EEL 4924 Electrical Engineering Design
(Senior Design)

Preliminary Design Report

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Project Title:
Pneumatic Exercise Machine

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Project Abstract:

The purpose of the project is to design a workout band machine. The user will be able to stand on a base that houses the pneumatic system and work out by lifting the bands. These two bands that the user can hold with his/her hands will be connected to this pneumatic air-pressure system in order to control the resistance, which would be equivalent to lighter or heavier weights.

This product will be useful in the fact that the user does not have to change out the weights every time that he/she wants increase or decrease the intensity. It will allow the user to continue in the workout without even getting off of the product's base. This will also allow the user to get rid of the excessive amount of dumbbells and make it unnecessary for the user to drive to a gym every time.

Features:

- Increase/decrease the resistance equivalent to the corresponding weights
- Air-pressure resistance instead of weights
- Wireless control from the handle
- Repetition and velocity data shown on a LCD display

Note: We may work on pre-set workout programs if we have extra time at the end.

Technical Concepts:

The goal of the project was to create a very fluid and minimalist method of resistance exercise. Conventional exercise methods require heavy weights and frequent switching of weights over the course of a workout. Using air pressure to create resistance provides a safe and efficient way to work out. In addition, exercise statistics can be logged for user feedback. Level of resistance, time and day of workout, and number or repetitions provide the user the benefit of tracking their progress and optimizing their workout.

There were initially a few different methods of creating a resistance that could be electrically controlled. A motor system was considered. The disadvantages were safety concerns, noise, and potential lack of precision. Muscle wire, commonly used in robotics, was researched. They turned out to be far too fragile to heat and had a very slow tension change over time. Air pressure is easy to provide via an air compressor or air pressure tank. Electronic air pressure valves are very precise and will allow varying air pressure to be quick and accurate.

The design requirements are as follows:

1. The mechanical pneumatic system will need to be built. This will consist of an air pressure source that is set to a maximum PSI. The air pressure source can be a tank or electrical air compressor. The air pressure source will output to the air pressure regulator valve. The valve will output to a pneumatic cylinder. Attached to the other end of the cylinder will be a cable pulley system. As more pressure is allowed into the cylinder, the force required to pull the cylinder's pump will increase.
2. The electronically controlled regulator valve receives input signals ranging from 4-20 mA. This amp source will be provided one of two ways. The first way assumes that a microcontroller can provide an analog output current, and would directly send signals to the regulator. If this is not possible, then a voltage source can be supplied. A digital potentiometer can take input from the microcontroller and provide the correct resistance to output the correct current to the regulator.
3. To provide seamless changing of resistance, a method of wireless control must be implemented from one of the handles at the end of the pulley system. This is where the user would have their hands. We need to choose a microcontroller with an RF receiver. A basic RF transmitter would be placed in the handle. Functions to be controlled remotely would include:
    a. Increase resistance
    b. Decrease resistance
    c. Adapt mode
    d. Enable statistic tracking to computer

4. A sensor would provide data collection by measuring displacement along two points on the cable. The data collection would include repetitions and velocity.
5. The adapt function would use the velocity data to determine how fast the resistance is being pulled. If deemed to fast by some standard that can be set, the resistance will automatically increase in increments until an appropriate resistance is achieved.
6. The microcontroller also needs a wireless transmitter will be able to send data to a computer program to log statistics. If time and money permit, it would be ideal to be able to automate resistance changes through the computer program. A user could have a pre-set routine to follow instead of manually changing resistance.

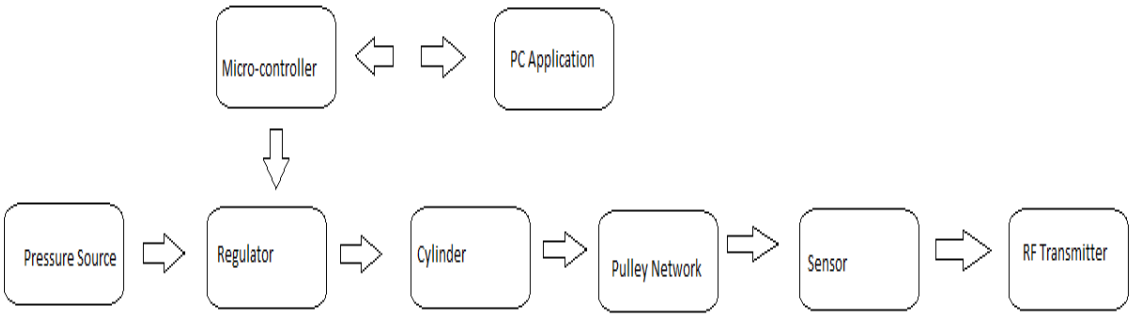

Fig. 1: General Flow of All Equipment

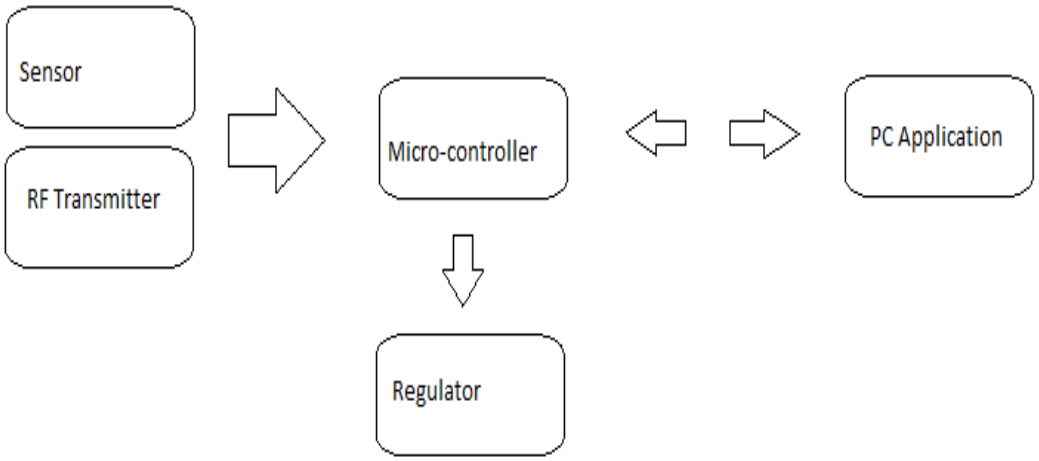

Fig. 2: Electronic Flow

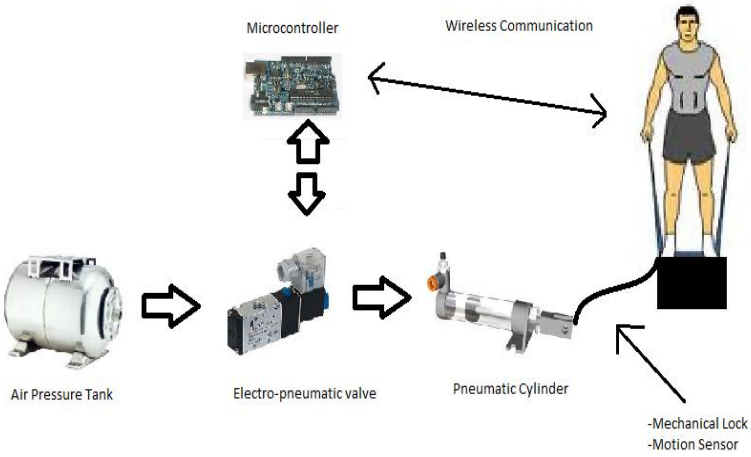

Fig. 3: Parts Images

Labor Distribution:

The following is a breakdown of each team member's projected labor by approximate percentage.

	Gino Tozzi	John Yun
Preliminary Research	50	50
Design Phase	70	30
Board Construction	30	70
uP Coding	70	30
PC Coding	30	70
Mechanical Construction	50	50
Test and Debug	30	70

Project Timeline: