Ball handling test plan

Testing with ramp

Objective 1: Investigate how the damping system in the current robots is performing.

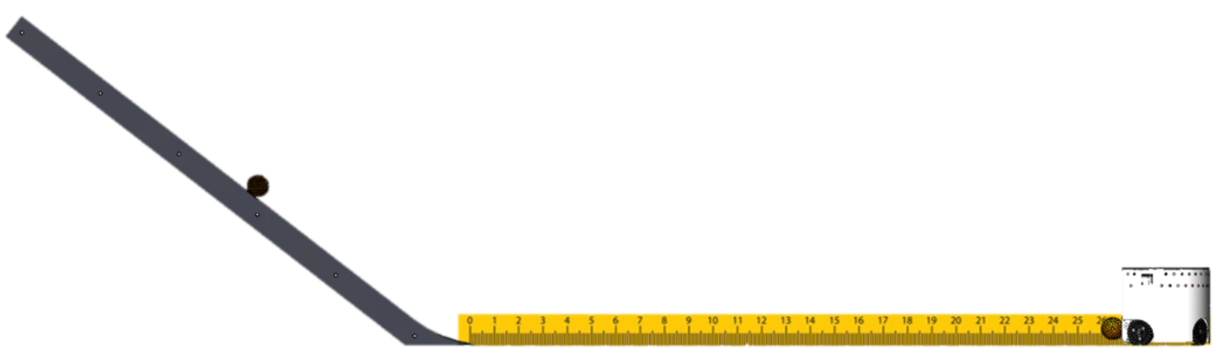
Currently sponges are used as damping for the front assembly. However, this solution does not seem to be very effective and reliable. Furthermore, the effectiveness of the damping varies for different robots mainly due to the way the sponges have been glued to the front assembly.
We want to test the current damping in order to find out how well the system performs and to be able to compare this to a possible new design.

In an ideal situation, the ball does not bounce off the front assembly when it arrives. In the current situation, the ball does bounce off when a ball approaches the robot. We will test this by shooting balls at the robot for different velocities and see how far the ball bounces off. We can test this for different situations. The robot could be stationary or moving. Furthermore, we can observe the influence of the rotational speed of the dribbler in handling the ball when it arrives. Several robots will be used since different robots might show different behaviour.

Equipment:

- Ramp
- Measuring tape
- Field
- Robot
- Ball
- Camera

Set up:



The ball will be dropped from different heights in order to test the damping behaviour for various ball velocities. The approximate velocities that have been used during the test are 1.0 m/s, 1.5 m/s, 2.0 m/s, 2.5 m/s, 3.0 m/s, 3.5 m/s. The maximum allowed speed for the ball during a game

is 6.5 m/s. It is not known how often this actually happens during a game. The robots can shoot the ball at different velocities, but it is not clear at which velocities. The velocity of the ball/the power with the ball is being kicked depends on the distance the ball has to cover. The bigger the distance, the higher the velocity. (This is not ideal since the robot will shoot very softly e.g. when it is close to the goal). The measuring tape will be used to see how far the ball bounces back (during the test, the measuring tape started at the robot and ended at the ramp. So when the ball was caught by the robot, the distance measured was 2.5cm).
The test will be repeated with different robots and for different rotational speeds for the dribbler.

Catching the ball seems to work best if the velocity of the dribbler matches the velocity of the ball on the contact surface between the dribbler and the ball. The angular velocity of the dribbler could maybe be increased gradually once the ball has been caught. This might improve the dribbling when the robot is moving. On the other hand, the backspin on the ball should not be too high when the ball is being kicked. Too much backspin might decrease the distance the ball will roll. (This could be tested by letting the robot kick the ball using different dribbler speeds to keep the ball with the robot before kicking).

Transmission motor to dribbler:
We are now using gears for the transmission from the motor to the dribbler. The small gear (28 teeth) should be attached to the motor, the big gear (36 teeth) to the dribbler. If this is done the other way around, the dribbler rotates too fast and it takes some time for the ball to actually stick to the robot. The gear ratio seems to be fine.

A possible point of improvement is the location of the motor. In the current design, the motor is located directly above the dribbler and is only fixed on one side. Because of this, it can happen that the motor doesn't stay in place (horizontally) and bends down about, causing the dribbler to touch the motor. This would not happen if the motor is a bit further away from the dribbler. This can be done in several ways. Firstly, we could add a third gear to still have the transmission that is required. However, a third gear makes the design more complicated. Another option would be to have bigger gears with the same ratio as the current gears. Though, this would also mean that we need more space. This should be taken into account in the design of the front assembly. A third option would be to use belts instead of toothed gears. This would allow us to place the motor and the dribbler further apart without increasing the size of the gears. A disadvantage of belts is that slip might occur, which would make the dribbler less reliable. Furthermore, it might be better to have the motor fixed on both sides and orient it in such a way that the encoder cable of the motor can be easily attached to the bottomboard. Another solution could be to make a construction that holds the motor in place. In any case, it should not get in touch with the dribbler.

Test execution

Robot nr: 8 (reasonable damping even though one sponge is not fixed)
Dribbler: off
Robot stationary

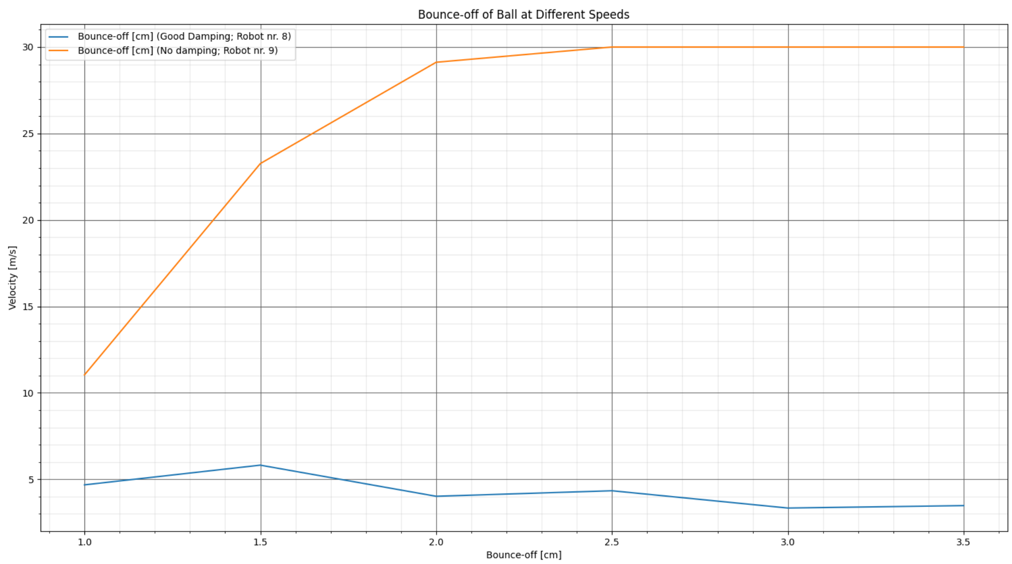
Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
4.7	6.1	5.2	4.7	3.4	3.5
4.6	6.2	2.8	3.4	3.2	4.0
4.6	6.6	3.4	3.2	3.7	3.1
4.7	4.7	3.5	3.6	3.2	3.2
4.8	5.5	5.2	6.8	3.2	3.6
4.68	5.82	4.02	4.34	3.34	3.48

For 2.5m/s and more, the ball gets a backspin from the dribbler even though it is off.

Robot nr: 9 (barely any damping)
Dribbler: off
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
8.5	25.6	30+	30+	30+	30+
10.0	19.2	27.7	30+	30+	30+
11.8	19.7	23.0	30+	27.5	30+
12.5	29.4	24.9		30+	30+
12.4	22.4	30+		30+	30+
11.04	23.26	29.12	30+	30+	30+

The ball never gets a backspin from the dribbler when it is off. (that may be because this dribbler was spinning less easily than the one of robot nr 8)



Robot nr: prototype new FA PETG flexure
Dribbler: off
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
3.5	4.0	13.0	6.5	8.5	15.5
4.3	4.0	10.8	9.8	18.0	8.5
5.5	4.9	5.2	10.0	6.8	16.7
5.6	5.0	8.4	10.9	13.0	17.0
3.4	3.5	4.0	4.0	19.8	21.4
4.46	4.28	8.28	8.24	13.22	15.82

The new FA performs better than a robot without damping, but worse than a robot with reasonable sponge damping. Probably the plastic springs are too stiff.

Robot nr: prototype ear plugs (round part facing towards side)
Dribbler: off
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5*	2.5	3.0	2.5	2.7	12.9
2.5	2.5	2.5	2.5	2.5	2.6
2.5	2.5	2.5	6.0	7.0	2.6
2.5	3.1	3.2	7.4	3.7	5.0
2.5	5.2	3.5	9.8**	2.5	2.6
2.5	3.16	2.94	5.64	3.68	5.14

*When the ball arrives in the middle of the dribbler, it is caught very well. When it arrived at the side, the distance varied between 3 - 7 approximately.
** There was quite some variation. Sometimes the ball was caught very well, other times it bumped off quite far. Might be because the ball didn't arrive exactly in the middle or because of non-flat surface.

Robot nr: prototype ear plugs (round part facing towards front)
Dribbler: off
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
4.2	2.5	4.8	3.8	2.5	6.5
3.8	3.9	4.0	6.9	2.8	2.7
5.0	4.5	4.3	6.5	3.4	3.0
6.2	4.0	4.4	4.0	3.5	11.8
6.5	3.5	2.5	7.6	3.5	3.7
5.14	3.68	4.00	5.76	3.14	5.54

Robot nr: prototype ear plugs (circular part facing towards front)
Dribbler: off
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
8.5	10.5	2.5	2.5	2.5	2.5
10.5	8.5	2.5	2.5	2.5	2.6
7.0	4.5	2.5	2.5	2.5	2.6
7.5	8.2	2.5	2.5	2.6	3.0
9.5	7.3	2.5	2.5	2.5	6.5
8.60	7.8	2.5	2.5	2.52	3.44

Upon higher impact, the damping worked unexpectedly well. For low velocities, the stiffness of the earplugs is probably just too big.

Robot nr: prototype ear plugs (circular part facing towards side)
Dribbler: off
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
4.0	3.5	2.5	2.5	2.7	2.5
5.8	2.5	2.5	2.5	2.5	2.7
6.2	2.5	2.5	2.5	2.6	2.8
3.0	2.5	2.5	2.6	2.6	5.5
2.5	2.5	2.5	5.0	2.6	2.8
4.30	2.70	2.50	3.02	2.60	3.26

The earplug fell off sometimes (probably the impact during higher velocities was that big that the earplug didn't stay in place. However, this probably won't be a problem if the earplugs are glued.)

Conclusion: the results are best if the circular parts are facing towards the side of the robot.

Robot nr: prototype new FA TPU 1.5mm circle
Dribbler: off
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.7	2.5	2.9	2.9	2.5	2.9
2.9	2.6	2.7	2.8	2.8	2.5
2.9	2.5	3.0	2.8	3.0	3.2
2.9	3.1	3.0	2.5	2.5	2.5
2.8	2.8	2.9	2.5	2.5	2.6
2.84	2.70	2.9	2.70	2.66	2.74

Robot nr: prototype new FA TPU 1.0mm circle
Dribbler: off
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
4.0	2.5	2.5	2.5	2.5	5.5
4.5	2.5	2.5	2.5	2.5	6.7
4.0	2.5	2.5	4.0	2.5	5.1
4.3	4.0	2.5	2.5	5.0	4.8
2.5	4.0	3.7	4.0	2.5	6.5
3.86	3.1	2.74	3.1	3	5.72

Robot nr: prototype new FA TPU/PLA 1.5mm circle
Dribbler: off
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
5.1	2.6	2.6	3.4	6.0	6.0
5.2	3.2	3.4	3.6	2.7	5.3
5.2	2.7	3.4	3.5	2.6	5.5
3.4	3.1	2.6	3.4	2.6	5.5
5.0	2.6	2.6	3.5	2.8	5.8
4.78	2.84	2.92	3.48	3.34	5.62

Robot nr: 8 (reasonable damping even though one sponge is not fixed)
Dribbler: 2/7
Robot stationary
Gear ratio: small(motor) to big(dribbler)

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5 (caught)	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	3.0	2.5	2.5
2.5	2.5	2.5	2.5	2.7	2.5
2.5	2.5	2.5	2.9	2.5	2.5
2.5	2.5	2.5	2.5	3.3	2.5
2.5	2.5	2.5	2.68	2.7	2.5

*During the second test round, the ball bounced off further and didn't stick to the dribbler.

Robot nr: prototype new FA TPU 1.5mm circle
Dribbler: ? (unknown speed)
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5

Robot nr: prototype new FA TPU 1.0mm circle
Dribbler: ? (unknown speed)
Robot stationary

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5

Robot nr: 8 (reasonable damping even though one sponge is not fixed)
Dribbler: 4/7
Robot stationary
Gear ratio: small(motor) to big(dribbler)

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5	2.5	2.5	3.0	2.5	4.0
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	3.0
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.7	2.5	2.5	2.5*
2.5	2.5	2.54	2.6	2.5	2.9

*doesn't work perfectly anymore, it has more trouble with catching the ball.
In general, at higher ball velocities the ball bounces off further but is still caught because of the backspin the dribbler gives to the ball.
Without the chipper plate, the dribbling and ball catching also seems to be working better (chipper plate should not stick out too much). Therefore, the chipper plate has been removed after this testing round.

Robot nr: 8 (reasonable damping even though one sponge is not fixed)
Dribbler: 4/7
Robot stationary
Gear ratio: small(motor) to big(dribbler)

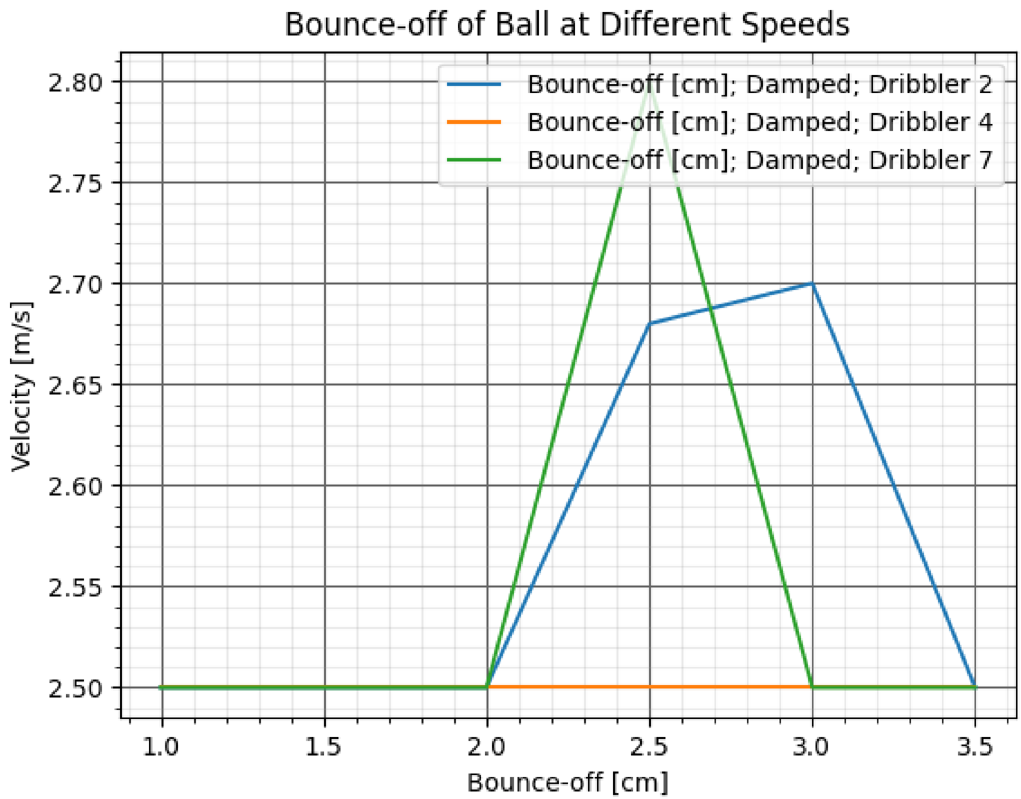
Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5

The robot rotates slowly

Robot nr: 8 (reasonable damping even though one sponge is not fixed)
Dribbler: 7/7
Robot stationary
Gear ratio: small(motor) to big(dribbler)

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	4.0	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.8	2.5	2.5

For lower ball velocities, a lower dribbler rpm works better. The extra spin that the ball gets because of the dribbler accelerates the ball so much that it bounces off again (slightly).



Robot nr: 15 (barely any damping)
Dribbler: 2/7
Robot stationary
Gear ratio: small(motor) to big(dribbler)

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5	5.0	2.5	2.5	29.0	2.5
2.5	3.3	2.5	2.5	26.7	2.5
2.5	3.7	2.5	2.5	2.5	2.5
2.5	3.6	2.5	2.5	10.2	2.5
2.5	2.5	2.5	2.5	21.5	2.5
2.5	3.62	2.5	2.5	17.98	2.5

It does stick, but it is not stable. It bounces on and off the entire time.

For 3m/s, the ball doesn’t get any backspin from the dribbler when it hits it (except the one time it caught the ball).

Robot nr: 15 (barely any damping)
Dribbler: 4/7
Robot stationary
Gear ratio: small(motor) to big(dribbler)

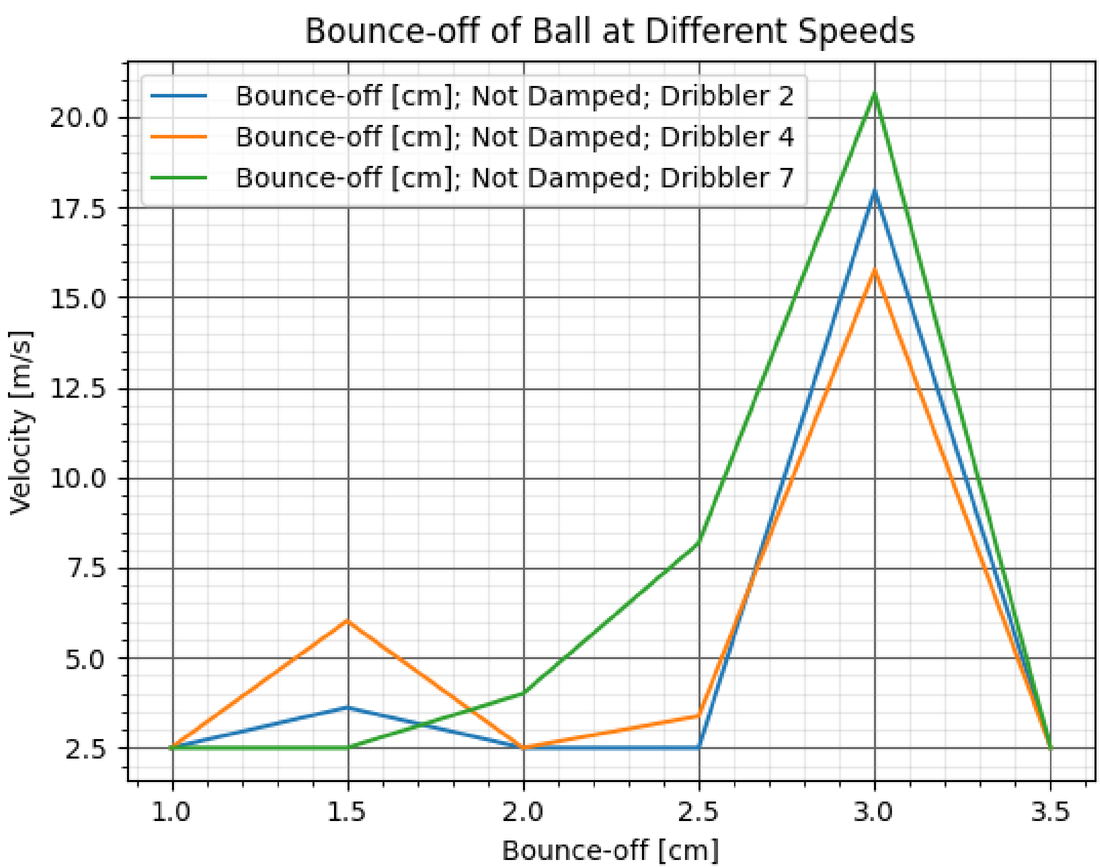
Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5	5.8	2.5	2.5	24.0	2.5
2.5	6.6	2.5	2.5	12.6	2.5
2.5	6.0	2.5	2.5	11.4	2.5
2.5	5.0	2.5	3.4	20.0	2.5
2.5	6.7	2.5	6.0	10.9	2.5
2.5	6.02	2.5	3.38	15.78	2.5

For 3m/s, the ball barely gets any backspin from the dribbler.

Robot nr: 15 (barely any damping)
Dribbler: 7/7
Robot stationary
Gear ratio: small(motor) to big(dribbler)

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5	2.5	5.5	14.5	18.2	2.5
2.5	2.5	2.5	2.5	20.5	2.5
2.5	2.5	7.0	10.5	20.7	2.5
2.5	2.5	2.5	6.5	22.0	2.5
2.5	2.5	2.5	6.9	22.0	2.5
2.5	2.5	4	8.18	20.68	2.5

For 3m/s, the ball gets some backspin but not enough to go back to the robot after the first bounce.



Robot nr: 15 (barely any damping)
Dribbler: 7/7
Robot stationary
Gear ratio: big(motor) to small(dribbler)

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5	3.8	2.5	20.0	23.9	2.5
2.5	11.2	2.5	17.0	19.5	2.5
2.5	6.9	2.5	14.5	26.1	2.5
2.5	10.1	2.5	15.5	30	2.5
2.5	9.9	2.5	24.0	29	2.5
2.5	8.38	2.5	18.2	25.7	2.5

Dribbler is rotating faster now because of different gear configuration. Bouncing is way worse compared to other gear configuration (as expected).

Robot nr: 7(reasonable damping)
Dribbler: 7/7
Robot stationary
Gear ratio: big(motor) to small(dribbler)

Distance (cm) - velocity 1m/s	Distance (cm) - velocity 1.5m/s	Distance (cm) - velocity 2m/s	Distance (cm) - velocity 2.5m/s	Distance (cm) - velocity 3m/s	Distance (cm) - velocity 3.5m/s
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.5	2.5	2.5

It still bounces a bit, but it is much better than the one without damping.

Testing with onboard kicker

This type of test is closer to the real situation on the field. A kicker of the robot is used in order to speed up the ball. It is currently not very clear how the kicker power is related to the ball speed. In order to find out this relation, a set of empirical tests will be done to figure out which ball speed corresponds to a certain kicker power. For this, the settings in the python repository are changed.

The ball is kicked over 2 meters and the time is obtained from camera videos. The velocity is obtained by dividing 2m over the time. Loss in velocity due to the dissipation of energy is neglected in this case.

Kicker Power [Power 0.25] Velocity [m/s]	Kicker Power [Power 0.5] Velocity [m/s]	Kicker Power [Power 0.75] Velocity [m/s]	Kicker Power [Power 1.0] Velocity [m/s]	Kicker Power [Power 1.25] Velocity [m/s]	Kicker Power [Power 1.5] Velocity [m/s]
1.25	4.57	6.96			
1.33	4.44	6.96			
1.33	4.85	6.67			
1.06	4.57	6.96			
1.24	4.61	6.89			

Good damping results

Based on the measurements and the videos, some things can be noted:

- Without dribbler:
    - The ball bounces off less compared to the robot that barely has damping.
    - Against expectations, the ball bounces off less far for higher ball velocities. This might be the case because the damping of the entire robot has a higher influence for higher velocities. In the videos can be seen that the robot itself acts as a damping system for higher velocities. The robot moves slightly back and forth upon impact with the ball. For lower velocities, this behaviour is hardly noticeable with the bare eye and mainly the front assembly seems to be absorbing the impact.
    - The chipper moves up upon impact with the ball. However, this doesn't seems to influence the damping
- With dribbler 2/7:
    - The ball bounces off quite far, but has just enough angular velocity to roll back to the robot and get in touch with the dribbler. Once it has hit the dribbler again, it rolls smoothly.
    - If the robot is not oriented completely straight w.r.t the ball, it might happen that the ball bounces off under an angle and doesn't return to the middle of the robot but to the side (and hits the front assembly, but not the dribbler). This should be prevented. During a match it is likely that the robot receives the ball under an angle, so the ball should not bounce off too far.
    - For higher velocities (3, 3.5), the velocity of the ball seems to be higher than the velocity of the dribbler.
- With dribbler 4/7:
    - The ball bounces off less far.
    - The ball rolls smoothly quite soon after first impact with the dribbler.
    - For high velocities (3.5), the velocity of the ball seems to match quite well with the velocity of the dribbler. The catching of the ball goes very smoothly if the velocities of the dribbler and the ball are (close to) similar.
- With dribbler 7/7:
    - The ball doesn't bounce off very far (comparable to 4/7 dribbler speed).
    - The ball bounces back and forth more compared to 4/7 speed, but keeps in touch with the dribbler.
- With dribbler 7/7 with big gear on motor:
    - It takes quite long for the ball to catch up with the velocity of the dribbler. Therefore, the ball bounces off of the dribbler a couple of times before it sticks for the lower velocities. For higher ball velocities, it only bounces completely off once. Even when it keeps in touch with the dribbler, it keeps bouncing back and forth.

Bad damping results:

- Without dribbler:
  - As expected, the ball bounces off of the robot further for higher ball velocities.
  - The front assembly barely moves when the ball hits it (only the left part of the front assembly moves a little bit back for velocities 2.0m/s and higher, the right part does not move at all).
  - The robot moves a little bit backwards when the ball hits it, but not as much as when it has good damping.
  - The chipper goes up when the ball hits the front assembly, but it doesn't seem to chip the ball so it shouldn't be a problem.
- With dribbler: (the chipper plate was removed for these tests, maybe the chipper does chip the ball a little bit when the dribbler is on, which makes it harder for the robot to catch the ball) (from the video Rbt8_2/7Dribbler_3.0m/s_1, it seems like the chipper chips the ball out of the front assembly when the robot tries to catch the ball)
  - 2/7 dribbler speed:
    - The robot never really catches the ball. When the ball hits the front assembly, it bounces back but the dribbler gives it enough backspin to come back to the dribbler. Then it bounces again and the backspin from the dribbler makes the ball come back. This happens over and over again (see video Rbt15_2/7Dribbler_1.0m/s_2).
    - For 1.5 and 3.0m/s, the ball bounces off further than for the other ball velocities. The backspin given by the dribbler is not high enough so the robot doesn't catch the ball.
    - For velocities 1.5m/s and higher, the ball is only caught if it touches first the dribbler and then the ground (see videos Rbt15_2/7Dribbler_3.0m/s_1 and Rbt15_2/7Dribbler_3.0m/s_2)(put the videos in 0.25 speed to see this better). Therefore,we don't know how good the damping is when the ball rolls flat on the ground… our set up was made in such a way that the ball would always hit the dribbler first for 2.0, 2.5 and 3.5m/s ball velocities.
    - For velocity 1.0m/s, if the ball touches both the dribbler and ground at the same time, it bounces off further than for other velocities when the ball touches the dribbler first. However, since it has such low velocity, the ball is given enough back spin to come back to the dribbler.
  - 4/7 dribbler speed:
    - Again, the robot never actually catches the ball.
    - When it does, the ball bounces less far away from the robot.
    - Again, the ball always touches the dribbler before the ground for 2.0, 2.5 and 3.5m/s ball velocities. When it touches both at the same time (for 1.5 and 3.0m/s), the robot never catches the ball.
  - 7/7 dribbler speed:
    - Small gear on motor dibbler:
      - The ground was more flat during this experiment. Therefore, the ball could hit both dribbler and ground at the same time for 1.5,

    2.0, 2.5 and 3.0m/s. Every time it did, the robot didn't catch the ball.
    - The robot also never actually catches the ball.
- Big gear on motor dribbler:
    - The robot never actually catches the ball
    - For 2.0 and 3.5m/s, the ball first touches the dribbler and then the ground.
    - For the other velocities, both dribbler and ground are hit at the same time, so the robot never catches the ball when this happens (except for 1.0m/s but that's because, with its low velocity, it doesn't bounce too far away and the backspin from the dribbler brings it back).