Vital Signals Lab
Rehabilitation

Fall 2024
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This file contains the report and results of the simulations conducted.

Abstract

Rehabilitation in Today's World refers to a set of processes and treatments aimed at helping individuals regain or improve their physical, mental, and social abilities after injury, illness, or disability. In today's world, with advancements in technology and medicine, rehabilitation methods have become more diverse and effective. These methods help individuals restore their independence and improve their quality of life. Rehabilitation is not only for those with severe injuries but also for individuals suffering from chronic conditions such as diabetes, stroke, or arthritis.

Modern Approaches to Treatment and Rehabilitation is one of the most significant advancements in rehabilitation is the use of modern technologies such as robotics, virtual reality, and artificial intelligence. For example, rehabilitation robots assist patients in relearning specific movements they have lost. Virtual reality is used to simulate environments where individuals can enhance their motor or cognitive skills. Traditional physical therapies, such as physiotherapy and occupational therapy, have become more effective by integrating these technologies. Additionally, psychological treatments and social support are essential for improving the mental and emotional well-being of patients.

The Importance of a Comprehensive Approach in Rehabilitation treatments should adopt a comprehensive approach that addresses all aspects of a patient's physical, psychological, and social well-being. Combining the expertise of various professionals, including physicians, physiotherapists, psychologists, and social workers, can create a multidisciplinary and effective treatment plan. Moreover, raising awareness among families and communities about supporting individuals during rehabilitation is crucial. Today, with an increased emphasis on person-centered care, rehabilitation not only helps improve individual functionality but also plays a vital role in reintegrating individuals into society and enabling independent living.

Project

In this project, we developed the Flappy Bird game. The objective of the game is to control the bird to navigate through obstacles using a grip force mechanism. The game is programmed in MATLAB, although it can also be implemented in Python. Additionally, to capture analog signals and convert them to digital, we use an Arduino and a PowerLab device.

At the start of the game, we have included a menu for both new and existing users. If a user is playing for the first time, they are prompted to enter their name and are assigned a unique ID. Existing users can enter their ID to access their profile. This feature allows us to maintain user profiles and their history, which can be utilized for future reference or analysis. It is worth noting that the game data such as the user's score in each attempt and the time spent per attempt is stored in a .txt file. This ensures that all game-related information is systematically saved for each player.

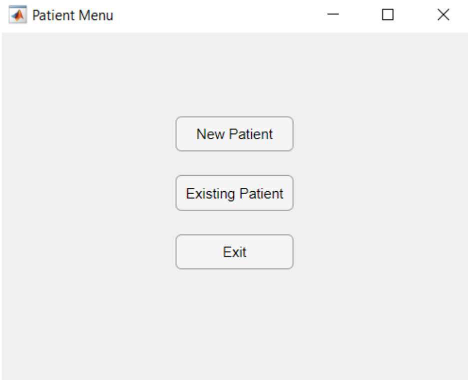

Figure 1 (Patient Menu)

After opening or creating a user profile, the next menu is displayed.

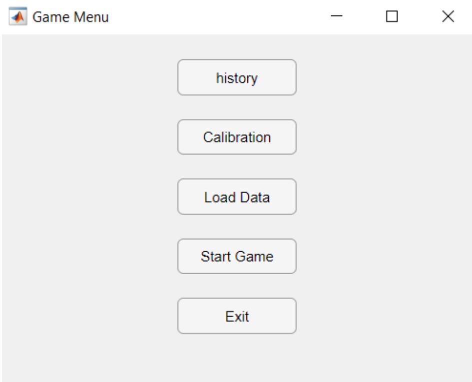

Figure 2 (Game Menu)

The first item in this menu pertains to the user’s history and progress report over time. As shown in the figure below, the user's scores and corresponding times for each attempt are plotted, enabling the identification of rehabilitation trends and progress. This visualization helps in tracking improvements and evaluating the effectiveness of the training.

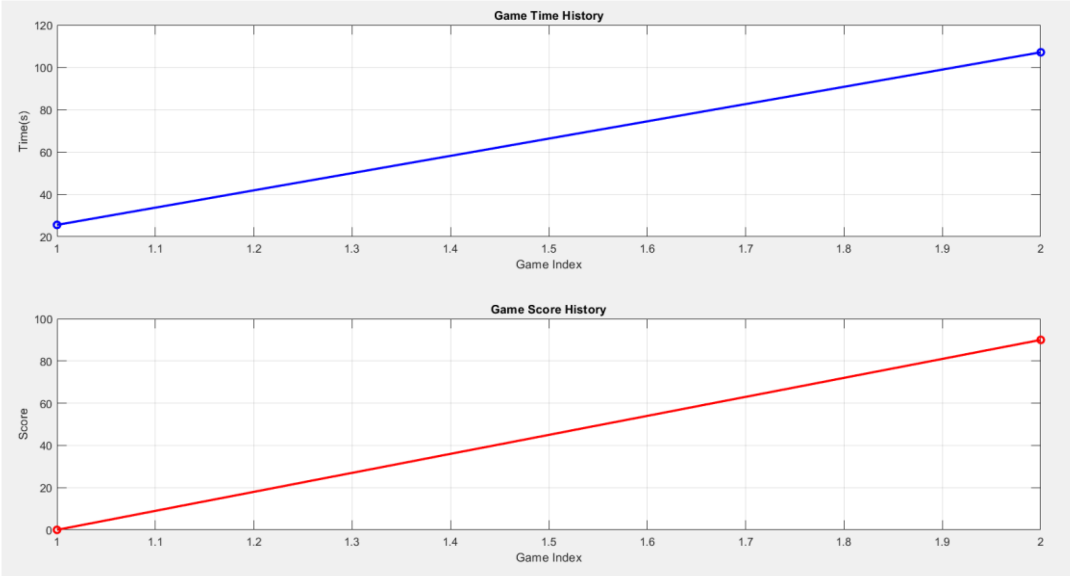

Figure 3 (Patient History)

One of the most critical aspects of this project is the calibration phase. In this phase, we aim to capture the user's signal and determine its maximum and minimum values. The reason for performing this calibration will be explained in more detail in later sections.

In the "Load Data" section, we load the received data and record its minimum and maximum values.

The "Start Game" section initiates the game. The game screen consists of a small circle for controlling the bird and a series of obstacles. Real-time signals are received from the Arduino. Based on the minimum and maximum values determined in the calibration section, every new data point received from the Arduino is normalized by subtracting the minimum and dividing by the range (maximum - minimum). This normalization ensures that the control signal is consistent and aligned with the user's calibrated range, allowing for smooth and accurate control in the game.

```
Calibration complete. Min: 0, Max: 1.9531
```

The normalized signal is multiplied by the height of the game screen. This method allows us to position the bird in the game based on the user's force, keeping it at the desired level on the screen. Next, to ensure smooth movement of the bird, we applied two techniques:

- We multiply the difference between the calibration signal's minimum and maximum values by a factor smaller than one. This is because, during calibration, the user exerts their maximum force, but during the game, the obstacles are designed in such a way that the user does not need to apply their maximum force.
- We also implement a moving average filter to smooth the bird's movement, preventing sudden or excessive jumps in its position. This ensures the bird's movement remains fluid and more natural.

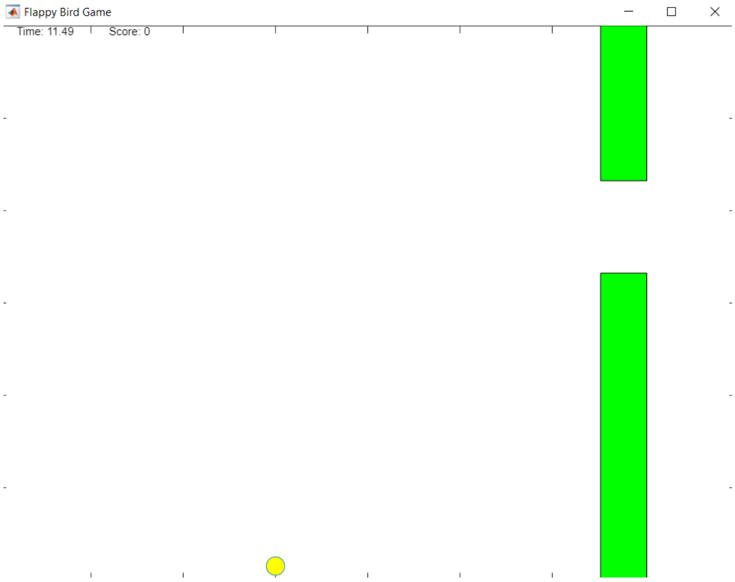

Figure 4 (Game Screen)

It is worth noting that the calibration data for each attempt is also saved in each user’s file, so the maximum value can be used to assess the progress of the treatment. Another point to mention is the speed of the game. The game is designed in such a way that the bird's position is fixed, and the obstacles move at different speeds. This speed can be adjusted in each game to change the difficulty level, making the game either easier or harder.

calibration_data_1.mat	1/7/2025 10:49 AM	MATLAB Data	1 KB
calibration_data_2.mat	1/7/2025 10:51 AM	MATLAB Data	2 KB
Patient_2_Mana.txt	1/7/2025 3:25 PM	Text Document	1 KB

Figure 5 (Patient folder)

Data in this game is received from the Arduino Uno board. The baud rate is set to 9600, and we receive the data with a 200-millisecond delay, without performing any complex operations on it. However, if the microcontroller or, more specifically, the ADC (Analog-to-Digital Converter) were more advanced and powerful, we could have improved the game's speed and made the bird's movement even smoother. A better ADC would allow for more frequent and precise signal readings, enabling finer control and enhancing the overall game experience.

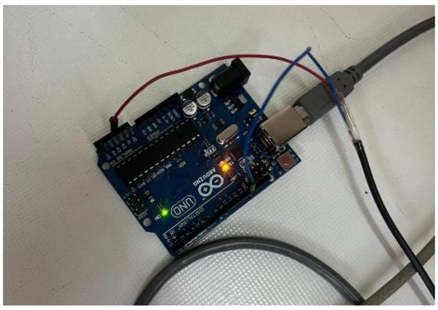

Figure 6 (Arduino Uno)

The method of using the PowerLab is as follows.

First, we connect the grip force sensor to the EOG POD and then connect it to the PowerLab. Next, we connect the BNC cable from the PowerLab to the Arduino, ensuring that the red wire is connected to the positive terminal and the blue wire to the ground (GND) terminal. This setup allows for the proper transmission of the analog signal from the grip force sensor to the Arduino for further processing.

Figure 7 (Power Lab & BNC cable)