Safety of mutli agents systems

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Abstract—**Our project is based on the question of how similar agents can cooperate. Can they avoid collisions with walls or with each other and work together effectively? This paper examines which components are necessary to ensure safety in such systems. In particular, we focus on sensors and cameras that allow robots to detect walls, obstacles, and other agents. Our goal is to reduce dependency on timing and instead rely on sensor data and environmental perception.**

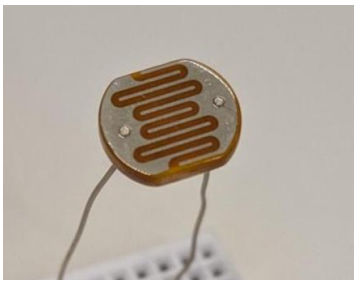
Keywords—light sensor, color sensor, black und white sensor

I. Introduction

Multi-agent systems have developed from theory into practical applications. In robotics, they enable faster and more efficient workflows, but they also introduce safety challenges. Robots must detect obstacles, including other robots, and react accordingly to avoid collisions.
This paper focuses on the use of sensors and cameras to improve safety in a warehouse-like environment. We analyze which technologies are required for reliable detection and how they can contribute to safer robot interaction.

II. Light sensor

Light sensors are commonly used to detect changes in ambient light, for example to start a system when a light signal is detected. In robotic applications, they can serve as simple but reliable input devices for triggering actions.

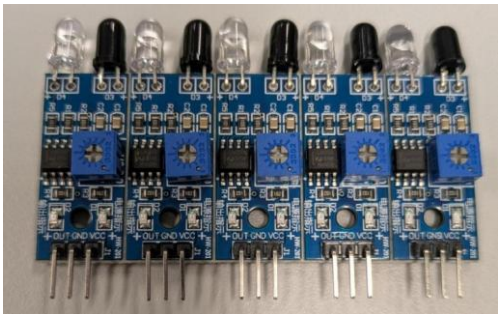


III. Color sensors

Color sensors work by measuring the intensity of reflected light in different wavelengths, typically red, green, and blue. This allows robots to distinguish between different colors and react accordingly. In contrast to simple light sensors, they provide more detailed information about the environment.
For example, a robot can be programmed to identify and pick up objects of a specific color. In controlled environments, color-coded areas can also be used to guide robots efficiently. This reduces the need for complex navigation systems and allows for more structured workflows.
However, color detection depends on external factors such as lighting conditions and surface properties. Changes in brightness or reflections can affect the accuracy of the sensor. Therefore, it is important to calibrate the sensor properly and ensure stable lighting conditions.
In addition, color sensors can be combined with other sensors, such as distance sensors or cameras, to improve reliability. By integrating multiple data sources, robots can make more accurate decisions and better adapt to their environment.

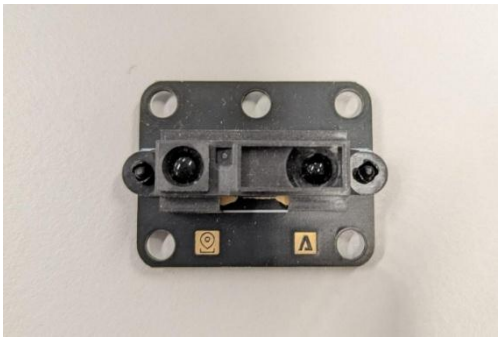
IV. Black und white sensors

These sensors are designed to distinguish between dark and light surfaces. They are commonly used for line-following tasks, where a robot follows a predefined path on the ground. The sensor provides a simple digital output, which makes it reliable and easy to use. This type of navigation is especially useful in structured environments such as warehouses. However, it becomes less effective if the lines are unclear or if multiple paths are too close to each other.



V. Distance sensors

Distance sensors measure how far away an object is, often using infrared or ultrasonic signals. They allow robots to detect obstacles such as walls, objects, or other robots in their surroundings. This makes them essential for safe navigation and collision avoidance. The sensor continuously provides distance data, which can be used to adjust movement in real time. However, their accuracy can be affected by the material or shape of the detected object.



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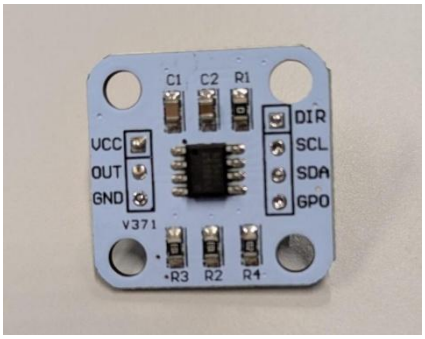
VI. Camera

Cameras provide advanced perception capabilities compared to simple sensors. They can detect colors, shapes, and positions of objects in the environment, allowing more complex interactions. In our project, cameras help reduce the need for multiple individual sensors by combining several functions in one system. This enables more flexible decision-making based on visual input. However, cameras require more processing power and can be affected by lighting conditions.

VII. Angle rate sensor

Angle rate sensors, also known as gyroscopes, measure rotational movement. They are useful for maintaining a straight driving path and improving turning accuracy. By tracking changes in orientation, the robot can correct its movement more precisely. This helps reduce errors that occur when relying only on wheel movement. However, these sensors require careful calibration and can be difficult to interpret correctly.



VIII. State of litetare

Right now, our gameboard is done. However, we built it a little bit differently. They hadn't delivered the pipes on time, so we got creative. For example, the ramp is supported by wooden blocks, the pipes are recycled from two years ago, and the Botguy House is slightly unstable. Programming the robot in the Upper Start Box has begun. The robot knows when to stop collecting the poms and successfully returns to its Start Box. The robot in the Lower Start Box is driving in front of the Botguy House. We plan to program an Arduino to ensure stable alignment on a straight path. We have started to implement the starting ritual in our code but are still figuring out how to implement the ending. We can successfully use our Black-White sensor and light sensor. The angle rate sensors are still a big problem for us because of the ranges that don't match well. We plan to 3D-print a shovel to collect the poms and sort them internally.

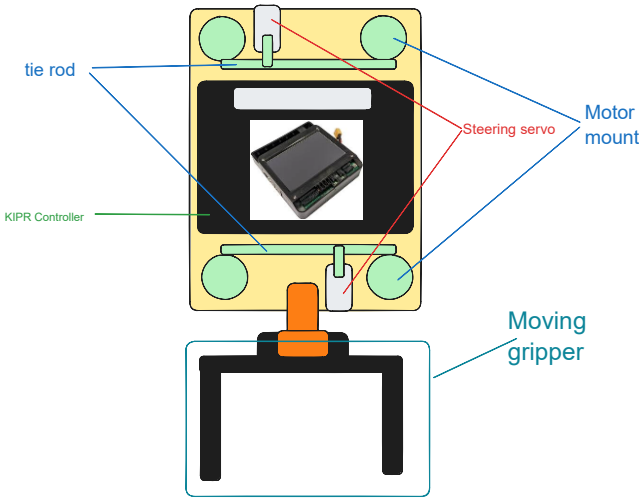
IX. Concept and design

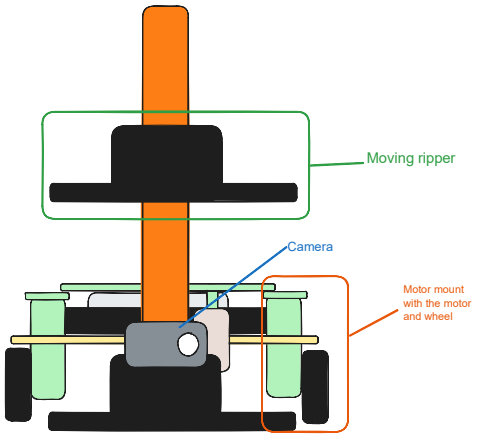
A. *Robot of the Upper Start Box*

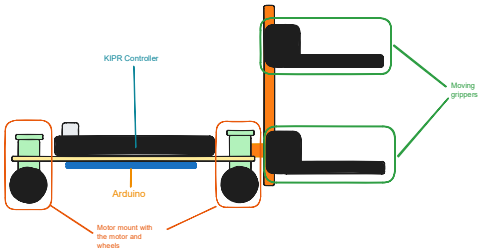
This robot should have a long arm at the front to reach down the floor while it is standing on the ramp. This robot is designed to pull the buckets out of their original position and throw the poms over the railing. To collect the poms, it should have a shovel mounted on the side. This shovel should sort the poms by color and carry them until they are thrown over the railing. The robot also has a black-and-white sensor close to the ground and a light sensor to detect the start signal.

B. *Robot of the Lower Start Box*

This robot is built similarly to a forklift. It has two forks at the front so it can lift two elements at the same time. The forks are controlled by two motors that are mounted on the module. All the other motors for the wheels are connected to an Arduino. This Arduino ensures that the robot drives a straight path. The body of the robot is 3D-printed, and the forks are as well. At the bottom of the fork there is a black-and-white sensor to ensure that the robot follows black lines. The robot has a small flag installed so that we can turn the light sensor in any direction. The camera is installed on the first fork to recognize the colors red, blue, green, and orange. We also have two servos to turn the wheels to the same angle.







X. Implementation

We started implementing our strategies in late January. Soon we realized that it might have been a little late to start, but once you' start, you can't back out anymore. The arm of the robot in the Upper Start Box is not finished yet. We still have to figure out how it is supposed to grab the buckets, and the shovel is still being printed. The two forks of the second robot are already installed, but we can't program them yet, because the Arduino isn't finished. The angle sensors are tricky because we haven't figured out how to combine two completely different ranges into one.

XI. Results / Conclusion

We hope to implement the angle sensors and the Arduino in the future. For now, the light sensor and the black-and-white sensor are working perfectly. The safety of multi-agent robots is very important for the staff inspecting them.

XII. References

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