FLYCYCLE PROJECT PROPOSAL

PHASE-2

University of Maryland

Team: MRE (Medical Robotics and Equipment) Lab

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1) Goal and Objectives

We propose to further improve upon the work done on modernizing the Flycycle, donated by ATR Corporation to the Maryland Robotics Center. This robot is a Virtual Reality (VR) exercise machine that provides a complete as well as an entertaining workout for the upper and the lower body. The idea here is to combine the lower body workout of riding a cycle with the upper body workout of hand gliding. Using the feedback from the sensors, the user is completely immersed into the VR game which is controlled by his body movements. The full exercise entails activities like climbing, diving, banking and pedaling.

The objectives are twofold. The first avenue is developing coursework for students on the Flycycle system. This would include an introduction to the Flycycle system, an overview of the mechanical design and the components being used, a brief introduction to virtual reality and an exhaustive tutorial on getting started and developing games in Unity. Unity is a cross platformed game engine which can be used to make 2D and 3D games. The objective here would be to make the students familiar enough such that they can create their own games and test them out on the Flycycle. The course would be ended by organizing a competition on the best game developed for the Flycycle.

The second avenue is using the system for rehabilitation of patients, such as patients with muscle dystrophy. The sensor data from the Flycycle can be used to track critical information as how long the person is taking to finish a game/task and what kind of forces are being applied on the Flycycle. An important advantage here is the immersive virtual reality experience. This will help the user enjoy the rehabilitation program.

To summarize, the project consists of the following Five objectives:

1) **Developing an exhaustive tutorial on getting started with Unity and how to make VR integrable games for the Flycyle.**
2) **Creating a course on the Flycycle which will cover all the essential components and make the student ready to develop and play games on the Flycycle.**
3) **Organizing a competition on the games developed by the students at the end of the course.**
4) **Explore areas for the use of Flycycle Robot for rehabilitation Purposes such as for pediatric patients with muscle dystrophy.**
5) **Develop rehabilitation games integrated with force sensors to give an immersive rehabilitation experience.**

At the end of this project, we will execute all the above objectives to build a first of its kind Flycycle used for exercising with a Virtual Reality experience.
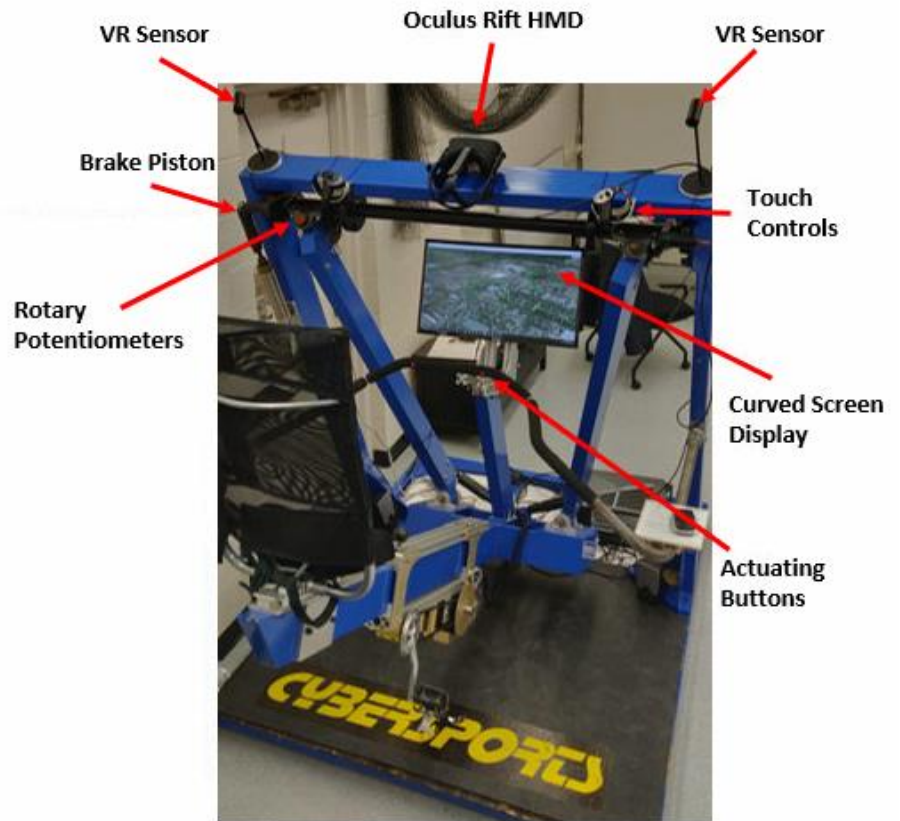
2) Prior Work

The first phase of the Flycycle project was modernizing it and integrating it with virtual reality. The first steps of the project were identifying all the components and making a list of things that could be reused to modernize the Flycycle. After careful evaluation, we replaced the existing controllers with Arduino microcontroller along with changing the monitor and the CPU. With this we were able to simulate basic keyboard and mouse-controlled games using the Flycycle. Later, we integrated the rotary potentiometers of the Flycycle with a game controller. This allowed better control in the games and opened up access to hundreds of games in 2D and in 3D (virtual reality). Figure 1 shows the Flycycle setup with its components. For virtual reality integration, we decided to go with Oculus Rift. The VR sensors are mounted in such a way that

they can track the motion of the Oculus Rift HMD (Head Mount Display) at all positions. The rotary potentiometer on the touch controllers are replaced by the Flycycle potentiometers to give all motion control.

Figure 1: Flycycle
Showing the major components

Two games are tested on the Flycycle both with and without the VR integration. The first game is a **Flight simulator**. Here the planes pitch is mapped from the pitch of the Flycyle and the same is done for the roll. The angle of the view can be controlled by the buttons on the Flycycle. The simulator is equipped with information like the elevation of the plane, eye height, the roll and the pitch angle with respect to the ground, etc. This gives the user a realistic experience of actually flying a plane. Moreover, the flight simulator is integrated with google earth and therefore you could even fly over your own house. Upon integrating it with Oculus, the experience gets even better. Because of the HMD, the user gets a 360 degrees immersion of the world and gets to control the plane while exercising. Figure 2 (a) shows the view of the flight simulator passing over the University of Maryland. To see the video demonstration, of the simulator, please click here and for VR integrated flight simulator, please click here.

The second game is **Asphalt 8**. This is a racing game and it is chosen as the game in 2D itself is very immersive. Plus, it also opens an avenue for different people to compete in the game. The direction of the motion of the car is controlled by the roll of the Flycycle while the pitch

Figure 2: (a) The Flight Simulator View- showing the pitch and roll angles (b) The Asphalt 8 – Racing Game

controls the barking. The different buttons mounted on the Flycyle actuate the nitro and the different camera angles. Similar, to the previous game, the VR integration gives a 360-degree immersion and helps the user exercise while enjoying the game. Figure 2(b) shows a screenshot of the car racing through the track. To see the video demonstration, of the game, please click here.

3) Project Plan and Milestones

For this project, we will be using the Flycycle robot donated by the ATR corporation to the Maryland Robotics Center. The project is divided and executed into five objectives. 1) Assembling the Robot when it arrives at Robotics Realization Lab. 2) Identifying and ordering replacements to Modernize the Robot and its interface. 3) Integrating a Desktop game with the Flycycle sensors to get an entertaining Fitness experience. 4) Developing a VR interface using headsets such as Oculus Rift to get a completely immersive experience of the game. 5) Explore areas for the use of Flycycle Robot for rehabilitation Purposes such as for pediatric patients with muscle dystrophy.

In objective one, with the help of the technical lead from the ATR corporation, we will assemble and set up the Flycycle robot in the Robotics Realization Lab. This will include, making sure that all parts are attached properly and understanding the basic instructions and guidelines on handling the robot. The next part would be to experiment with the limitation of the actuators of the robot and get a better design perspective.

For objective two, a through analysis of the existing sensors will be made. Also, a study will be carried out on what parts can by modernized to make the robot compatible with the recently developed state-of-the-art VR games and software's as the robot was designed a long time back. Once this is done, the new sensors and parts will be integrated with the Flycycle and a basic demo of the Flycycle will be carried out. Here, the outputs from different sensors will be studied and checked if the integration was successful.

For objective three, a game will be developed so that the Flycycle can interact with the game and give a visual feedback on the computer screen. This will enable the user to play the game using his own body. The game would be either be developed in Android or in IOS. The theme of the games would be on similar grounds as flight simulators or car racing games, so that the acceleration can be controlled by the pedaling speed of the Flycycle and the steering of the vehicle will be controlled by the user's body (using the potentiometers mounted on the top two arms of the Flycycle). The level of effort required can then be used to set different levels in the game. Although, the difficulty level of the game would not be able to be changed significantly because of the passive degrees of freedom. Once the game is operational, we should have a fully functional Flycycle robot set up.

The fourth objective, is to make the Flycycle VR compatible. This will enable the user to get a completely immersive experience of the game. This is in comparisons with the latest developments made in the field of VR Fitness. Companies like ICAROS and Black Box VR have already started working on combining physical fitness with Virtual Reality games to give a fun and immersive workout.

The final objective for the summer is to explore areas in which Flycycle can play a critical role as a rehabilitation robot. As the Flycycle aims as working out the entire body, it can help patients build muscle strength. Also, if we integrate active degrees of freedom into the robot, then we can vary the stress incurred on the muscles and tone the muscle as required. The area targeted would be using the Flycycle for pediatric patients with muscle dystrophy.

The two milestones for the summer project are; 1) Modernize the Flycycle, so that the user is able to interact with a computer game using his body movements. This should be completed by the end of July.

2) Make the Flycycle VR ready and convert the regular fitness sessions into a completely immersive fitness exercise. Also, explore the potential of the Flycycle as a Rehabilitation Robot. This should be completed by the end of summer (month of August).

3. Budget for the Summer

Items	Cost
Computer Screen	750
Industrial Grade Joystick Potentiometers	75X4=300
Oculus Rift with Accessories	1200
Oculus PC	2700
Sensors and Miscellaneous Electronics	4500
Additional Hardware and Replacements	3000
3D Prints	800
Graduate Research Assistant: Anirudh Topiwala (40 hrs./week @$15/hr.)	7800
Total Cost	20000 $