Bench Press Smart Helper

ECE 445 Team 35

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Introduction
Injury-related concerns

- According to a recent study by BMJ Open Sport & Exercise Medicine conducted over sub-elite to elite powerlifters, up to 46% of injuries in powerlifting are caused by the bench press.

- According to St. John and St. Elizabeth hospital, the two most common bench press-related injuries are the subacromial bursitis and the torn rotator cuff.

- Recovery from a torn rotator cuff might take 4 to 6 months or even longer in severe cases.
Performance-related concerns

To avoid those injuries, one tends to:

- Not perform the exercise at maximum intensity
- Perform at maximum intensity, but not to failure
- Choose alternative exercises
Performance-related concerns

NOT Ideal, because:

- The best exercise according to the two largest EMG studies conducted for chest activation is the **BARBELL BENCH PRESS**
Introduction

THE SPOTTER
Our solution

We:

- Eliminate the need for a spotter
- Allow you to always perform the exercise at maximum intensity
- Guarantee that you get the best result out of the bench press
Objectives
Motivation

Bench Press Leg Self Spotting

Smith Machine for Bench Press
Objectives

High Level Requirements

1. Repetition Tracking & Failure Detection
2. Hoist Activation
3. User Control
Objectives

Repetition Tracking & Failure Detection

- Python computer vision program
- Real-time coordinates tracking and time measurements
- Provide useful help and prevent injuries
Objectives

Hoist Activation

- Protection relays
- 3.3V from Raspberry Pi to 5V in microcontroller
- Physical integration
Objectives

User Control

- User input (repetitions to be performed without and with help)
- Adjust position of hoist
- Mobile control
Design
Design
Control Subsystem

Key Requirements:

- **Hardware**: establish communication protocol
  Raspberry Pi ➔ PCB ➔ Hoist

- **Software**: track the motion of the barbell accurately and develop the hoist activation logic

Major Challenges:

- PCB implementation
- Barbell coordinate tracking
- System integration
PCB Design
Sensing Subsystem

Key Requirements:
- The webcam should be able to capture the barbell from end to end horizontally and follow along the vertical motion.

Major Challenges:
- Different camera resolutions
- Varying lighting conditions
- Background noise
Mechanical Subsystem

Key Requirements:
- Remove the manual switch of the hoist
- Control the hoist with our PCB
- Mounting frame

Challenges:
- Hoist control with ATMEGA328
- Capacitor discharge
Power Subsystem

Key Requirements:
- Level shifter must perform the $3.3 \text{ V} \rightarrow 5 \text{ V}$ conversion correctly (within a desired range)

Major Challenges:
- Malfunctioning components
- Late component arrival / tight deadlines
Conclusions
What we learned

Personal:
- Value engineering skills in solving real life problems
- Teamwork and consistency are key to success
- Almost nothing works on the first try.

Technical:
- PCB design and optimization.
- Component interconnection and communication.
- Soldering
- System Integration
- OpenCV
Conclusions

**Future direction**

- Optimize the structure
- Modify design for commercial and gym compatibility purposes
- Adjust for other exercises
THANK YOU!

Questions?

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