

# Exermote: An Exercise-Controlled Remote

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## INTRODUCTION

Often TV watchers lead sedentary lifestyles, rarely getting up from the couch. Our group plans to encourage healthier living by developing a remote control that forces users to perform an exercise whenever they want to change the channel, volume, or more. For our first prototype, we programmed an input emulator to read a Nintendo Wii Remote's (or Wiimote's) motions (exercises) and translate these into actions on a computer. We also performed an informal user study using a "Wizard of Oz" method and a TV. The purpose of this was to assess the usefulness and usability of a potential finished version of our design, as well as to gain insight for future iterations.

Our idea falls into the realm of ubiquitous computing because we are combining two everyday activities, watching TV and exercising, using technology. We are turning a typically inactive pastime into something that is physically beneficial to the user. Our concept leverages the idea of making ordinary effortless tasks more challenging and dynamic. Exercising has already been incorporated into gaming, but by combining it with television controls, we will encompass a much larger population. Our ideal device would be comfortable, unobtrusive, and customizable. It would be used casually and regularly as a supplement to the conventional remote. Over time it would improve or maintain a user's strength.

## PREVIOUS/RELATED WORK

Our concept involves integrating gestural control of appliances (i.e. TV) with exercise (i.e. dumbbell weight repetitions). Previous designs for appliance control have employed direct camera-based detection of hand gestures [2], or sensor-based detection of gestures initiated by either a physical remote [3] or a wearable device [6]. Meanwhile exergaming products, fusing exercise and gaming, have attempted to detect physical activity using related strategies. For example, Dance Dance Revolution relies on a touch-sensitive dance pad [1], whereas more recent innovations such as Wii Fit and EA Sports Active exploit pressure sensors in the Wii Balance Board [4], as well as the accelerometer and optical sensor embedded in the Wiimote [5]. EA Sports Active additionally engages an elastic resistance band or a leg strap.

Several open-source resources exist for linking Wiimote gestures to TV control operations. Popular scripting libraries for custom Wiimote programming include DarwiinRemote, Java-based wiigee, as well as our scripting choice, GlovePIE. In addition, devices already exist that integrate the Wiimote and a dumbbell, such as the CTA Digital "Dumbbell Set for Wii" and the

Company X "Everlast 2lb Dumbbells". These provoke the question of whether our device is innovative enough to compete in the market. However we have yet to find another concept that uses fitness gestures to control the TV or related appliances.

## OUR WORK

### Physical Considerations

Considering how to make our device effective but unobtrusive, we came up with several possible physical designs that are shown and described in Appendix 1. These gave us an idea of what a final product might look like. We also looked into which exercises would be practical for use in a seated position, feasible to script, and would map well to functions on a remote control.

### Implementation

We used a Wiimote to imitate the dumbbell. The Wiimote's internal sensors that measure acceleration, pitch, and roll are able to accurately detect the exercises, and the built-in Bluetooth makes the computer connection possible. The exercises were programmed using the scripting language of GlovePIE, which allowed for quick testing with easy manipulation and control of the Wiimote. To implement the gestures, we read Wiimote sensor outputs to understand which sensors were being affected and by how much. For example, when performing a butterfly, the remote was accelerating in the X and Y directions, but did not move much in the Z axis. We mapped the gestures to different keys, allowing various applications and scenarios to be tested. For example, the keys could be mapped to work with MythTV or iTunes, creating different exercising experiences.

### User Study

*Description.* We conducted an informal, unpublished user study prior to obtaining IRB approval. We used a "Wizard of Oz" method in order to gather real data before building functional hardware prototypes. The study mimics control of the following TV operations: (1) power on/off (2) channel up/down (3) volume up/down. The user was given two 2-lb dumbbells to perform exercises. The study initially consisted of two parts, but we eliminated Part I after a trial run because it was redundant. The steps are listed in Appendix 2.

In Part II, we directed the user to do weight reps while one of us pressed the corresponding buttons on a conventional remote. This effectively simulated the link between the exercises and TV control operations. For example, one butterfly rep appeared to the user to activate the TV power mechanism. Each dumbbell was additionally marked with masking tape to indicate a

“trigger” for switching modes. The full list of steps is provided in Appendix 2.

*Results.* Following the testing portion, we gave participants a questionnaire (shown in Appendix 2). All the testers thought that the exercises were not difficult and were satisfied with this. Overall they said that the exercises mapped very well to the actions, though one would have preferred if the exercises for volume and channel changes were switched. The testers were split on their likeliness to use the system to improve strength, but most were not likely to use it around company. They all agreed that the device is easy to comprehend and use. Of the possible additions, the subjects liked the adjustable weight and customization ideas, but were split on the rest. The most preferred sketches (as shown in Appendix 1), in order, were numbers 2 (standard dumbbell shape; Figure 4) and 1 (glove; Figure 1). Almost all the testers labeled themselves as regular channel surfers.

*Implications.* This study enabled us to assess the usability of a prototype system and determine how dumbbell exercise gestures can be meaningfully mapped to TV controls. It gave us an idea of how marketable future versions of the product might be. Our idea has potential but more features are necessary.

## **DISCUSSION**

With respect to design issues, we learned that dumbbell exercises may not be ideal for TV watchers since they may be obstructed by couch seats. A custom device for couch-based exercise might be more appropriate. From an ergonomic perspective, the user should be able to hold the device and push its trigger without any discomfort.

During the scripting process, we found it difficult to choose universal constraints for acceleration and angular position, since each person does each exercise slightly differently. A personal trainer could mitigate this problem if his or her proper demonstration of the exercises could be effectively communicated to users. Another approach would be to allow the user to train the system, customizing it to his or her gestures. Otherwise, despite high sensitivity to speeds and angles, limitations in the GlovePIE API and Wiimote made it tough to distinguish similar exercises (e.g. front raise and lateral raise).

Natural mapping was a significant concern, since it brought conflicting trade-offs to light. For instance, completing a single rep may engage both upward and downward motions. However some TV control operations are “unidirectional”. For example channel up and volume up operations may be more intuitive to learn if exclusively mapped to upward gestures. In addition, we wanted to group opposite controls together (such as channel up and down) but because there were no clear pairings between disparate exercises, we resorted to a mode-based solution. For example, channel up requires a shoulder press, whereas channel down requires a shoulder

press with a trigger pressed. However this solution is not the most user-friendly, since modes may be easily confused. There is also the issue of a user wanting to exercise without changing TV settings. This could also be solved with modes, but again it would be a trade-off. On a different note, there are many buttons on a conventional remote that are not represented in our scripted exercises or user study prototype. However our focus is not to repackage all the operations on a conventional remote. Instead we aim to provide a few frequently used controls to encourage TV watchers to stay moving while seated.

In the user study, participants were quickly taught the exercises and controls, and were given reminders when needed. However real users would have more time to learn but no coaches present. On the other hand, though real users may theoretically have more time to absorb the gestures, they may not have the patience for a system that does not rapidly adjust to them. All our test users were male, but it would be interesting to see if gender would play a role in opinions and ideas.

## **FUTURE WORK**

The next step of our project would be to get it to work more accurately, with more exercises, and on a television instead of a computer. We would also create a smoother, more comfortable physical device and consult trainers about proper weight training technique. We could then develop a program that overlays instruction diagrams on the TV when a user picks up the weights, reminding him or her which exercises will perform which actions (Appendix 1, Figure 7). The program would also include customization capabilities, so that users could choose sets of exercises to target their specific goals. There are several directions that the project could go from there. Additions could be made such as adjustable weight or the option to use bands or cardio instead of dumbbells.

For our project 2, we plan to do something even broader, but still related to the ideas of exercising and/or remote controls, thus leveraging what we learned in project 1. One possibility is creating a wearable universal remote or gestural system that controls multiple items around the house, such as the toaster and lights. In another idea we would encourage walking by developing a trail with dynamic displays or audio that can be controlled with a wearable remote. Similarly, the display or audio device could be a personal item that is activated by a smart remote with sensors. There are many other possibilities that we will consider before making a decision.

## **CONCLUSIONS**

The idea of using exercises to control the TV is novel and has market potential. With thorough programming, comfortable physical design, and a learnable interface, the Exermote could help improve the health of TV watchers. Though there are many improvements we could make to our initial prototype, we will instead go in a new direction for our further work in order to maximize our learning.

## REFERENCES

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**APPENDIX 1 – SKETCHES AND MOCKUPS**

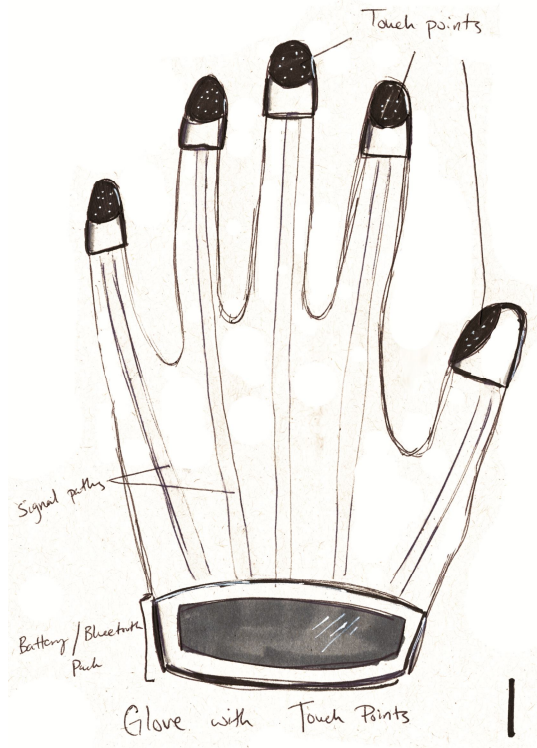


Figure 1 – Gloves with touch points on the fingertips provide an easily accessible interface in a small amount of space. The gloves provide comfort and grip for the user while exercising. An issue with this idea is comfort, because gloves can get hot.



Figures 2 and 3 – Sample physical glove prototype.

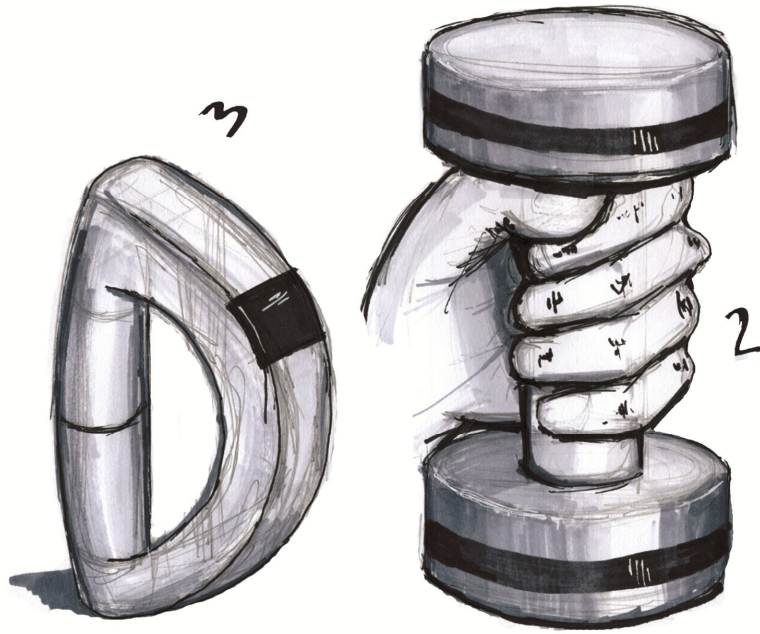
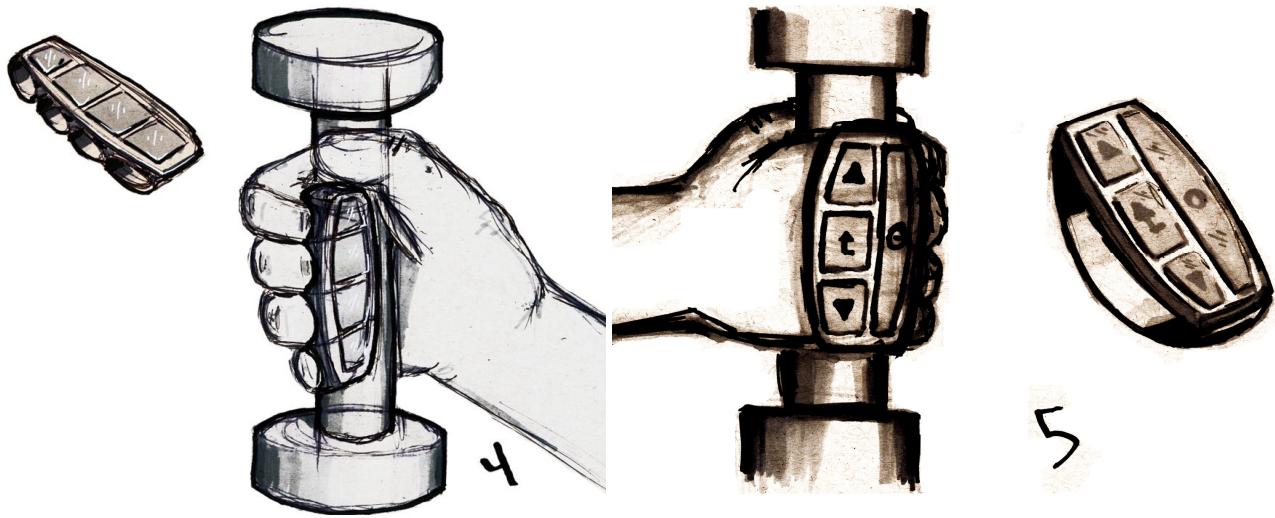


Figure 4 – Adding the Exermote idea into a new dumbbell lets the exerciser continue using the standard dumbbell shape, but extends the number of ways it can be utilized through technology.



Figures 5 and 6 – Strapped-on devices provide the user with the same grip as a normal dumbbell while adding an accessible interface close to the hands. They also allow people to use any dumbbells they choose, which lets users retain the knowledge of previously used devices while integrating technology into them.



Figure 7 – The interface on the television screen would consist of a colored bar on the bottom to contrast against the background and would include blinking pictures of the exercises for each function.

## APPENDIX 2 – USER STUDY

### User Study Guidelines

Part I. *Omitted after trial with first test user.*

- 1) Study leader demonstrates three exercises with two dumbbells to test user:
  - a) butterfly
  - b) shoulder press
  - c) bicep curl
- 2a) User does 1 rep of butterfly with dumbbells.
- 2b) User turns TV *power ON* with conventional remote.
- 3a) User does 6 reps of shoulder press with dumbbells.
- 3b) User goes 6 *channels up* with conventional remote.
- 4a) User does 5 reps of bicep curl with dumbbells.
- 4b) User brings *volume down* by five units with conventional remote.

Part II. *Conducted with all test users.*

- 1) Study leader demonstrates six exercise variations and one number-drawing gesture to user:
  - a) butterfly: *power ON*
  - b) butterfly with trigger pressed: *power OFF*
  - c) shoulder press: *channel up*
  - d) shoulder press with trigger pressed: *channel down*
  - f) bicep curl: *volume up*
  - g) bicep curl with trigger pressed: *volume down*
  - h) trace 54 and then press trigger: *channel changes to 54*
- 2) User turns TV *power ON*: 1 butterfly rep.
- 3) User goes 6 *channels up*: 6 shoulder press reps.
- 4) User brings *volume down* by 5 units: 5 bicep curls with trigger pressed.
- 5) User changes to channel 54: traces "54" followed by trigger press.
- 6) User turns TV *power OFF*: one butterfly rep with trigger pressed.

### User Study Questionnaire

1a. How difficult were the exercises you needed to do in order to control the television?

Not difficult at all                      Very difficult

1 ---- 2 ---- 3 ---- 4 ---- 5

1b. Please list any specific exercises that were particularly difficult or not.

2a. How satisfied were you with this level of difficulty?

Too easy                      Too difficult

1 ---- 2 ---- 3 ---- 4 ---- 5

2b. If any, list the specific exercises that were too easy or too difficult.

3a. How well did the exercises map to what you were doing? For example, was the bicep curl a good exercise to control the volume?

Mapped very poorly                      Mapped very well

1 ---- 2 ---- 3 ---- 4 ---- 5

3b. List the exercises that were not mapped well, if there were any.

4. How likely would you be to use this remote system to improve your strength?

Not likely at all                      Very likely

1 ---- 2 ---- 3 ---- 4 ---- 5

5. How likely would you be to use this remote system around company?

Not likely at all                      Very likely

1 ---- 2 ---- 3 ---- 4 ---- 5

6. How well did the device fit in your hand?

Not well at all                      Very well  
1 ---- 2 ---- 3 ---- 4 ---- 5

7. How easy is the device to comprehend and use?

Not easy at all                      Very easy  
1 ---- 2 ---- 3 ---- 4 ---- 5

8. Below are some possible add-ons or changes that we could make to future iterations of this product. Rate them on how much you'd like to see these implemented.

                    Would not like this at all                      Would like this a lot

a. Adjustable weight                      1 ---- 2 ---- 3 ---- 4 ---- 5

b. Bands or cardio instead of weights                      1 ---- 2 ---- 3 ---- 4 ---- 5

c. Different exercises for up or down (for channels and volume), instead of pressing trigger or not  
1 ---- 2 ---- 3 ---- 4 ---- 5

d. The option to customize which exercises perform which actions

1 ---- 2 ---- 3 ---- 4 ---- 5

e. On-screen reminders of exercises when you pick up the weights

1 ---- 2 ---- 3 ---- 4 ---- 5

f. Please list any other ideas.

9. Which sketch do you prefer?

10. What kind of TV watcher are you? For example, do you change channels often or do you sit down knowing what you want to watch?

11. Please list any suggestions for improvement.

### APPENDIX 3 – GLOVEPIE SCRIPT

```
//Exermote script
```

```
var.still = ((|wiimote.RelAccX| < 2) & (|wiimote.RelAccZ| < 2)) &  
(|wiimote.RelAccY| < 2)
```

```
var.onlyY = ((|wiimote.RelAccX| < 3) & (|wiimote.RelAccZ| < 3)) &  
(|wiimote.SmoothPitch| < 30);  
var.onlyX = ((|wiimote.RelAccY| < 3) & (|wiimote.RelAccZ| < 3)) &  
(|wiimote.SmoothPitch| < 30);  
var.onlyX1 = ((|wiimote.RelAccY| < 3) & (|wiimote.RelAccZ| < 3));
```

```
var.curl = (((|wiimote.RelAccY| > 15) & (|wiimote.SmoothRoll| > 70)) & var.onlyY) &  
(wiimote.A = true)
```

```
var.fraise = (((|wiimote.RelAccX| > 10) & var.onlyX) & wiimote.A)&  
(wiimote.SmoothRoll > 160)
```

```
var.upright = ((|wiimote.RelAccX| > 6) & var.onlyX) & (((wiimote.SmoothRoll < -80)  
& (wiimote.SmoothRoll > -120)) & wiimote.A)
```

```
var.up = ((var.onlyX1 & (|wiimote.RelAccX| > 10)) & (wiimote.A &  
((wiimote.SmoothRoll < 120) & (wiimote.SmoothRoll > 60))))
```

```
var.bfly_Roll          = wiimote.SmoothRoll > -40  
var.bfly_SmoothPitch = (wiimote.SmoothPitch > 20) & (wiimote.SmoothPitch < 80)  
var.bfly_X            = |wiimote.RelAccX| > 10  
var.bfly_Y            = |wiimote.RelAccY| > 10  
var.bfly_Z            = |wiimote.RelAccZ| < 4
```

```
var.butterfly = (var.bfly_X & var.bfly_Y) & (var.bfly_Z & var.bfly_SmoothPitch)
```

```
//Butterfly
```

```
if var.butterfly {  
    keyboard.B = true  
    keyboard.B = false  
    wiimote.led3 = true  
    wiimote.Rumble = true  
    wait 400 ms  
    wiimote.Rumble = false  
}
```

```
//Biceps Curl
```

```
if var.curl {  
    keyboard.A = true  
    keyboard.A = false  
    wiimote.led1 = true  
    wiimote.Rumble = true  
    wait 400 ms  
    wiimote.Rumble = false  
}
```

```
//Front Raise
```

```
if var.fraise {  
    keyboard.F = true  
    keyboard.F = false  
    wiimote.Rumble = true  
    wait 400 ms  
    wiimote.Rumble = false  
}
```

```
//Upright Row
if var.upright {
  keyboard.U = true
  wait 500 ms
  keyboard.U = false
  wiimote.Rumble = true
  wait 400 ms
  wiimote.Rumble = false
}
```

```
//Shoulder Press
if var.up {
  keyboard.L = true
  keyboard.L = false
  wiimote.led2 = true
  wiimote.Rumble = true
  wait 400 ms
  wiimote.Rumble = false
}
```

```
//4th led will light if Biceps Cur, Shoulder Press, and Butterfly are performed
if ((wiimote.led3 & wiimote.led2) & wiimote.led1){
  wiimote.led1 = false
  wiimote.led2 = false
  wiimote.led3 = false
  wiimote.Led4 = true
}
```