Electrical, Computer & Energy Engineering
University of Colorado Boulder

Pace Sensing Gear: An Easier way to Move

ENGINEERING EXCELLENCE FUND

CYCLE-MATIC

Grant Allgood, Chris Cosenza, Billy Murillo, Ryan Spencer, Casey Turtle, Jack Wilson

Product Overview

Much like in the development of cars, we first had manual bikes. Like cars, manual gear shifting for bikes works well but allows room for user error, which could be harmful to the bike/car as well as being inefficient for the user. The solution to this is to have a bike attachment that switches gears on its own, with environmental input (e.g. pedal speed, torque etc.) rather than user input. This is the Pace Sensing Gear (PSG).

Features

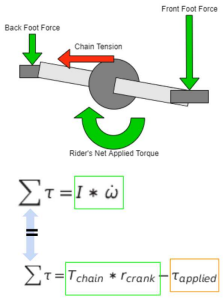
- Plug & play device that can be installed on any standard 7-speed bicycle with ease.
- Rechargeable 12-volt lithium-ion battery that allows for several hours of continues riding on a single charge.
- Ability to switch to 'manual' mode allowing the bike to be shifted in a more traditional fashion.
- Durable weather resistant encasing.

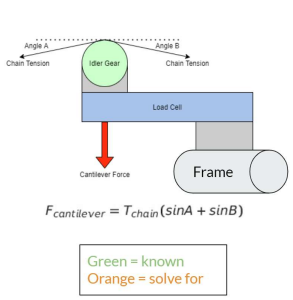
The Need of the PSG

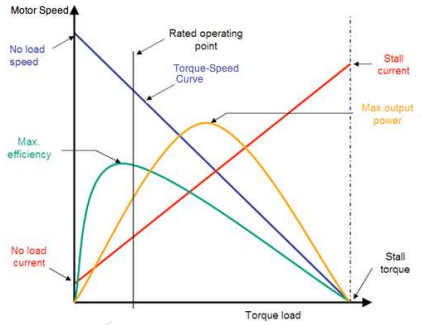
Biking is an incredibly popular mode of transportation with about 15% of Americans, or 45 million people, made at least one bicycle trip for transportation this past year, with even more worldwide. With an ever-growing environmental awareness worldwide, these numbers will continue to grow. While traditional gear shifting is not a difficult concept, majority of riders do not utilize their gears for an optimal energy output. With the PSG riders are assured to be in the perfect gear for the terrain they are currently riding. While the PSG is perfect for beginner riders even the most experienced of riders will appreciate the precise, worry free shifting that PSG provides.

How It Works

Once properly attached and turned on the PSG receives and processes sensor data from a Hall effect sensor (HES) and the load cell. The HES is set up with the HES attached to the lower part of the seat tube in line with the front chain ring where a magnet is placed, this data provides the PSG with the angular rate or frequency at which the rider is pedaling. The load cell is set up in a custom-built mechanism on the chain stay where the torque the rider is applying to the pedals at any given time is directly measured from the tension in the chain and processed to estimate how much force the is applied to the pedal (see figure below). From both parameters, the rider can be placed on the Torque-Speed curve, as shown below. The sensor data is then ran through our algorithm to determine the optimal gear for the current situation, this then prompts an Actuonix P16 linear actuator that is attached to the rear derailer, to move the derailer a specific amount to then move the chain into the appropriate gear in a quick and smooth fashion.



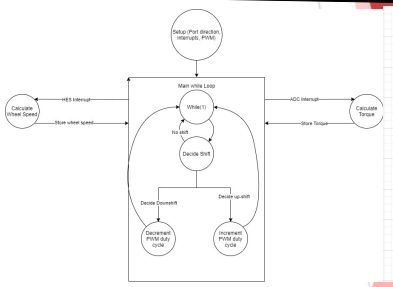


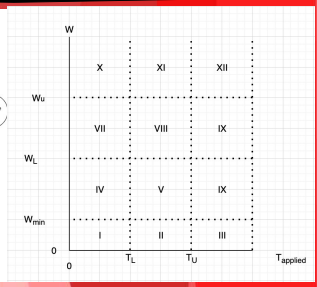


Moving Forward

- Companion smart phone app and handlebar phone mount to communicate with the PSG via Bluetooth to collect and display rider stats such as speed and mileage just to name a few.
- LEDs to indicate the current gear
- LEDs to indicate applied torque
- Easier installment of the PSG on a wider variety of bicycles.

Algorithm





Above on the left is the software flowchart for our shifting algorithm. On the right is the torque-rate chart split into zones. Our algorithm works by sensing how fast the rider is pedaling (rate), and how hard the rider is pedaling (torque). Based on these values, it uses case-based logic to make a decision to shift the bicycle up or down to help the rider stay with a reasonable zone for both torque and rate.

Control Board