Augmented Reality Mirror for Medical Imaging Outreach

Alex Wang[1], Cailey I. Kerley[1], Joshua D. Swartz[2],
Bennett A. Landman[1,3], Joel Howell[4]

[1] Department of Electrical Engineering and Computer Science, Vanderbilt University, Nashville, TN, USA
[2] Metropolitan Nashville Public Schools, Nashville, TN, USA
[3] Departments of Radiology and Radiological Sciences, Vanderbilt University Medical Center, Nashville, TN, USA
[4] Adventure Science Center, Nashville, TN, USA

INTRODUCTION

- The Augmented Reality Mirror is a demonstration platform for communicating the scientific results to a lay audience (targeting K-12) while providing a framework to offer research experiences to young (underrepresented) scientists and high school teachers. It interfaces an Orbbec3D Astra Pro camera with Unity3d to achieve real-time body tracking with overlaying anatomical models.

- New interactive course modules will be developed using the Augmented Reality Mirror. These modules will be targeted to a broad range of abilities from high school math/science/programming classes to graduate level seminars.

Application Overview

- The application was built in Unity3d and was written in C#. This is an open source project and all of the project code can be found on the Github page of Vanderbilt Medical-image Analysis and Statistical Interpretation Lab.

- There are three released versions of the Augmented Reality Mirror, each with a distinct functionality. They will be displayed in the Adventure Science Center in the near future.

  - Skeleton version: When a user steps in front of the camera, the application renders a skeleton overlaying the video stream. The application renders as many skeletons as the bodies detected by the camera.

  - Selection version: When detected by the camera, the user can select a bone using his or her hands to see its anatomical structure. Additionally, the application will only render the skeleton of the first body detected by the camera in order to maximize performance.

  - Record-and-Replay version: When detected by the camera, the application records the user's movement for a fixed amount of time and reconstruct a moving skeleton. Additionally, if enabled, it can export the collected to a csv file for possible analysis on the movement.
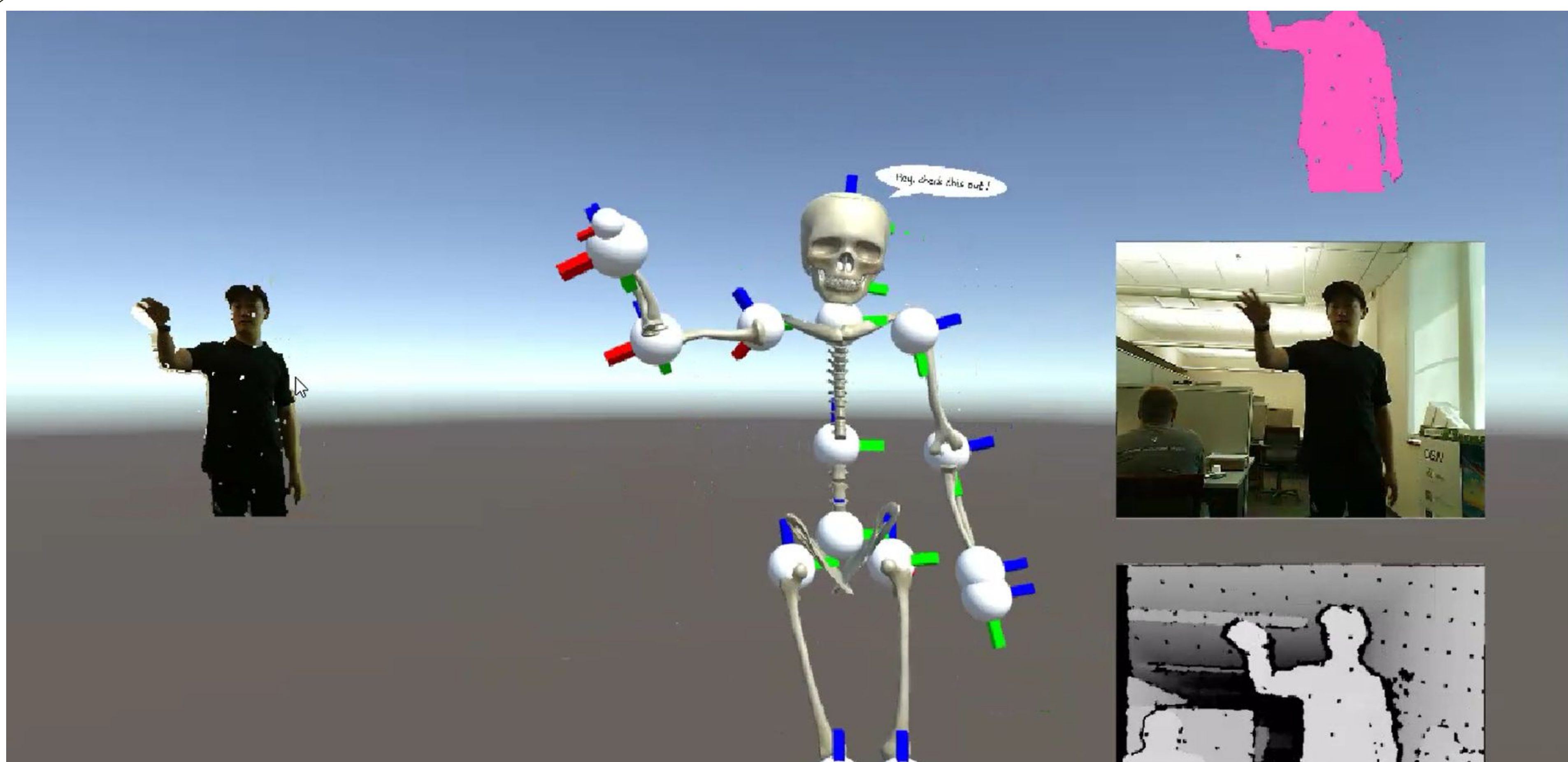
Figure 1. The initial proof of concept version of the Augmented Reality Mirror. The camera uses both color stream and the depth stream to detect the positions of the joints in a human body. The application scales and transforms the bones based on the positions of the joints.
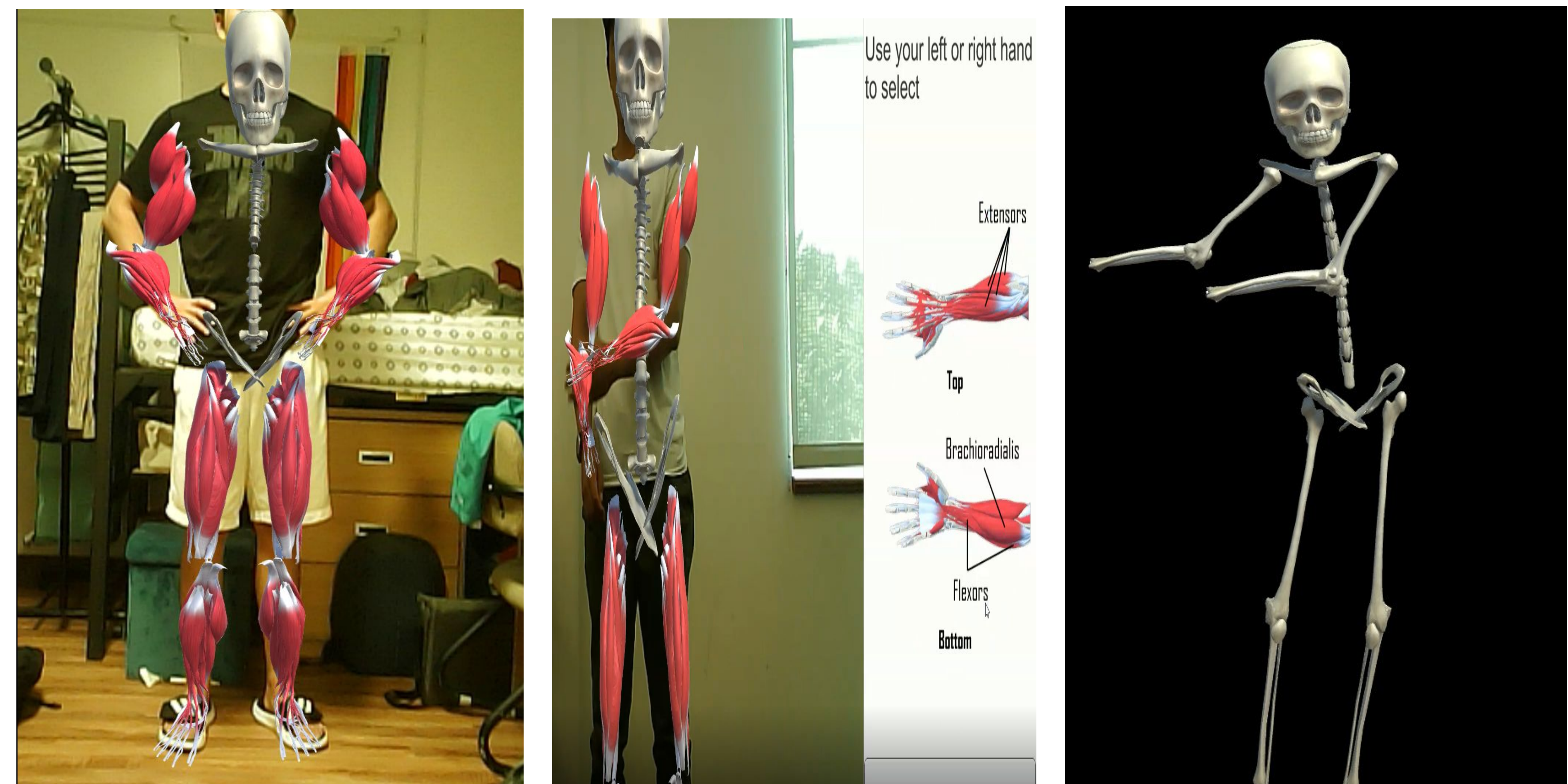
Figure 2. The three final versions of the Augmented Reality Mirror. The left picture is a screenshot from the Skeleton version; the middle one is a screenshot from the Selection version; the right one is a dancing skeleton generated by the Record-and-Replay version.

Launch Results

1. The Augmented Reality Mirror was first field tested in the Adventure Science Center on July 31st 2019. It went through three iterations of change since then. Better calibration and camera performance were achieved during the debugging phase. The final testing was completed on September 5th 2019. All three versions of the Augmented Reality Mirror worked as expected and the required hardware was transferred to the Adventure Science Center for future display.

2. A memory leak was discovered by monitoring the CPU and RAM usage during one of the field tests and was later fixed. Orbbec3D was notified for this issue since the discovered bug was inside the SDK published by Orbbec3D.

3. The Augmented Reality Mirror averaged 100 views per hour during the first test run in the Adventure Science Center and was well received by the audience.

Future Directions:

1. Dr. Joshua D. Swartz, who is the lead science teacher at the Metropolitan Nashville Public Schools, will design and implement a new interactive Computer Science course module using the Augmented Reality Mirror. At the end of the course, the students will implement their own versions of the Augmented Reality Mirror and demonstrate their programs in the Adventure Science Center.

2. More features will be added to the current versions and we will assist the Adventure Science Center with the official release of the Augmented Reality Mirror as well as any technical issues.

3. The Augmented Reality Mirror could be tailored into clinical use to study the behavior of human movement. One possible application is a monitoring and analysis system for injury recovery.