2017 Technical Binder

Polysteamus

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Strategy and Approach

During Week 1, after analyzing the game video, we established a matrix with which we would evaluate our potential robots.

It was determined that we would focus on scoring with gears rather than fuel, be able to climb, and play defensively when need be. We then considered the pros and cons of every design that was proposed to meet these criteria. The unique constraints of the 2017 game also affected our decisions.

Priorities

- **Gear Scoring**
  - Would we be acquiring from the gear chute or off the ground?
- **Climbing**
  - What type of rope could we use?
  - How can we make it easy for a driver to align and catch the rope?
  - What type of motor would be most effective?
  - How can we prevent backdrive?
  - Was velcro viable?
- **Defense**
  - What type of drivetrain facilitates this?
  - What wheels should we use?
- **Ease of Use**
  - How can we make a mechanism that is simple and efficient for a driver to use during a match?
  - Is it easy to build and repair?

Initial Prototypes

- **Drivetrain**
  - Colson Wheels
    - Pros: Traction and speed. Defensive capability.
    - Con: Less maneuverability than mecanum or omni wheels.
  - West Coast drive
    - Pros: Reliability for driver and maintenance.
  - Double stage transmissions
    - Low gear: 8:1
    - High gear: 21.5:1
    - Pro: Allows more offensive and defensive play.
    - Con: Requires more space than single stage.
- **Gear Acquirer**
  - Gripper
    - Pro: Can acquire off the ground.
    - Cons: Less efficient (needs to be lined up perfectly) and hard to build. Would limit the size of the robot further.
  - Gear Chute
    - Pros: Simple gear acquisition, easy for a driver. Less complex design involved.
    - Con: Could not acquire from ground. Needed method of preventing gear slippage.
- **Rope Configuration**
  - Eye
    - Pro: More secure than catching a knot.
    - Con: Requires a great deal of precision and time to attach robot to.
  - Knot
    - Pro: Could easily be caught by a spinning fork-like device.
    - Con: Slipping off the climber.
  - Velcro

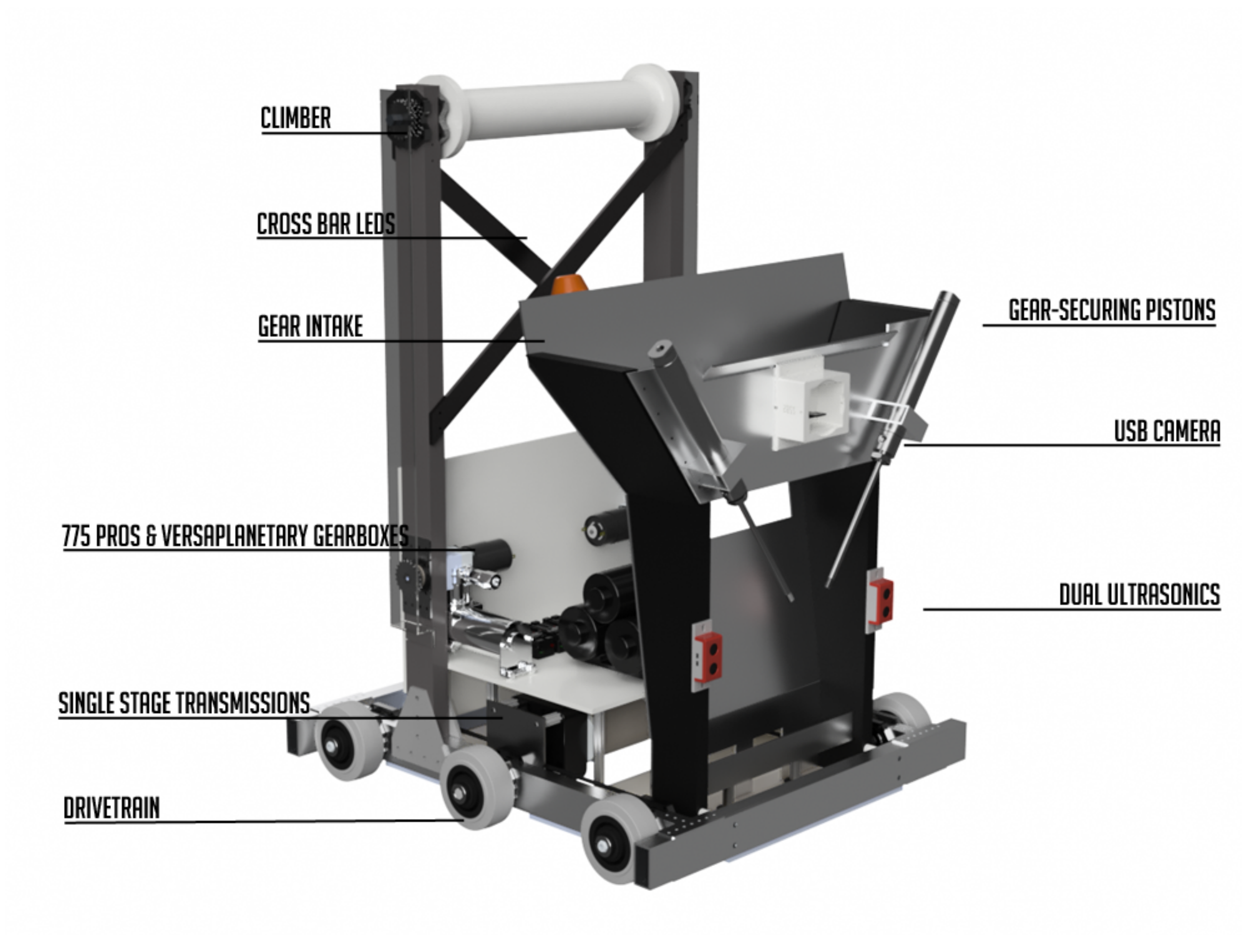
        - Pros: Easy to implement and easy for a driver to attach the robot to. The fastest way to climb.
        - Con: We were unsure about the legality of velcro; FIRST had yet to clarify its rule about rope materials.
- **Climber Mechanism**
    - Roller
        - Pro: Saves space.
        - Con: Would only work with velcro.
    - Spinning Claw
        - Pro: Could work with either a knot or eye.
        - Cons: Would have to be designed around the size of knot or eye. Takes up a great deal of room (the device had to be large in order to catch the rope and prevent slipping). Torque would cause robot to tilt.
    - Indirect Drive
        - Pro: Could use a gearbox to increase the speed of a climb.
        - Con: A gearbox and belt take up room.
    - Direct Drive
        - Pro: Saves space.
        - Cons: Needs a powerful motor (most likely a CIM), which draw more voltage. Would increase the number of CIMs we use.

Conclusion

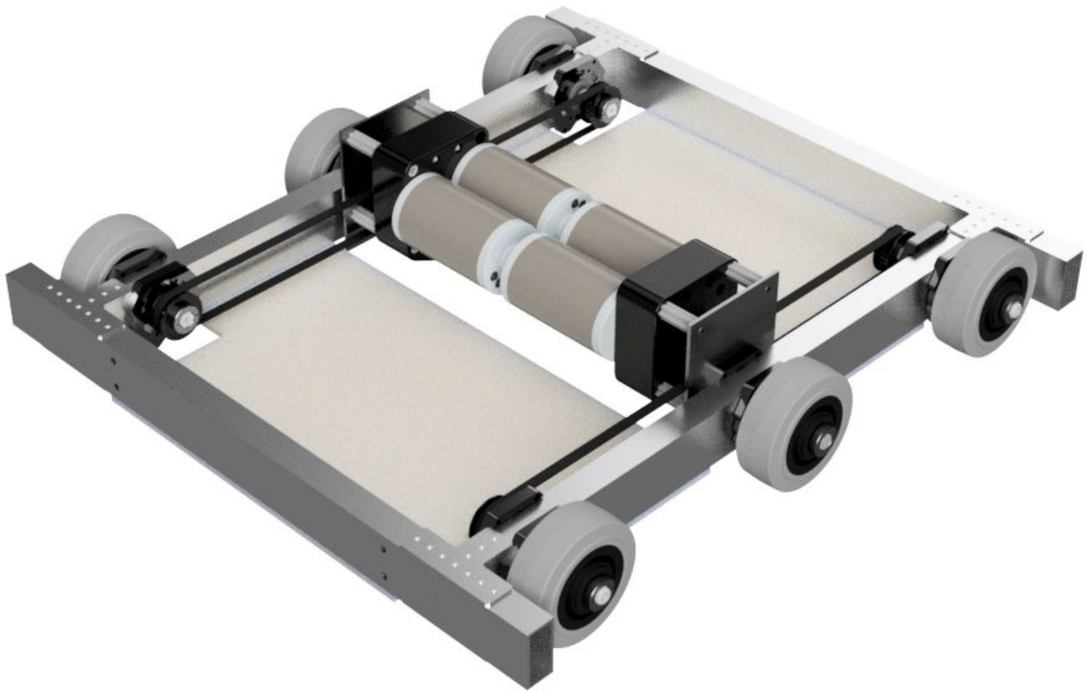
It was determined that the best way to address our priorities was through a robot that had a gear chute, velcro rope climber, and West Coast drive.

In order to accomplish this, we also chose to build our robot so it followed the volume constraints which would allow us to build taller rather than wider. This would mean that we would have a faster and more stable climb. However, the smaller width meant that the double stage transmissions would have to be replaced with single stage.

Final Mechanical Design



Chassis and Drivetrain



- **VexPro VersaChassis**
  - Durable and modular, yet lightweight aluminum chassis.
  - Dimensions: 23.5” x 25.5” x 36”
- **Six 4” Colson Wheels**
  - Allows defensive capability against mecanum teams.
- **Drop Center Configuration**
  - More maneuverability and offensive capability.
- **West Coast Drive**
  - Reduces weight and allows ease of maintenance.
- **Transmission**
  - VexPro Single Speed Double Reduction Transmissions
  - Adjusted to fit Grayhill encoders.

Gear Chute

- **Design**
  - Funnel-shape allows acquiring gears from human player station.
  - Sides are wooden, while the front and back (contact points for the gear peg) are aluminum.
  - Slot for gear peg to pass through.
- **Pistons**
  - Two 6” stroke pistons on the front prevent the gear from falling out during delivery.
  - Two smaller pistons raise and lower a shelf below the gear to hang it onto the peg.
- **Sensors**
  - Two Vex ultrasonic rangefinders for alignment to the gear peg.
  - USB camera and LED light ring.
    - Vision code; peg alignment in auton.
    - Gives the driver visibility.

Climber

- **Frame**
  - VersaChassis box tubing is lightweight but strong enough to support the weight of the robot.
  - Crossbars prevent the structure from twisting and is a place where LED light strips can be mounted, allowing visibility across the field.
- **Actuation**
  - Powerful motors that would not draw as much voltage as CIMs.
  - Used with VersaPlanetary gearboxes to reduce strain and increase climbing speed.
- **Roller 1.0**
  - 15” long, custom 3D printed roller.
  - Wrapped with male velcro to allow easy attaching to the rope.
- **Rachet System**
  - Hex shaft axle could easily be ratcheted.
  - Prevents back drive when climbing, easing the strain on motors.

Programming

Vision

- **Camera**
  - Microsoft LifeCam HD 3000
  - Mounted on the center of the gear chute, 20” off the ground.
  - Protected by a 3D printed mount, with a slot for a green LED light ring.
- **Processing**
  - Peg target found by filtering images, finding contours, and approximating the center of the target using OpenCV.
  - Target location then used to auto-align in autonomous and teleop periods, allowing for consistent gear scoring autonomous and scoring when driver's view is obstructed.

Drive Straight

- Gyroscope values are used to determine if the robot is veering off a desired course (due to field irregularities, wheel inconsistencies, driver error etc.) If the robot begins to move off of the desired path, it will correct its movement.

Electronics

Placement

- **Control System**
  - RoboRIO, radio, PDB, PCM, and VRM all located on a board facing outwards, allowing easy access for maintenance and inspection.
  - Central placement of PDB to ensure minimal wire length.
- **Periphery Components**
  - Components like Talon SRX's are mounted securely over the center of the robot, over the transmissions.
    - Placement makes wiring to motors and actuators more efficient.
  - VEX Ultrasonic rangefinders are mounted at a height so that they will not be struck by the gear peg.
- **Protection**
  - All outwards facing electronics are protected by Lexan shields.

Pneumatics

- **Application**
  - Two 6” stroke pistons are mounted to the front of the gear chute at an angle.
    - Secure the gear while the robot is in motion.
  - Small pistons raise and lower a shelf to hang the gear on the peg.
- **Systems Design**
  - Air tanks and compressor sit at the center of the robot.
  - Pressure gauge and release valve are mounted on the side for quick access.
  - Solenoids mounted behind the gear chute, where pistons are.

Design Modifications

After the robot was finished, problems arose at competition and the design of the robot had to be changed.

Gear Chute

- **Lip**
  - Problem: At the Hudson Valley Regional, it was discovered that the human loading station has less friction than the one built at Bronx Science. As a result, the gear would slide far more quickly and bounce off the back of the gear chute, falling out of the robot.
  - Solution: Using a dremel, vertical incisions about 2” long were made 13” apart on the front of the chute. We then bent the metal outwards, creating a lip.
- **Gear Shelf**
  - Problem: During quarterfinals, the gear began slipping out even when the pistons were engaged.
  - Solution: The lower metal bar was removed so the L-channel gear shelf could be extended.

Climber

- **Roller 1.0**
  - Problem: The rope was getting caught between the gaps between the roller and the frame, causing it to tear.
  - Solution: At the Hudson Valley Regional, since the roller is printed in three 5” segments, a bandana was placed between one of the joints, spacing out the roller to remove gaps on the ends.
- **Roller 2.0**
  - Problem: Even after the changes to Roller 1.0, the rope was still getting caught on screwheads on the climber frame.
  - Solution: A new roller with a diameter of 2.5” was designed with 4” endcaps.

- **Frame**