DP02: UNTETHERED FORCE FEEDBACK FOR VIRTUAL AND AUGMENTED REALITY INTERACTIONS

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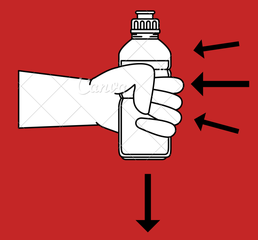

Project Goal

To design a wearable and mobile system for integrating force feedback in a virtual or augmented reality environment

Constraints

- lightweight
- mobility
- compactness
- VR/AR compatibility

Test Scenario

The subject is asked to pick up a water bottle and move it from point A to point B. To determine the effectiveness of the system, the subject first performs the task without any force feedback, then with the exoskeleton and finally the whole system with EMS. At each stage, we evaluate efficiency, precision, load factor and muscle fatigue.

Fig. 1: First iteration of exoskeleton

Fig. 2: Final iteration of exoskeleton

1 EXOSKELETON

The exoskeleton pulls the finger in the opposite direction when the subject grabs an object in VR.

1. First iteration design:

Simple crane-like structure with a ring around the finger pulling against a string actuated by a servo motor.
The main problem was that force was only felt at the tip of the finger.

2. Final design:

A three-segment modular glove-like design was completed for two fingers. Each finger is separately actuated by a servo motor. Due to the movement complexity of the thumb, it was immobilized in this design. Future work would include finding a solution for the thumb.

Applications

Primary benefit: increasing the realism of interactions in VR environments.

- Increased immersion in entertainment and gaming
- Training with realistic simulations involving use of tools: surgical simulations
- Remote controlled robotic hand/arm with more precision
- Physical rehabilitation: scenarios in VR within a safe and controlled lab environment

Design approach

- Focus on hands and arms – they are capable of discerning the most physical details when interacting with objects.
- Their difference in morphology and operation means they require two separate force feedback systems.
- Study of various research papers and looking at past designs of force feedback systems on hands and arms
- We opted for an exoskeleton design for the hand and a system involving electro muscular stimulations for the arm.

Fig. 3: System in action

To generate the weight of the bottle, EMS contracts the triceps of the subject creating a virtual downward force. Two electrodes are placed on the triceps aligned with the muscle fiber to target the specific muscles.

EMS 2

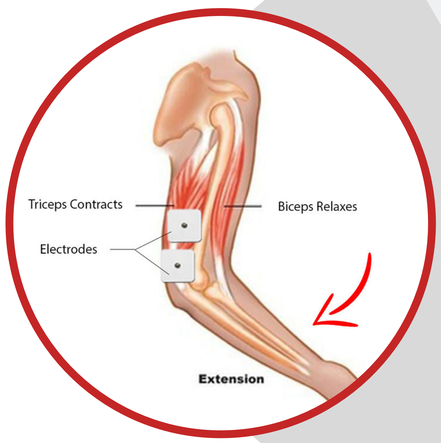

Fig. 4: Arm extension anatomy

Fig. 5: Electrode placements

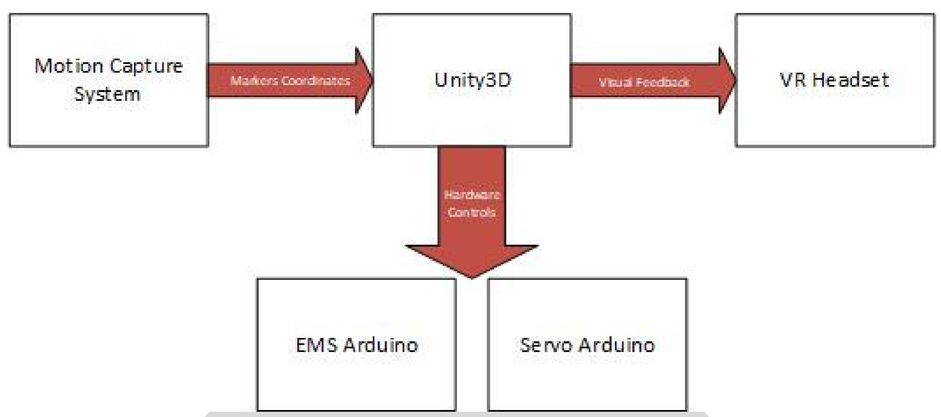

Fig. 6: System architecture

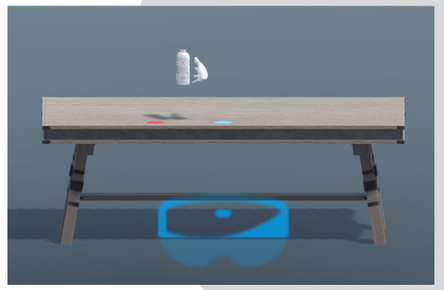

Fig. 7: VR environment

Fig. 8: MoCap markers placement on exoskeleton

3 VR ENVIRONMENT

With Motion Capture technology, user's movement are tracked and sent to Unity3D game engine. When the user grabs the bottle in the virtual environment, the game engine actuates the EMS and servo Arduinos. Additionally, Unity3D takes care of all the VR rendering and sending it to the HMD.

Conclusions

- We could not test our project on subjects (except on ourselves) and draw solid conclusions to answer our problematic. All ethic documents requesting human testing are approved however and a full test procedure and "water bottle" scenario was designed
- The thumb was immobilized in our design but further research could find a solution to this.