Developing a system for controlling computer games with a stationary exercise bike

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Introduction

Nearly half the U.S. adult population does not get enough aerobic exercise each week ("Adult Participation," 2013). As a result, many Americans are putting themselves at a greater risk of cardiovascular disease, type 2 diabetes, and even some cancers ("Physical Activity and Health," 2011).

The idea of exercise is often unappealing to people, and they instead opt for sedentary activities such as video games. This project aimed to combine exercise and video games to create an exciting environment where one can receive the benefits of cardio exercise while playing a computer game. The project focused on creating a system where any computer racing game could be controlled by exercising on a stationary bike.

Methods and Materials

A bicycle was mounted on a resistance trainer for stationary use (see Figure 1). A magnet was placed on the trainer's fly wheel so that it would be rotated by the back tire when the user pedaled. A Hall effect sensor was then attached beneath the wheel to allow the cyclist's speed to be calculated (Figure 3). A bracket was constructed and affixed to a Lazy Susan for the bike's front tire to rest in. An IR LED and two phototransistors were pointed at a black and white grid bordering the Lazy Susan (Figure 4) allowing the direction and magnitude of the bike's steering to be measured.

Figure 1: A bike with its rear wheel mounted on the resistance trainer and the front tire resting in the bracket on the Lazy Susan.

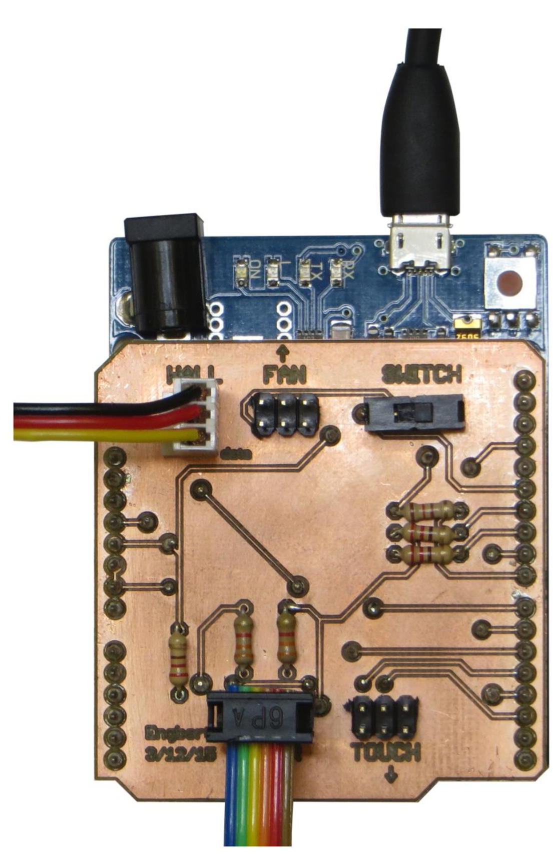


Figure 2: The custom PCB plugged into the Arduino® Leonardo with the connected Hall effect and steering sensors.

Methods and Materials (cont.)

An Arduino® Leonardo microcontroller connected to the sensors through a custom PCB and sent keyboard commands to the computer through a USB cable (Figure 2). A computer racing game was then controlled by the keyboard commands sent from the Leonardo. In the computer game, the vehicle's speed and steering were varied by rapidly modulating the arrow key presses sent to the computer. An Arduino® Uno was also utilized to receive commands from the Leonardo and to send IR commands to a remote controlled variable speed fan; setting its power level relative to that of the cyclist's speed.

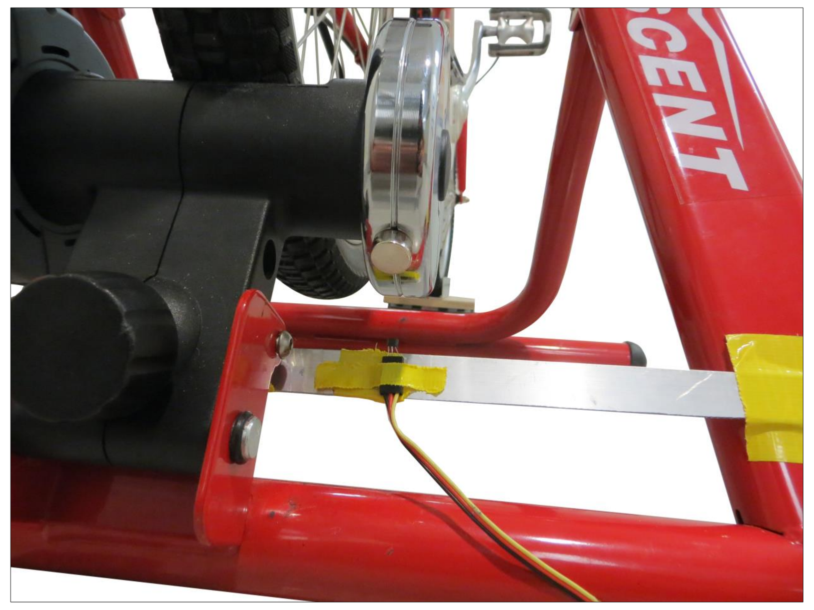


Figure 3: The Hall effect sensor mounted beneath the fly wheel of the bike stand. A magnet attached to the wheel was detected by the sensor after each rotation, allowing the user's speed to be calculated.

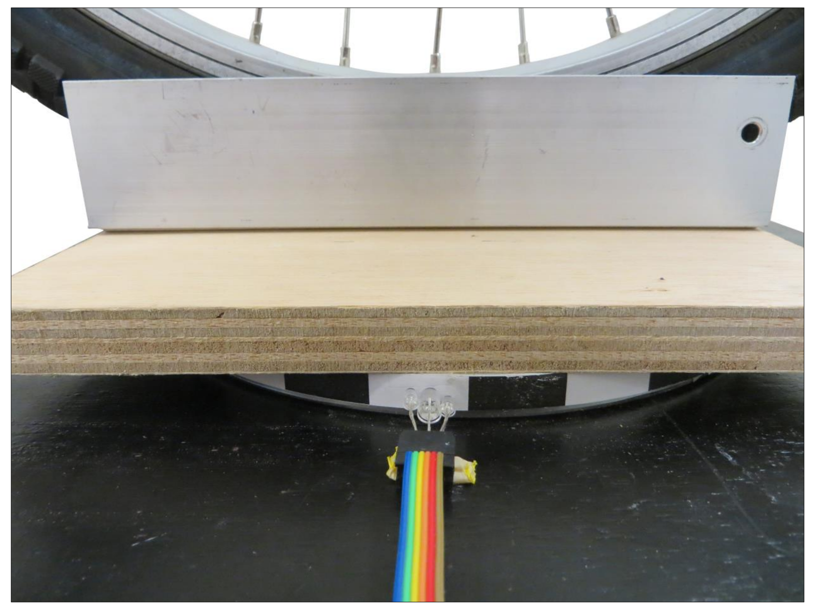
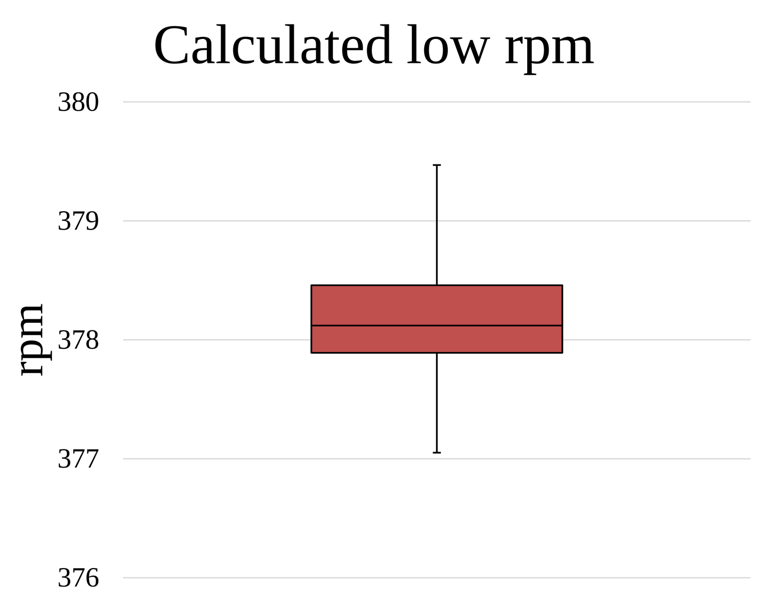
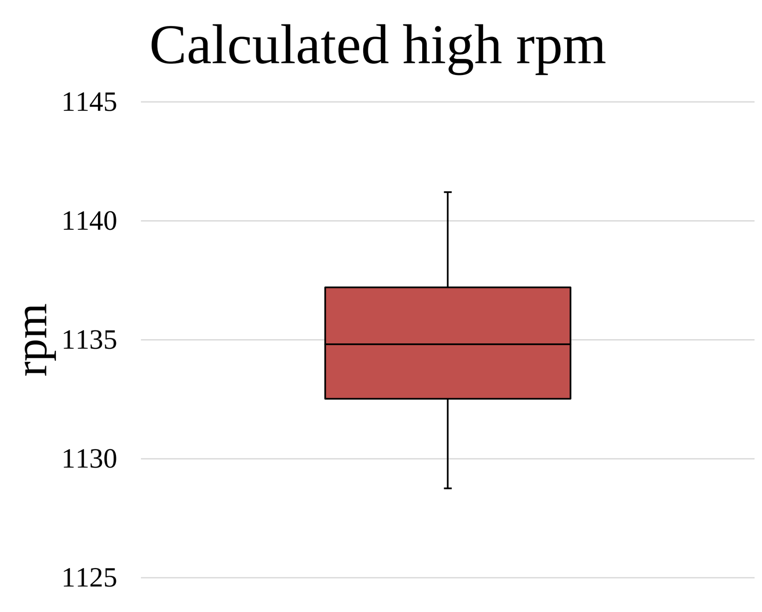


Figure 4: The bike's front tire resting in the Lazy Susan. An IR LED was mounted between two phototransistors pointed at the black and white grid for measuring the direction and magnitude of the user's steering.

Results



Graph 1: Distribution of 50 rpm measurements made by the Leonardo of a magnet rotating at a constant speed of 378 revolutions per minute.



Graph 2: Distribution of 50 rpm measurements made by the Leonardo of a magnet rotating at a constant speed of 1128 revolutions per minute.

Results (cont.)

In order to verify the consistency and accuracy of the system, the calculated rpm values were compared to the actual rpm (as determined by observing the Hall effect sensor with an oscilloscope) for two trials. The distributions of calculated rpm values for the trials are shown in Graph 1 and 2. The low and high rpm trial had standard deviations of 0.593 and 3.16 respectively. The steering was tested for 1000 turn iterations and no issues were present; the program consistently kept track of the position of the front tire.

The variable speed fan was never fully implemented. The Leonardo and Uno were able to successfully communicate the desired fan speed, but the Uno was unable to correctly set the fan speed all of the time. The issues stemmed from the fan failing to consistently receive the IR signal from the Uno.

Conclusions

The goal to create a system allowing computer racing games to be controlled by a stationary bike was accomplished. The project's speed and steering input methods were determined to be sufficient for modulated control of game-play.

The issues with the variable speed fan could be overcome if a sensor was added for the Uno to check the fan's current speed level. This would enable the Uno to identify when the fan failed to receive a signal, and then resend it as needed.

The project could be further expanded by incorporating a mobile app. The app could allow the user to alter the settings based on the specific computer game, adjust the exercise intensity, and provide feedback on the user's biking speed. Additionally, a multiplayer setup with two or more bikes could be constructed.

References

Centers For Disease Control and Prevention. (2011). *Physical activity and health*. Retrieved from http://www.cdc.gov/physicalactivity/everyone/health/

Centers For Disease Control and prevention. (2013). *Adult participation in aerobic and muscle-strengthening physical activities — United States, 2011*. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6217a2.htm