



Home-Based System for Rehabilitation Exercises

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Abstract

This project presents the design of a home-based rehabilitation system, structured for patients in need of arm and hand rehabilitation exercises, specifically stroke victims. The goal of this system is to provide inexpensive at home therapy, by presenting patients with a device which helps to encourage and motivate them daily, to complete assigned exercises. The mechanism allows them to gain independence in their everyday life, by enabling them to control objects such as a television. [Fig. 1] The system contains two interactive modes, television(TV) and game mode, both of which can be fully customized to fit the patients by an occupational therapist. The TV mode currently has five functions to control the television while the game mode utilizes a LED board to display specific movements for the user to complete. Both modes are controlled by a Graphic User Interface (GUI) that allows the occupational therapist to adapt the system to each individual patient by selecting which movements control which function of the remote and which patterns show on the LED board in the game mode. The prototype developed will be used in the clinic by a few patients to help better the system for future use.

Introduction

Physical rehabilitation exercises for many patients can often become mundane and repetitive tasks after long periods of time. Patients tend to lose motivation which can hinder their progress and recovery. In an effort to solve this issue we have designed a system meant to motivate patients and incorporate exercises into their daily lives.

In a recent (2014) study completed on the civilian population regarding favorite pastime activities it was found that on average people spend 2.61 hours [1] watching television on the weekdays, which was over four times the period of any other activity. The second most favored activity was socializing, however, implementing this into the project was not the direction we wanted to go in. The third most favored activity was playing games and computer use. Within our designed system we wanted to combine these two activities to motivate the patients by incorporating their favorite pastimes into their therapy. By doing so the patients stay driven to continue their rehabilitation and increase their independence within their lives.

System

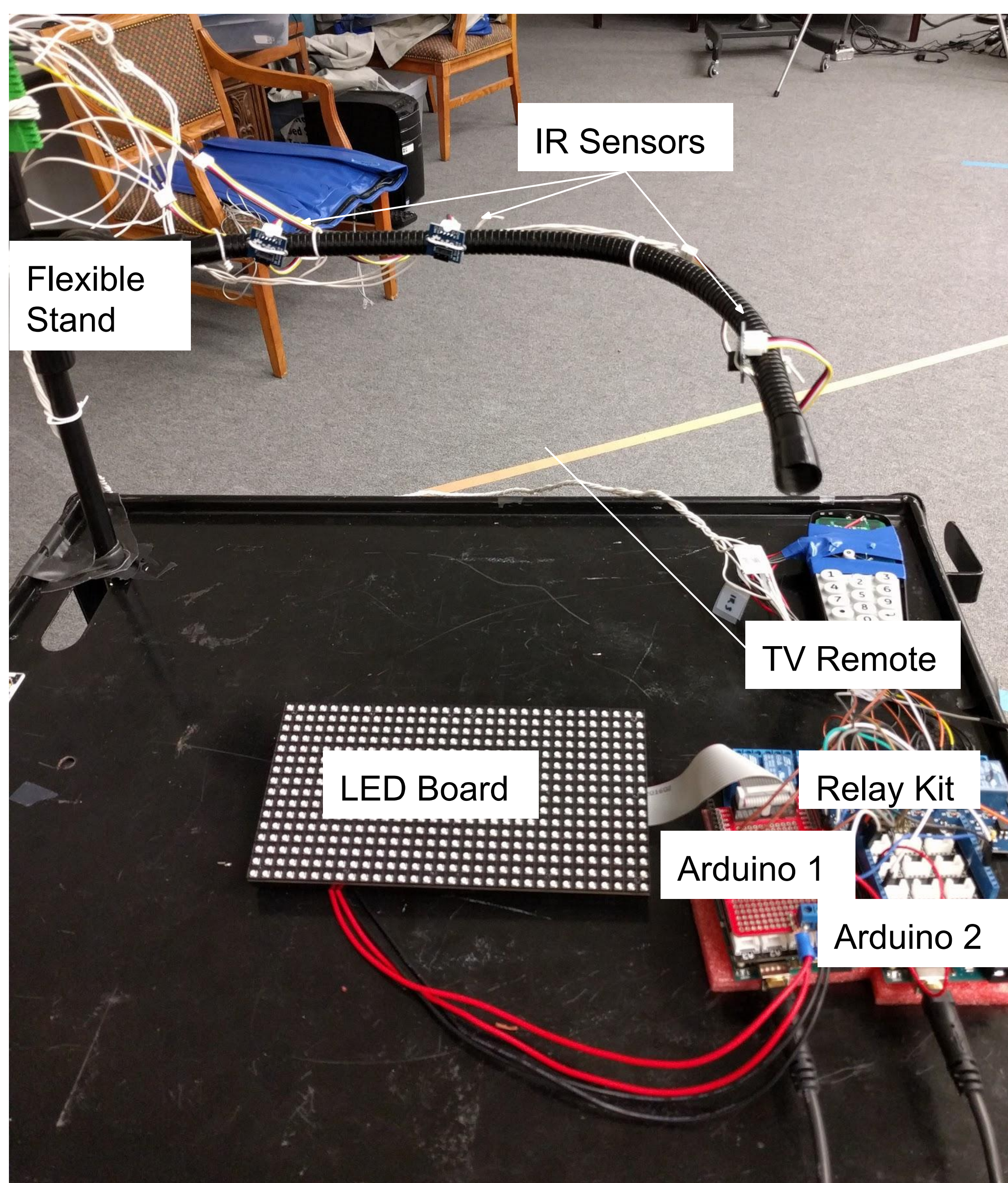


Fig. 1. System Design with labels.

TV Mode

The first mode included in our system is the Television (TV) mode. [Fig. 3.] This allows the patient to control specific remote functions (channel up/down, volume up/down, and power) with customizable movements set by an Occupational Therapist.

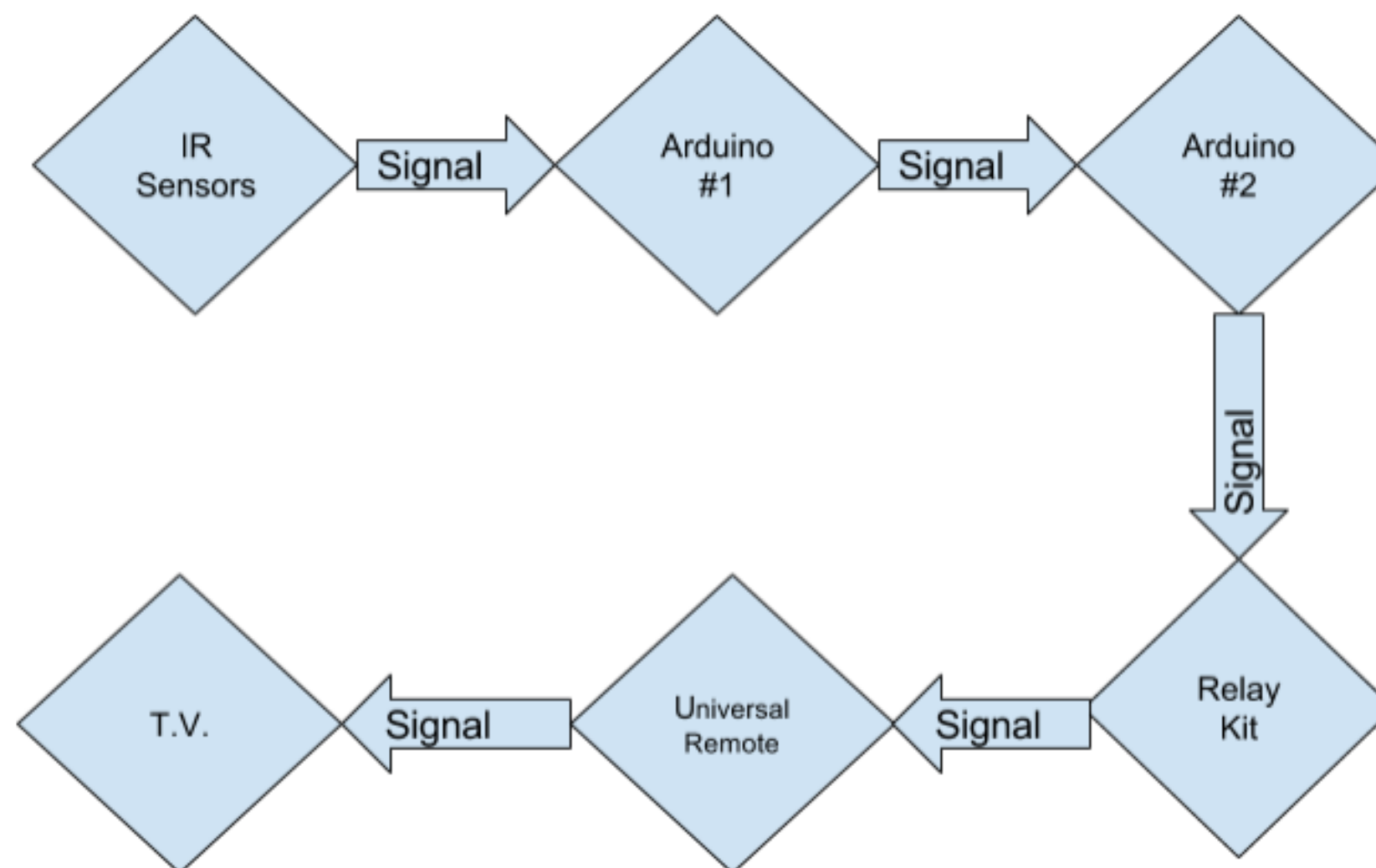


Fig. 2. TV Mode functionality flow chart

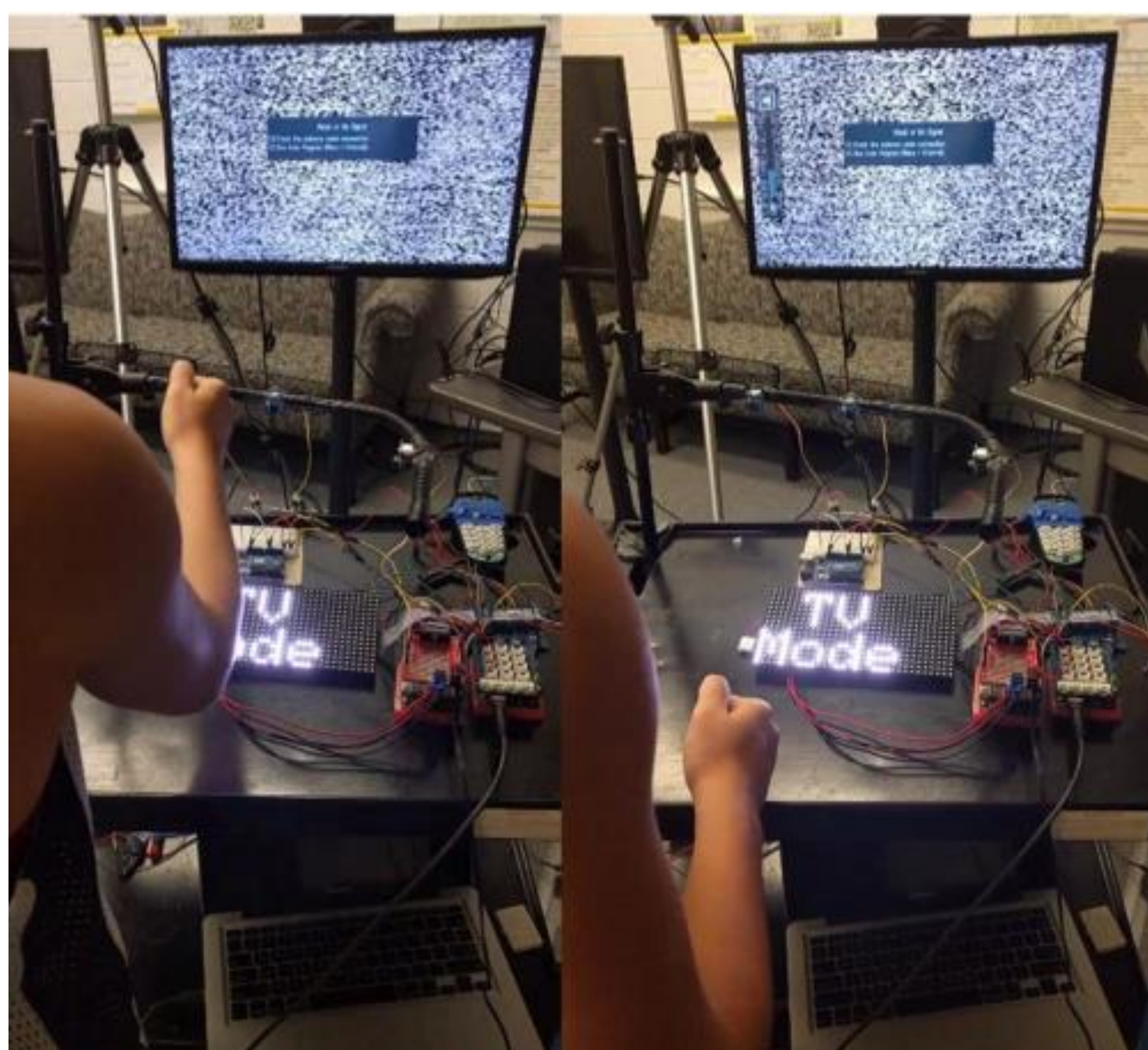


Fig. 3. TV Mode visual representation.

Game Mode

The second mode included in our system is the Game Mode. [Fig. 5] This gives patients an interactive way to complete set exercises with visual feedback and encouragement.

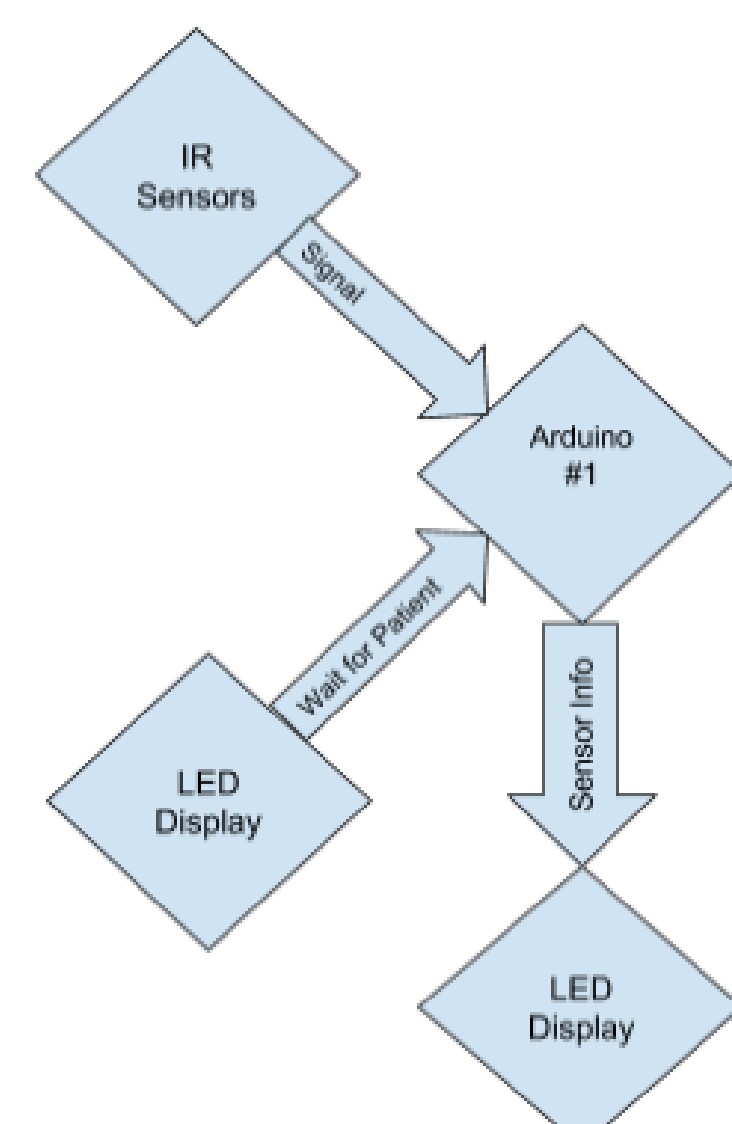


Fig. 4. Game Mode functionality flow chart.

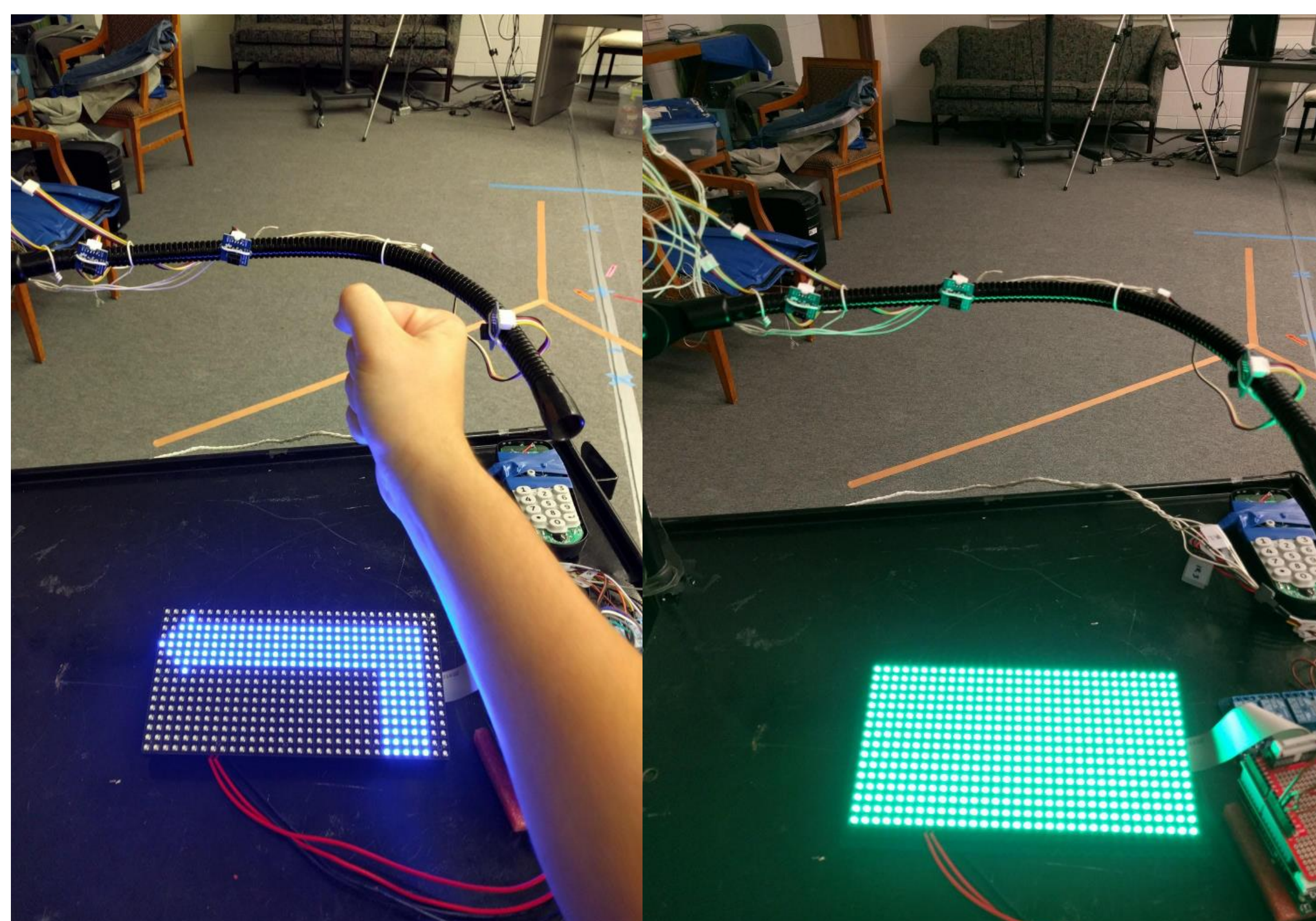


Fig. 5. Game Mode visual representation.

Graphical User Interface (GUI)

The GUI connects the Occupational Therapist to the system by allowing them to customize the movements for each patient. [Fig. 7.] They can choose which movements control the TV functions and what patterns are represented in the Game Mode. They also have control of visual aspects, such as color.

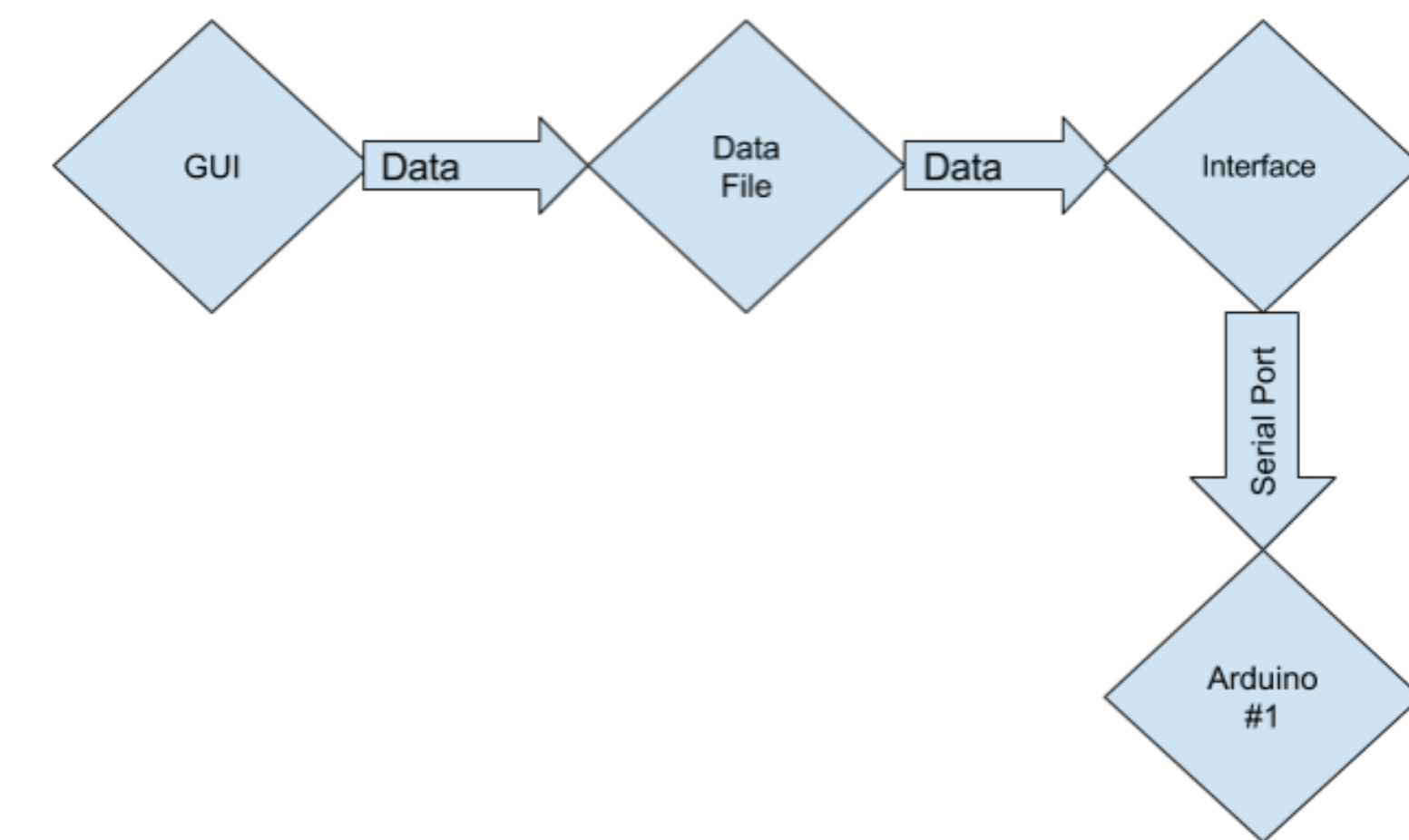


Fig. 6. GUI functionality flow chart

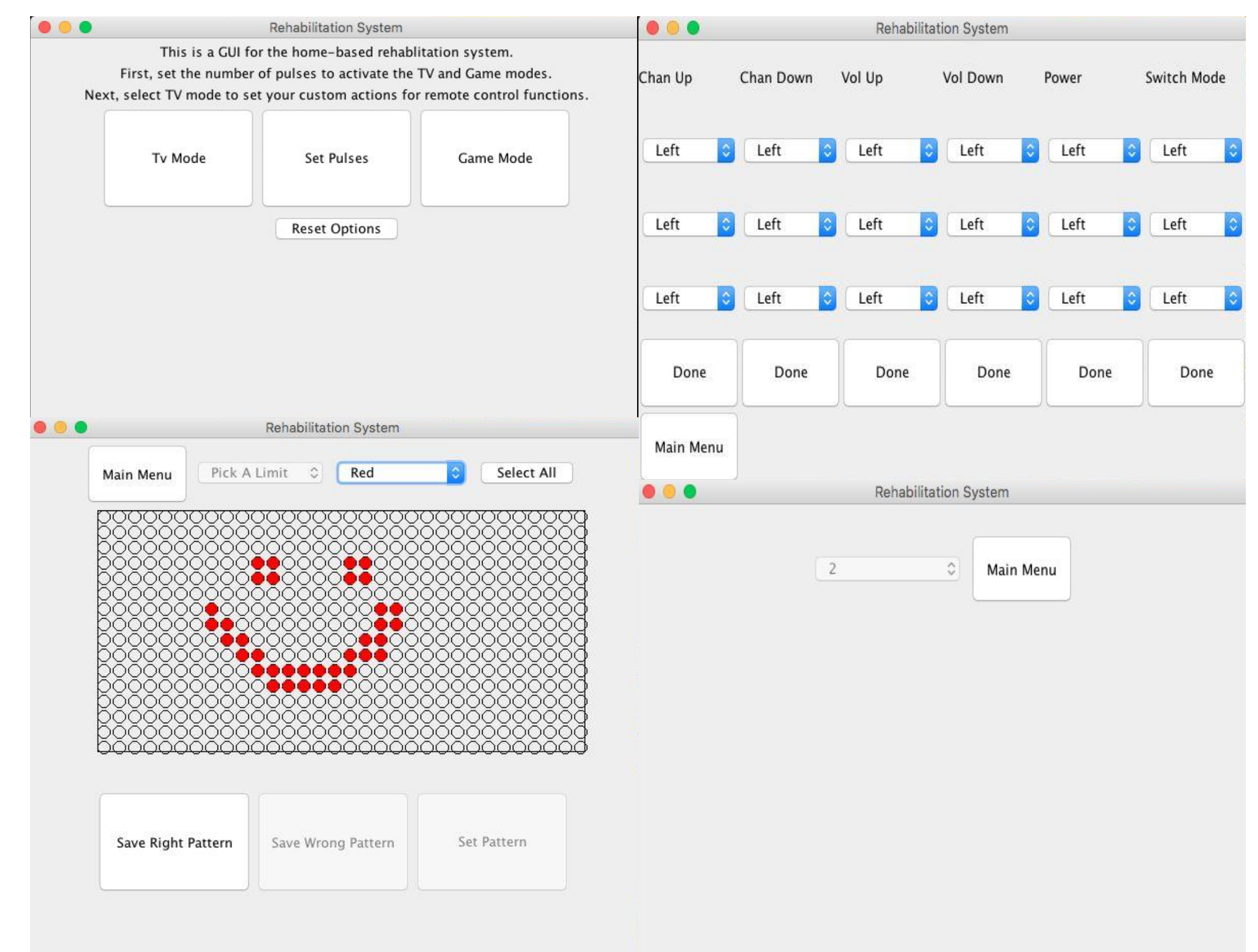


Fig. 7. The Graphical User Interface. Top left picture shows the home screen, top right shows the TV Mode, bottom left shows the Game Mode, and bottom right shows the set pulses screen.

Results/Conclusion

A prototype for the rehabilitation system has been successfully made and tested out by four non-impaired users. The prototype has been shown to an Occupational Therapist and it will now be shown to impaired-users to test it out.

Each mode has been tested separately and the Game Mode was tested by ourselves 10 times and had 100% accuracy in determining whether a specific exercise was successfully completed. The TV Mode often has trouble recognizing the customized movements and needs to be reset periodically. We gathered accuracy for each function by testing each one 10 times in a row. [Fig. 8.] As of now, the Game Mode part of the GUI has not been fully completed due to memory constraints on the Arduino Uno. The next step is obtaining more memory for the Arduino which will allow us to finish the GUI.

Further modifications to the system may include adding more sensors, a different stand, adding more options in the GUI, and increasing portability and compactness.

Movement	Number of Tries	Accuracy
Channel Up	10	90%
Channel Down	10	90%
Volume Up	10	90%
Volume Down	10	80%
Power	10	80%

Fig. 8. A table showing the accuracy for each function in TV Mode.

References

- [1] "Table 11. Time spent in leisure and sports activities for the civilian population by selected characteristics, 2015 annual averages," *U.S. Bureau of Labor Statistics*. [Online]. Available: <http://www.bls.gov/news.release/atus.t11.htm>. [Accessed: 30-Jun-2016].
- [2] Baran, Michael, et al. "Design of a home-based adaptive mixed reality rehabilitation system for stroke survivors." *2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society*. IEEE, 2011.