The Shooter

Shooting Test Feb 17, 2012

- Shooter Surface:
  - Knurled
- Set-Up
  - Human feed
  - We used a spare vise and a dolly to hold the shooter.
  - We had the release point about 1ft from the ground, and used a fixed angle.
  - Motor run using the servo tester set-up.
- Result
  - Standard Deviation on distance: 9.1 (68% of it is within 18.2 in)
  - Lateral Standard Deviation: 6.6 (68% of it is within 13.2 in)

Improvements Made

- Grooves implemented on friction test plate
- By tilting the plate at an angle until it slipped on the ball, we determined the friction coefficient of the plate
- Friction coefficient = tan of the angle
- *Original Iteration*: Knurled
  - Friction Coefficient of Original: 0.424
- *First Iteration*: ½ inch spacing, ½ inch groove, 1/16 inch deep
  - Friction Coefficient of First Iteration: 0.727
  - 71% increase
- *Second Iteration*: ¼ inch spacing, ¼ inch groove, 1/16 inch deep
  - Friction Coefficient of Second Iteration: 0.839
  - 97% Increase
  - Selected Solution
- Shooter Guide
  - Extra material on the top of the shooter guide, was removed.

Shooting Test Mar 7, 2012

- Shooter Surface:
  - 1/4” Grooves
- Set-Up
  - Human feed

  - Official Test Fixture (correct height)
  - Informal testing, no numerical data was collected.
  - Motor run using the servo tester set-up.
- Results
  - Using Anurag as a human target, we tested the shooter for consistency, we found that if we use the same ball, the shooter consistently lands in a repeatable position.
  - If we changed balls, we found that different balls had different landing points.
    - We noticed an inconsistency in the way different balls feel. ie Hardness
  - We also found that the new 1/4" grooves solved the height and distance issues that we experienced with previous surface treatments.
    - Thanks Fernando!

Shooting Test Mar 8, 2012

- Set Up
  - Target
    - The hoop was placed at 97" (~1" lower then actual)
  - Closed Loop Control
    - Allowed us to control the speed within 5 RPM and monitor the shooter speed
  - The Shooter
    - Accurate height
    - Clamped to the mini-bot pole base.
    - Shooter hood angle is maintained with a C-Clamp
  - Distance
    - Fender Shots ~ 44in
    - Key Shots ~ 12ft
- Observations
  - Shooter Speed
    - The calculations predicted a 20% drop in shooter speed
    - We saw that the speed drop was only ~10%
    - This suggests balls are still slipping in the shooter
  - Angle and speed
    - We determined that we have enough range and sufficient angles
  - Inconsistency
    - The ball shot inconsistently most of this afternoon, below are the factors that we think cause this issue.
    - We have determined that the inconsistency between the physical properties of the basketballs is a major problem. We need to address this ASAP.
- Possible Issues & Solutions:
  - Roller Friction (no changes in today's test)
  - Ball Elasticity (no changes in today's test)
    - The 3 basketballs have different elasticities, causing a difference in compression just as the ball is released.
      - Although different balls fly different distances, the trajectory of each individual ball is fairly consistent.
  - Balls are still slipping in the shooter
    - Compression may be insufficient
    - Surface Grip isn't to blame
  - Inadequate shooter wrap in current design
    - We need more ball-shooter wheel contact time so the ball can accelerate to the correct speed

        - In order to increase the "wrap" we tilted the shooter back and moved the hood to the fully extended position, giving the ball more time to contact the shooter.
        - This does not change the result too much, if we want to get significant wrap we will need to do some heavy modifications.
    - Rigidity
        - The current test fixture has very low rigidity, this allowed the recoil to vary between different balls, this could be a possible source of error.
            - When the shooter was braced by Mr. Xie, the consistency of the shooter greatly improved.
            - We were able to get all three balls to go into the basket, which previously was very difficult. This is our best result yet, we continued to test and got 11 out of 13 into the basket.
            - We believe that this issue contributes to a lot of the error in the shooter.
    - Ball exit guide
        - Mr. Xie added a PVC pipe to the top edge of the shooter to make the exit angle more consistent.
        - Although slight, this seemed to decrease the variation of between the different balls
- Other issues
    - Conveyor System
        - Belts track onto the raised portions of the roller.
            - Due to the low clearance between the shooter and the upper conveyor roller, this inconsistency lead to a stalling of the conveyor system.
- Data
    - We were unable to collect very detailed data on the shooter today, our objective was to mostly get a feel for the consistency of our shooter.
    - Ball drop test data:

	Drop Height		Return Height		Percentage	
#1	63	in	26	in	41.27	%
#2	63	in	23.54	in	37.37	%
#3	63	in	24.54	in	38.96	%

- Pending tests
    - Increase rigidity of the shooter
        - Re-Test for consistency
    - Once consistency is achieved
        - Shoot 3 balls in sequence
        - Backboard Shot VS Swish Shot

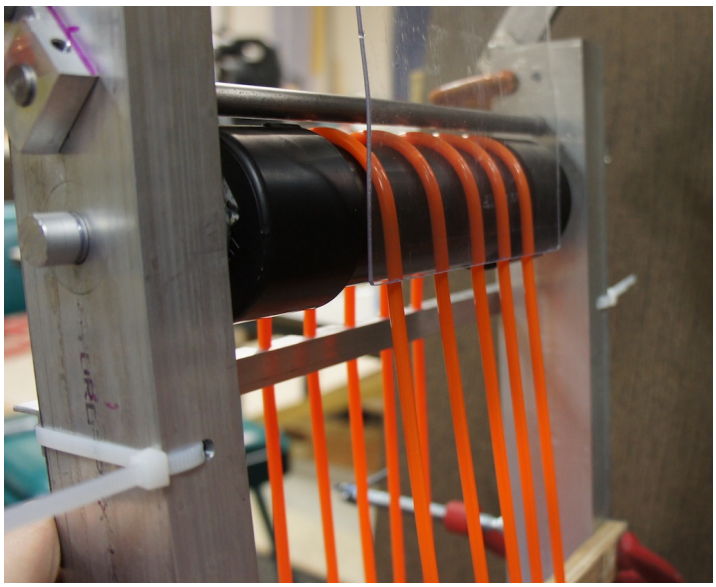
Shooting test Mar 9, 2012

- Set Up
    - Target & Distance are the same as yesterday
        - The hoop was placed at 97" (~1" lower then actual)
    - Servo Tester Controlled
        - Unfortunately we were unable to utilize closed loop control today, so we sufficed with using a servo tester+a jaguar speed controller.

    - The Shooter
        - Increased Rigidity

- Observations
    - Shooting Performance
        - Consistency was greatly improved
            - **Works like a boss - 18/18 shots made**
            - Both Fender and Key & All Three Balls
        - Balls must be centered fairly accurately in the conveyor
        - "Ball Exit Guide" improves consistency between balls
- Problems & Improvements Made
    - Rigidity
        - We increased the rigidity of our system by adding gusset support members and screwing it down to its base.
        - This setup greatly improved the rigidity of our shooter system, leading to more consistent shots.
    - Ball Variation
        - We added a piece of L-channel, the "Ball Exit Guide", on the top of our shooter hood. The hope is that this piece of aluminum will improve the consistency of the release of the ball even when the balls themselves are inconsistent.

- Possible Issues
    - Rocking on actual drive train
        - Test to see how much force is required to make drive train rock
        - Test how much recoil we actually produce
        - If the recoil can cause the drive train to rock, it will affect shot
        - May require pause before/after each shot to allow robot to settle
- Outstanding Tasks & Tests
    - Conveyors System
        - Address the issue when the belts ride up on the sides of the roller, jamming the system (Modify)
            - Chinmay notes that the ends of the roller are not holding the roller body well enough - roller has tendency to "buckle", making belts run over and jam
        - Back roller interferes with the polycarbonate shooter guide (Modify)
            - Fix it.



- Ball Feeder
  - Implement a “ball centering” system at the top of the conveyor to center the ball just prior to launch. (Add)
- “Ball Exit Guide” (Design and Machine)
  - Design and machine a part to replace the current L-channel
  - Must be light and rigid
- Safety Guard (Add)
  - We need to machine a new safety guard to cover up the front side of the shooter roller.
  - We can make one similar to Mr. Peake’s
- Testing
  - Shoot 3 balls in sequence (Test)
  - Backboard VS Swish (Test)
- Set up for right shooting settings (Test and Modify)
  - Test shooter and get data using closed loop control
  - Replace the pneumatic actuator assembly

Shooting test Mar 10, 2012

- First Setup
  - Same as yesterday, with the exception of a few modifications
    - New Rounded Ball Exit Guide
    - New actuator system for the shooter hood
    - Belt Guide
    - Less Rigid system (More Realistic)
    - Both conveyors were running
    - It was quite windy today, this could have effected our accuracy testing
    - Added Safety Guard

- Tests, Observations and Solutions
  - Pneumatic Cylinder Position & Angle
    - The current angles are not ideal
    - We need a steeper angle for fender shots and less of an angle for key shots
  - Polycarbonate interference

        - When the balls strikes the bottom of the polycarbonate guide, it causes the shooter assembly to jerk upwards
        - It also causes the ball to lose speed
        - Solution: Cut slits into the polycarbonate guide and bend it back to lessen the impact
    - Ball Exit Guide
        - The rounded version of the ball exit guide seems less effective
        - Go back to the original design
    - Ball Centering
        - This is today's focus, is to make the conveyor belt driver straight in order to feed the ball to the shooter correctly
        - We made two ball centering guides, identical to the ones on the robot and test them for performance
        - They can tolerate a little lateral displacement, but the ball must be relatively centered in order to shoot out accurately
        - The ball tends to "bounce" left to right when it travels up the conveyor
        - This can be solved either by moving the decoration polycarbonate onto the inside face of the conveyor, or by making more ball centering guides
    - Shooter Data: (testing from different feeding position)

Ball Guide	Ball Exit	Distance	Control	Angle	Accuracy
Low	Curved	Key	1820µs	58°	81%
Low	Curved	Fender	1750µs	58°	70%
Low	Straight	Fender	1750µs	78°	65%
Low	Curved	Fender	1780µs	78°	50%
Low	Curved	Fender	1750µs	78°	56%
Low	Straight	Fender	1770µs	78°	89%

- Tomorrow
    - Ball Exit Guide
        - Machine a square version out of 1/16" aluminum

- Shooter Guide
    - Modify polycarbonate to lessen the impact when the ball strikes it
    - Fix the position of the pneumatic actuators

- Testing
    - Shoot 3 balls in sequence (Test)
    - Backboard VS Swish (Test)

Shooting test Mar 13, 2012

Data can be found here:

(quick update by Diane)

- Setup:
    - In cafeteria to block the wind and rain

- Robot shooting accuracy/ speed tested from different locations (front of key, corner of key, front of fender, side of fender)

- Data and results
  - Consistency:
    - All shots consistent (but none 100%)
    - Considerable tweaking will be necessary
  - Data:

Description	Distance	Speed (RPM)	Hood Position	Ball 1	Ball 2
From fender	Distance at 45"	1800	L	1	1
From fender side	-	1600	H	0.75	1
From key	Distance at 113"	2000	H	0.67	1
From key corner	Distance at 113", 50.5 " to the left	2100	H	0.67	1
From back of the key	-	3700	H	-	0.75