Calculating the center of mass of our Mecanum-wheels-robot

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Abstract-

Our team wanted to make sure that our robots for this year's ECER Botball challenge are capable of doing their tasks. To do that, they must be able to lift the objects without tipping over. You could find out whether they can lift it through trial and error, which could possibly damage the robots. So that is why it was our goal to calculate the weight they can lift beforehand.

Introduction

AI can be usefully integrated into project development. It is often used to create a work plan. Another way AI can make the workflow easier is by letting the AI analyse the scoring sheet and create several possible routes our robot could take for getting the most points. This allows you to decide which route is easiest for you to program and at the same time scores the most points.

Our goal was to calculate the maximum weight our robot could lift without tilting and show the forces which are working in the robot. The robot's arm is quite like the one you see in following video “AT 2025 Botball Robot Run Example “. The most important difference between our robot and the robot in the video mentioned before are the mecanum wheels. These make a huge difference in the calculation of the tilting point.
Applying the knowledge won from the calculations and combining it with AI in our code is quite a challenge. The AI we would have chosen are not the typical one's ever body knows like ChatGPT and DeepSeek. These are large language models which depend on a huge data storage and need insane amounts of processing power which isn`t manageable for a wombat. Thus, we decided to go with a statistics AI model, if we would implement it in our code, which we can program ourselves. Its use would be to calculate the tilting it would do for grabbing different objects and lifting them up with highspeed which causes momentums in real time.

State of the Art

In Botball competitions, managing a robot's center of mass (CoM) is crucial for stability and performance. Advanced techniques include real-time CoM adjustments using robust control and learning algorithms that can counteract external forces. Robots can shift internal mass for balance or movement, as seen in spherical robots that roll by altering their CoM. Sensors and feedback systems can help optimize balance.

1. The advantages of calculating the center of mass are multifold:
2. Teams leveraging CoM control gain a competitive edge in performance and reliability.
3. For Botball, a low, central CoM enhances stability, especially during rapid movements or object handling.
4. Implementing these strategies improves agility and precision, allowing robots to navigate tasks effectively.

Concept/design

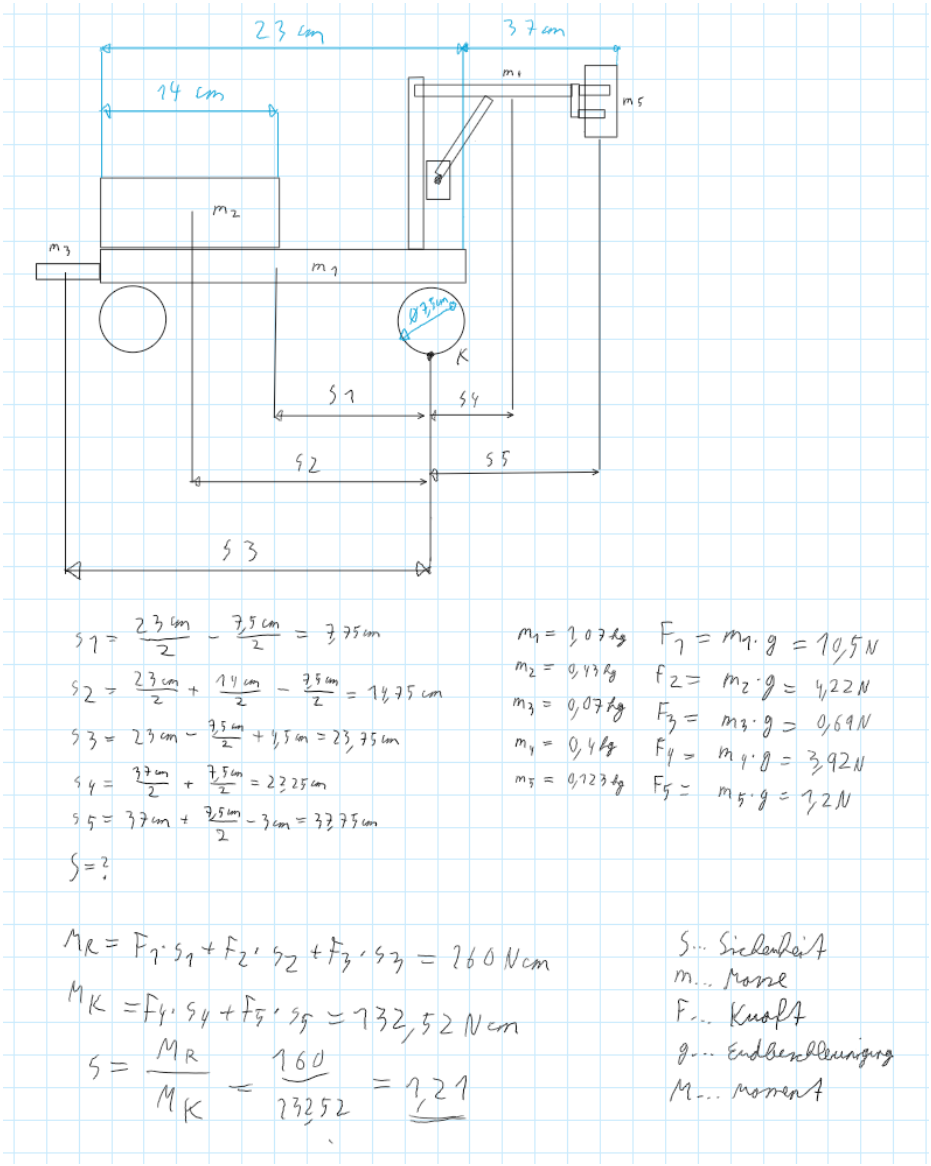
For the calculation, the design of the robot was taken into account, including the reach of the arm and the position of the center of gravity.

Our concept is to find out whether the robot can still pick up the Botguy at the maximum reach of the arm without causing the robot to tip over. For that we needed to do some preparation:

1. Weigh the masses of the individual parts
2. Measure the dimensions of the robot

Implementation

Now follow the calculations for the center of gravity:



Using the dimensions of the robot, I calculated the distances between the tipping point and the individual parts. I calculated the force for each of the masses. I then calculated the back torque and the tilting torque and calculated the safety. If the back torque were greater than the tilting torque, the robot would tip over and the value for safety would be less than 1. Anything above 1 means that the robot will not tip over. The higher the value, the better.

Results /Conclusion

We concluded that our current robot is capable of lifting the required objects. Since we calculated the safety with the heaviest object, in this case the Botguy, we can be sure that the robot is also able to lift everything else even when the arm is fully extended thanks to our calculations.