Belt v. Chain

A presentation by Cyber Blue 234

Drive Train Trends

Most of the FIRST community has tended to use #35 chain.

A smaller group of teams uses #25.

An even smaller group of teams uses Kevlar belts.

Reasoning Behind Analysis

- A high percentage of FRC Robots are designed with #25 or #35 chain drive and use 4 or 6 wheels for the final transfer of power from the robot to the driving surface.

- Chain drive is a known, proven system for transfer of power from the drive motors / transmissions to the drive wheels and between the wheels

- A recent, unofficial, survey of the 2008 Indiana Robotics Invitational robots showed a fairly even split between #25 and #35 drive chain.

- Seeing that there was little concrete evidence proving that ANSI #35 chain was better than 15 mm Kevlar belts, Cyber Blue wished to produce data by testing the two options.

TEST FACTORS

- Weight
- Strength
- Durability
- Reparability
- Chassis design complexity
- Efficiency
- Cost

Design of Experiments

Cyber Blue designed an accurate, objective evaluation, attempting to minimize variables that could impact the outcome.

To Minimize the test variables the following remained constant throughout the testing:

- Chassis
- Wheel mountings
- Transmissions (single speed)
- Drive motors
- Control components
- Control input devices
- Third pair of wheels (not driven) on 6W drive
- Battery

The following items changed between belt and chain tests:

- Transmission Drive: sprockets to pulleys
- Main drive wheels (one set for sprockets, one for pulleys)
- Rear drive wheels (one set for sprockets, one for pulleys)
- Transmission to main wheels (chain to belt)
- Main Wheels to rear wheels (chain to belt)

Testing and Execution

<u>Straight Line:</u>

- Autonomous code used to provide power to drive system (eliminate human error)
- Measured total distance, wheel encoder counts, battery voltage, speed
- Used data to calculate "efficiency" measures
  - Counts/cycle
  - Counts/volt
- Repeated test on inclined surface

Testing and Execution

Speed:

- Allowed initial acceleration of 25 ft
- Measured speed over next 25 ft

Pushing Power:

- Had robot push against wall to ensure “weakest link” was between wheels and floor – no belt slippage

Results

Efficiency

Belt drive is 3% to 4% more efficient than chain.

- Belt was 6% faster to set distance from stop
- Belt traveled 8% farther for given power input
- Belt was 14% faster in speed test after initial acceleration

Results

Weight

To minimize variation between tests, systems were maintained at same weight

Opportunity to lighten belt system by approx. 2 lbs

Load Capacity/Stretch

Both systems held up to load testing typical of FIRST robot drive system

Observations

- Belt provides improved efficiency and less rolling resistance which allows more capacity for other robot systems
- Belt can provide a lighter drive system, allowing more weight for other systems
- Belt requires a more integrated design and precise manufacturing because the belt length and wheel to wheel center distance is more "fixed". Wheels and belt must be assembled concurrently, unlike chain
- Belt requires more physical space because of the width differences for varying load capacities
- For FIRST applications, there were no stretch/load capacity differences

Next Phase For Belt vs. Chain Analysis

- Testing to verify the typical "stretch" seen in chain drive systems over time
  - Chain stretch
  - Sprocket wear
- Machining of drive pulleys to verify weight reduction
- Testing of #25 chain vs. 9 mm belt

White Paper/Contact

http://www.cyberblue234.com/whitePapers.html

Collin Fultz – mentor
collinfultz@att.net

Questions…