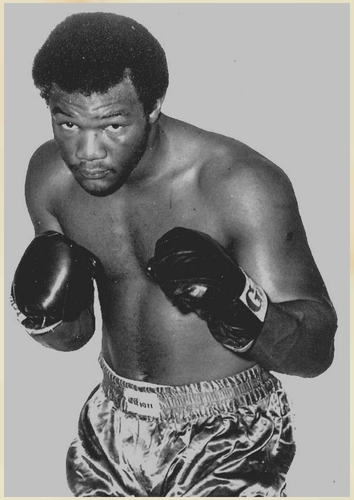


Lean-Mean Skating Machine

Simon Wagner

Product Description

The Lean Mean Skating Machine is a small portable device that attaches directly to a longboard and helps the rider perfect his/her pumping technique. It will use an accelerometer to calculate a moving average of the board's oscillation frequency, as well as the velocity in real time. The device will display this data, and indicate if the frequency of oscillations is causing the rider to accelerate or decelerate at the current speed.

Target Audience

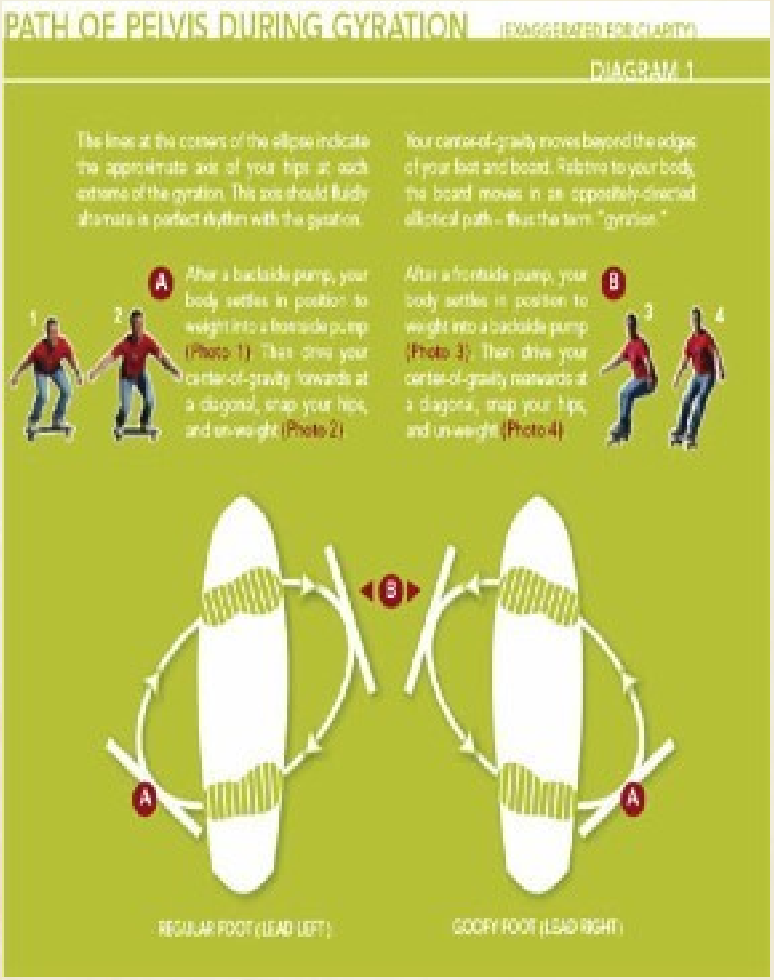
- Environmentalists - promotes an alternative mode of transportation that is emissions-free
- Fitness buffs - not only is skating a great exercise for the lower body, but the pumping motion also greatly strengthens the core
- Longboarders - fast growing community (e.g. college campuses)
- LDP (Longboard Distance Pumping) enthusiasts - skaters around the world spreading the stoke of pumping

Longboard Basics

- Originated in California in 1950s as a land alternative to surfing
- Deck - refers to the actual board (often wood). Comes in variety of shapes, materials and sizes for a variety of functions. Generally between 37 and 50”. The most common shape is the pintail.
- Trucks - mounts for attaching wheels. Provides steering by turning in direction of rider’s lean. Should be loose for pumping.
- Bushings - polyurethane discs that connects the trucks to the kingpin. Controls flex and turning of board. Softer bushings provide more rebound while harder bushings provide more stability.
- Wheels - much larger since there is no concern for weight (65-85 mm) and softer for a smoother ride (72a-86a). Should be “grippy” for pumping.

What is pumping?

- Goal: accelerate without putting feet on the ground
- How: shift one's weight in sync with the board's movement
- Physics: Pushing the wheels toward the center of the board's turning radius creates a centripetal force (F=mv^2/r). The grip on the wheels causes that force to push against the riding surface. The surface applies force back to the wheels with a forward component creating acceleration.



Oscillation Properties

- The rotation of the deck on the Z-axis has a linear relationship to the rotation of the trucks and wheels on the XY plane.
- Faster oscillations result in more acceleration
- The faster the rider is traveling, the faster he/she must oscillate in order to accelerate
- When the oscillations fall below a certain threshold (dependent on velocity), pumping turns in to carving. The weaker centripetal force does not result in as much forward acceleration.

Test Riders

- Name: James Kelly
- Age: 20
- Hometown: Petaluma, CA
- Sponsor: Loaded Boars

- Name: Louis Pilloni
- Age: 24
- Hometown: Thousand Oaks, CA
- Sponsor: Sector 9

Test Boards: Loaded Vanguard

- Deck: Flex 3, Bamboo
- Trucks: Randal 180mm
- Wheels: Orangutang In Heats (75mm, 83a)
- Bushings: Khiro Cone Bushings (85a)

Test Boards: Loaded Dervish

- Deck: Flex 1, Bamboo
- Trucks: Randal 180mm
- Wheels: Orangutang Freerides (70mm, 86a)
- Bushings: Venom Bushings (80a)

Test Boards: Sector 9 Prototype

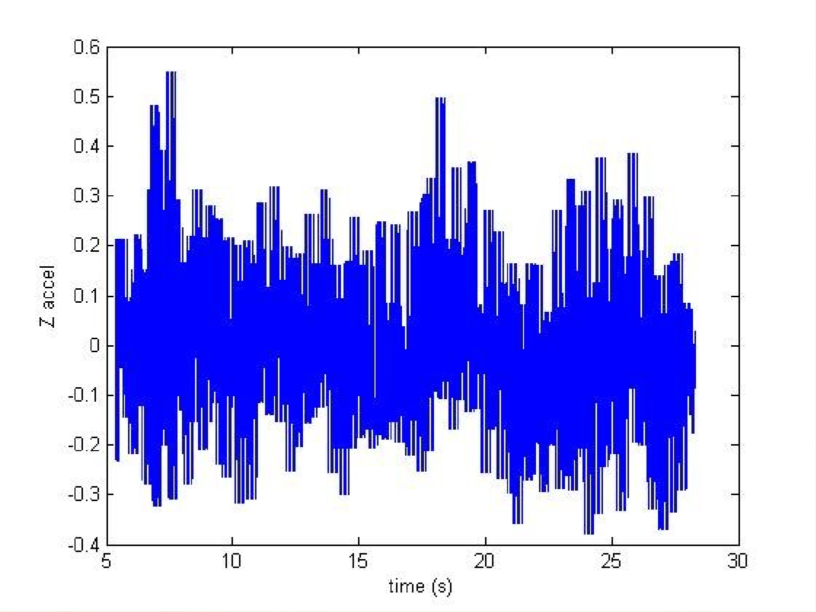
- Deck: ????
- Trucks: Paris 180mm
- Wheels: Sector 9 Slalom Wheels (70mm, 86a)
- Bushings: Venom Bushings (80a)

Experimental Controls

- Riding stance: toes pointed slightly forward, feet shoulder width apart
- Surface incline = 0 degrees
- Riding distance (approximately equal)
- Riding path: straight line
- Initial Start: 3 kick-pushes

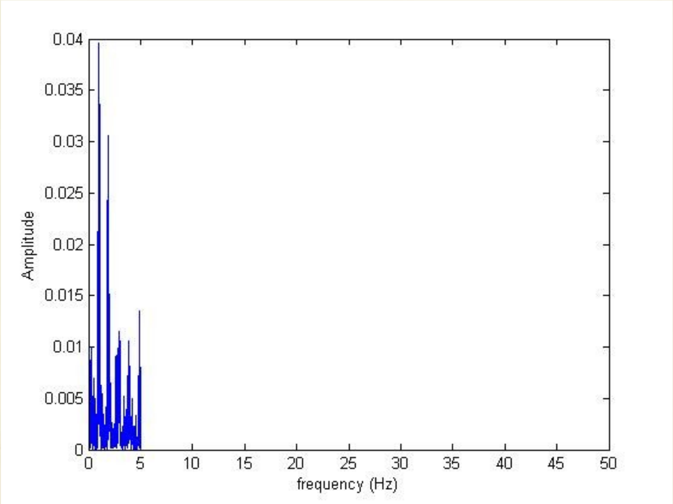
Testing Algorithm

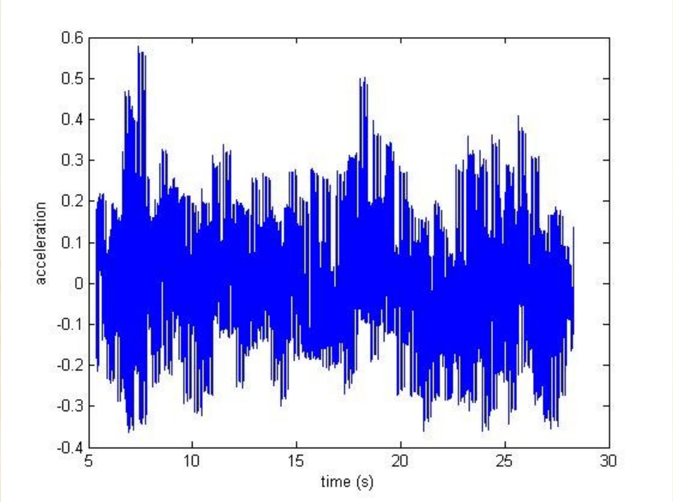
- filter out data collected when not pumping
- Calibrate for gravity by subtracting initial avg value
- Determine the frequencies of oscillation by using FFT



Testing Algorithm

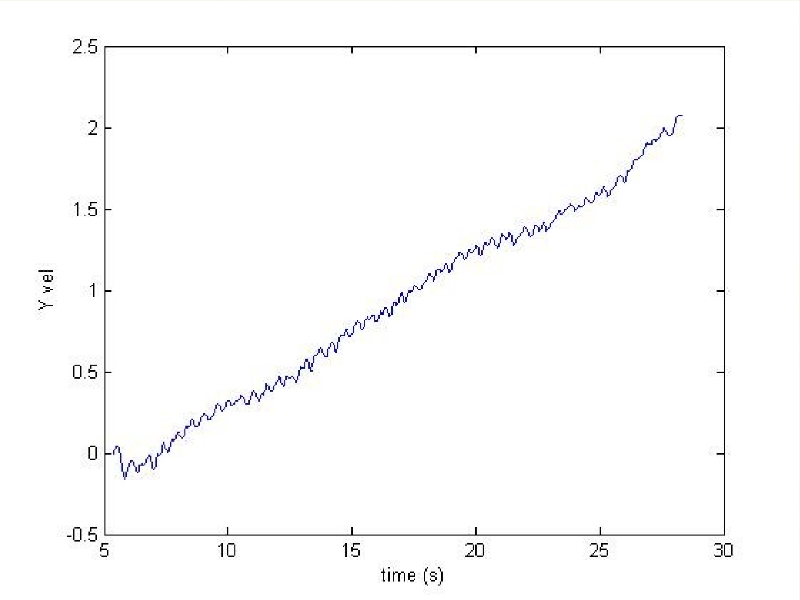
- Smooth out accelerations using a low pass filter
- Calculate avg velocities for periods of oscillation
- Find corresponding difference in incremental acceleration





Testing Algorithm

- Take the integral of Y accel to get Y vel
- Plot Y Vel vs time to see for what set of points acceleration is greatest
- If data were better, plot of Z pos vs. Y pos would help show frequency of oscillations.



Current Issues

- Y and Z values are not initially calibrated to account for gravity (or initial board displacement)
- Calibration of Z values is inconsistent due to rotation of dongle and inconsistent force of gravity on Z-axis
- Similar issues with Y-values, though not as apparent
- Because acceleration due to gravity is so hard to account for, it is difficult to figure out how to incorporate inclines and declines into experiment

Commercialization

- Low sensitivity accelerometer (similar to that found in iPhone would suffice)
- Real-time calibration of Y and Z values
- Small microprocessor (battery powered)
- Small display of oscillation frequency and velocity
- Create iPhone app

Future Improvements

- Use heart-rate monitor and show BPM on display
- Use GPS for velocity (and possible directions feature)
- Transmit directions to bluetooth headset, as well as periodic data
- Solar powered microprocessor
- Use very high frequency oscillations to trigger an alarm that indicates speed wobble