Further developments in the future should focus on the extension of this system in different directions. Two short-term developments should be prioritized,which shall include the further developments in visualizing the shoulder, another joint commonly affected by musculoskeletal disorders. This therapy will require the adaptation of the proposed biomechanical model for patient-specific shoulder kinematics for use in real-time applications. Secondly, we will perform a comprehensive validation study with patients comparing the proposed system with conventional methods of joint examination.

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