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DIP-TRAINER

Project Handout

Motivation

Fitness is one of the considerable aspects of a balanced lifestyle. One of the most useful parts included by fitness is the bodyweight strength workout, that improves strength, stamina, coordination and even injury resistance of the body.

We are a team of two gentlemen inspired by sport and healthy lifestyle. Both of us have a couple years of fitness experience - so we were able not only to train, but to observe many different people at their strength workout.

The significant conclusion of our observation is that only about 20-25% of the average gym visitors are able to demonstrate a clean form of the basic bodyweight exercises.

Therefore we decided to create a device, that helps to controll the proper form of the most popular bodyweight exercises and even more.

Exercises

The most popular exercises that help to develope the upper body are the push-up, pull-up and the dip.

Image 1.1: Push-up - classic and well-known chest, tricep and shoulder exercise.

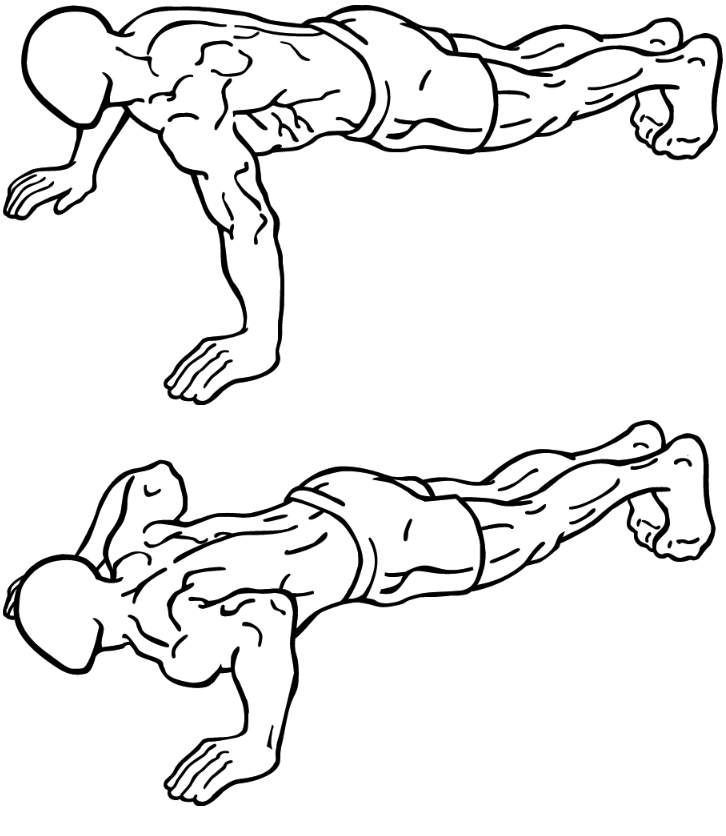


Image 1.2: Pull-up – one of the best back and bicep exercises.

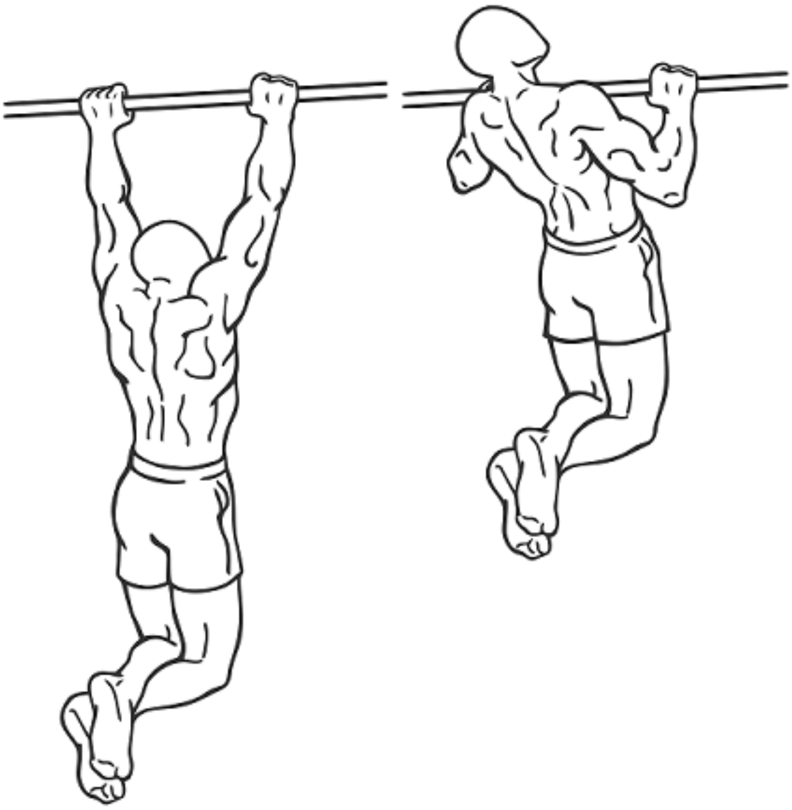
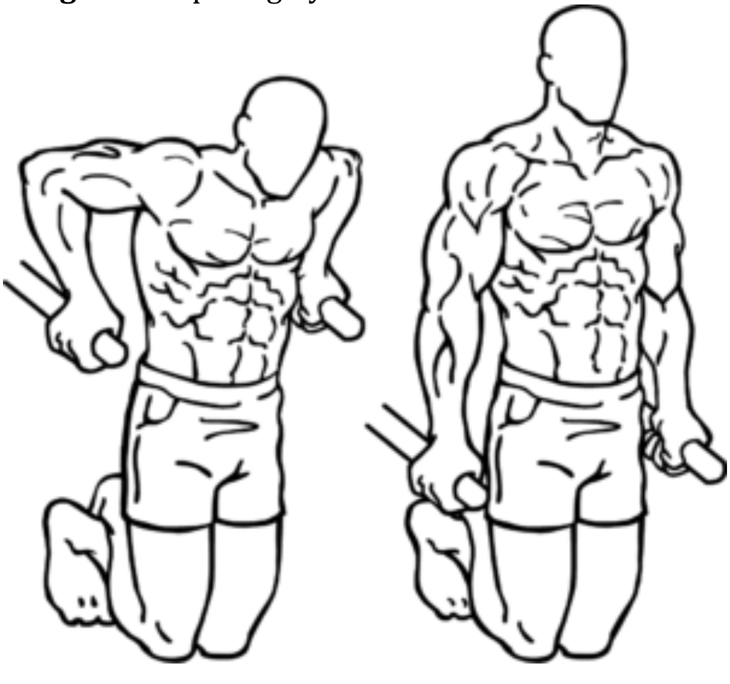


Image 1.3: Dip – highly effective lower chest and tricep exercise using a dip bar.



The proper form of all three exercises depends on clean and controlled way of body movement and on the high **amplitude**, so you let the muscles do the complete work. Only the correct technique allows you to gain an optimal result of the strength workout.

Functionality

The device includes a following training modes for all three exercises:

- Score mode: you choose the exercise and try to do a maximal amount of repetitions. After that you can call up your status depending on the result. There are 5 jocular states: „Nerd“, „Feeble“, „Engineer“, „Brave Guy“, „Alpha Male“. Don’t take them too serious ☺

- Training mode: you choose the exercise, quantity of the repetitions, sets and the pause length to develope the complete personal upper body routine.

To establish the amplitude control, the device should be attached to the upper arm with a straps to measure the angle inclination during the exercise.

After the set start, you can hear the preparation countdown of 5 secons to take the initial position. After that you have to perform the first repetition in the proper form. The amplitude of the first calibrating repetition will be saved and the following repetitions will be compared to the first with a 5° angle tolerance. Only the correct repetitions will be counted and signalized with a sound signal of the buzzer.

Implementation

The prototype of the device contains following components:

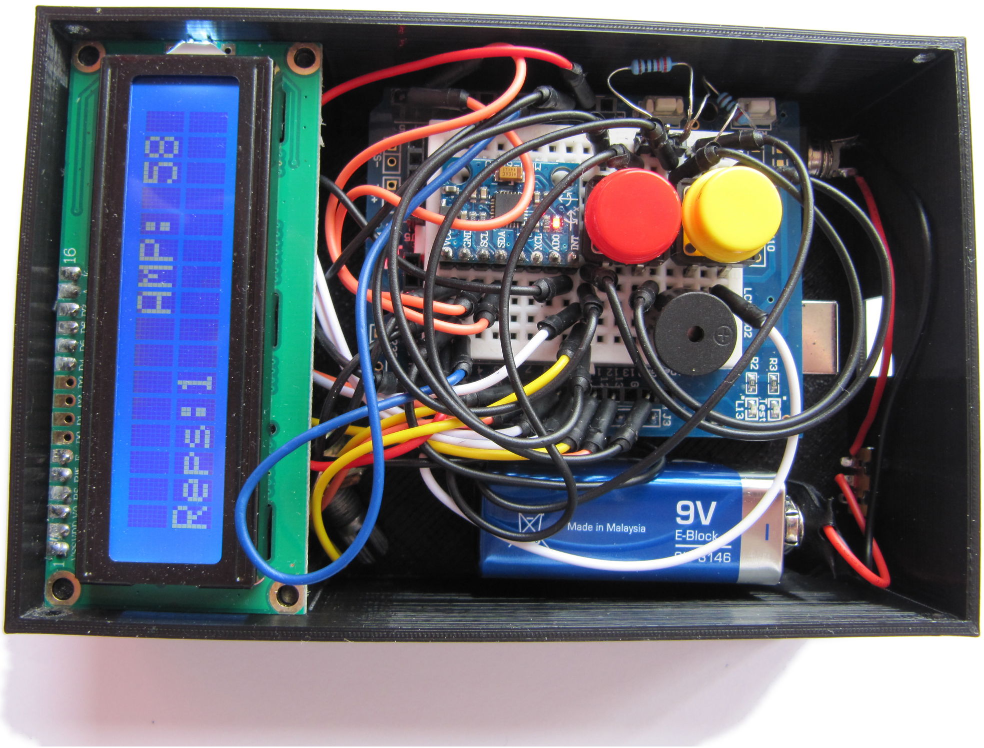
- Microcontroller board (Arduino UNO)
- Arduino UNO extension board with a little breadboard
- LCD Display (HD44780 1602)
- Two buttons with corresponding resistors (100Ω)
- Passive buzzer
- Triple-axis accelerometer with gyroscope (MPU-6050)
- Nine-volt battery with adapter
- 3D-printed two-part case with corresponding screws
- Connection cables

The switching details of the components are trivially. All I/O components and accelerometer module are connected to the extention board via breadboard with cables.

In order to the inclination angle measure we have used a MPU 6050 triple-axis accelerometer with gyroscopic sensor. This chip contains not only the sensors, but also 1024 byte FIFO buffer working over interrupt to place the calculated acceleration data. The values need to be calculated due to inaccuracy of the single sensors. To perform these calculations, MPU 6050 also contains DMP(„Digital Motion Processor“), that is able to transform inaccurate raw values into yaw-pitch-roll or Euler angles interpretation.

As a basement we used the MPU-6050 handling library written by Jeff Rowberg and implemented our needed functionalities on top of it. The complete sketch is attached to this handout in the *diptrainer.zip* file.

Image 2.1: Open-case view of Dip-Trainer



Problems

We also have confronted a several stability issues working with a MPU-6050. The main problem was the complicated code that we had as a basis. Jeff Rowberg did a colossal amount of coding performance to bring the unstable MPU-6050 to work. So as we implemented our function routine on top of it, we got immediately a couple of stability issues and the device didn't work anymore. With an eye to finalizing the project we spent almost the entire time until the deadline with studiying the configuration routines of DMP, until we obtained the stability and could do our first digitally-controlled push-ups. Thereby we had not enough time to carefully analyse the ergonomics, print our own extention board without a breadboard and tons of cable and take many another aspects into account. Nevertheless, we have implemented the main functions and brought them to work correctly.

Image 2.2: Overview

Perspectives

After improving of ergonomics and size and implementing of additional functions(pedometer, GPS-tracking, pulsometer and many others) the device will have a start-up potential as an allround fitness-tracker for the people inspired by sport.

Sources

Jeff's Rowberg MPU-6050 code:
https://github.com/jrowberg/i2cdevlib/tree/master/Arduino/MPU6050

Exercises images:
http://www.wikiwand.com/en/Dip_(exercise)

http://physics.stackexchange.com/questions/110638/when-we-do-pull-ups-does-the-bar-takes-more-weight-than-when-we-hang-down-on-t/110643

https://upload.wikimedia.org/wikipedia/commons/thumb/5/5b/Dips.png/300px-Dips.png