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# IAT 320 Final Group Project

## Project: Smart Dumbbell

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Video link: <https://youtu.be/n1VCqQyiFU8>

**Abstract**

This paper describes the concept, input, output, mapping, and implementation of the Smart Dumbbell. It also explains how the prototype is used to explore body movements, and how digital feedbacks, such as the transformation in LED light colours and brightness, is used to guide users to perform biceps dumbbell exercises and wrist rehab practices correctly.

**Author Keywords**

Physical exercise; Bicep dumbbell; Body movement; Technology; Interactive fitness devices; Rehab exercise; Embodiment.

**Introduction**

The domain of this invention is an interactive device for wrist joint rehab and weight lifting exercise.

The concept is to provide efficiency and convenience for individuals' self-training. There is dual functionality for this interactive device for individuals, who exercise for bicep weight lifting or wrist rehab purposes, with minimal to no assistance from any trainer or physiotherapist.

Having an interactive device that aids individuals with self-training is very important for users. This is because it can not only save their time and energy on

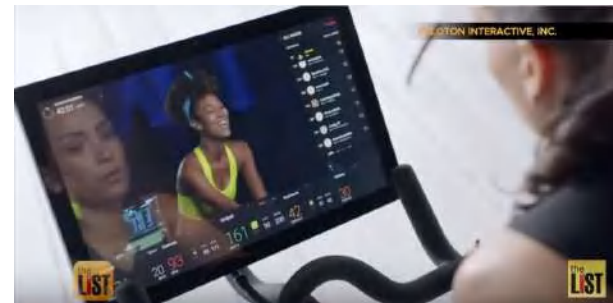
commuting to fitness clubs or physiotherapy clinics but also saves their money for hiring professionals.

There are several interactive technologies that have focused on tracking or boosting a user's performance in the field of fitness. One example is called *Mirror*. *Mirror* is an interactive mirror that puts a virtual trainer in front of the user to track the user's performance [3]. Another example is *Peleton Tread*. It displays live stream fitness classes on the screen, which is mounted on treadmills and fitness bicycles [3]. The third example is called *Tonal*, which involves home personal training with customized resistance level and weight. It allows users to personalize their equipment as desired [3]. The default setting is at beginner's level. *Tonal* will adjust accordingly as the user gets stronger and will notify the user when enough training is completed. The fourth example is *Fitness Interactive Twall* for team sports players. This interactive fitness wall is made to help improve coordination, balance, and accuracy. [1] The last example is *Trazer*. It is an interactive tool that consists of a belt, which is attached to sensors for tracking the position of the user. The user requires to move toward the avatar in the square shown on the screen at a fast pace. [4]

With the above inspirations, an interactive physical activity related device is created, which is the Smart Dumbbell. According to Mayo Clinic, if an individual's wrist is bent or angled during bicep curls exercises, it is possible that he/she may get injured and/or the efficacy of his/her exercise may be lowered [2]. Therefore, the Smart Dumbbell can be a good alternative to the traditional dumbbells, as it reminds users to adjust their hand gestures when their hands are tilted beyond the acceptable range.



*Mirror*



*Peleton Tread*



*Tonal*



Twall



Trazer

### Concept

The concept is to provide efficiency and convenience for individuals' self-training to engage them to do the exercise correctly. Healthy individuals can use it to perform bicep weight lifting, and patients with wrist joint issues can use it to do wrist rehab exercises without assistance from others. The LED lights will guide users and help them to maintain a good posture, which is made to prevent wrists and arms injuries from exercising with heavyweights in incorrect gestures.

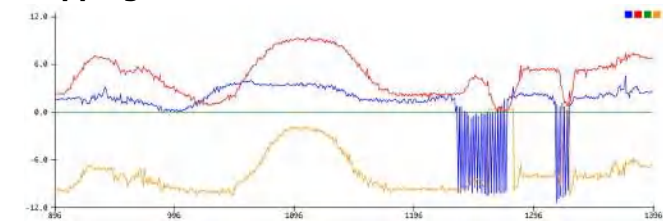
### Input

One input is the x, y, z coordination, which is measured by using an accelerometer. Another input is the amount of light that is captured by a light sensor.

### Output

One output is switching on or off the 5 LEDs in pink colour and their change in brightness. Another output is the change between green and red colour of 2 other LEDs. Besides, the third output is to switch on or off of the eighth LED in blue colour.

### Mapping



Continuous mapping: any change in the orientation of the dumbbell with a slow pace movement will cause a gradual change in the brightness of the 5 pink LEDs unless the movement is sudden or the dumbbell is tilted in the wrong direction.

Discrete mapping: the blue LED indicates whether the person has started to interact with the dumbbell. In other words, when the user holds the dumbbell, the blue LED turns on.

### Interaction & User Experience

The Smart Dumbbell has dual functionality. Its LEDs are the main indicators of the correct and incorrect movements (orientation/position/pace) of the hand and arm. If the user holds the dumbbell in a straight position and moves it up slowly and straight, the two LEDs on the sides remain green. Also, with this correct

movement and pace, the pink LEDs, which are located between the two green LEDs, will light up one by one. Otherwise, the side LEDs will turn red one at a time depending on the position. If the dumbbell is tilted too much to the left, the left LED will turn red; if the dumbbell is tilted too much to the right, the right LED will turn red. The correct movement for the rehab purpose is to move the wrist straight up and down slowly without any arm lifting and rotation. And for the weight lifting purpose, the correct movement is to moving the forearm straight up and down around the elbow.

### Technical Implementation

The components include an accelerometer, a light sensor, an Arduino Flora, 8 RGB LEDs, conductive threads, a plastic tube, a sandbag, a battery holder, and 3 batteries.



*Sewn circuit*

The two sensors and the LEDs are attached in series to the Arduino.

### Discussion/Conclusion

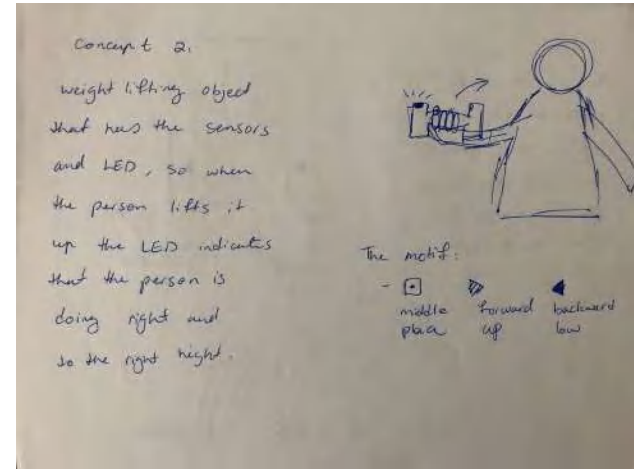
Improving a person's physical performance is a complex subject. Thus, implementing interactive technology into this field becomes our primary focus.

The aesthetic of using LED as visual feedback is very interesting and apparent when notifying the user about their performance and whether they are doing the correct or incorrect movement. For the side LEDs, we used conventional red (for wrong) and green (for correct) colour to convey the accuracy of users' movements more clearly. The problem we are solving is to provide a time-saving, financially friendly and cost-effective workout experience, which also enhances the self-training process. With the Smart Dumbbell, users do not have to arrange appointments and meet in-person with bodybuilding trainers for weightlifting or physiotherapists for wrist rehabilitation.

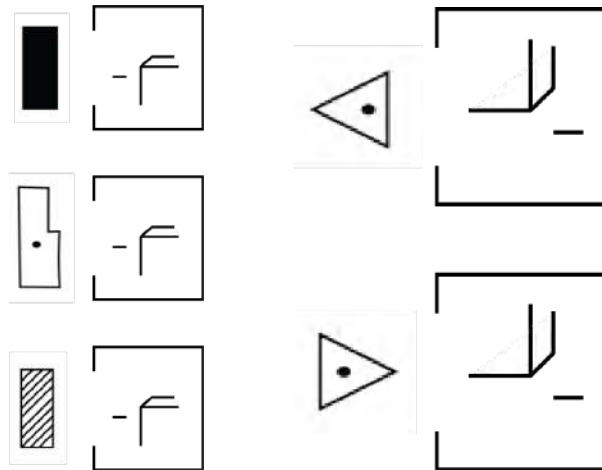
During user testing, most users understand the flow and pace of the LEDs for up and down movement, and the red and green colours for incorrect and correct movements. Hence, they adjusted their wrist or elbow movements according to the feedback they received from the LEDs. The challenging part was the initial step of grabbing the dumbbell since there are no indicators to show users the specific position to hold the dumbbell. This could be fixed by adding a mark on the dumbbell for the hand grip.



User testing



The initial sketch of the concept

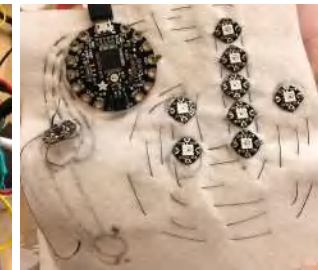


The correct movement

The incorrect movement



First prototype



Failed sewn prototype





*Sewn circuit inside plastic tube*



*The working prototype*



*The final prototype*

## References

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## Contribution

### Sahar Feyzallahzadeh

concept, design, initial sketch, coding, physical prototype, iteration and sewings, writing, research.

### Sherry Wang

concept, design, motif, prototype materials, writing

### Carol Lam

concept, filming, video editing, design, prototype appearance, writing