

SolarFlare: Autonomous, self-charging robot for early wildfire detection

In recent years, climate change has become increasingly prevalent and a personal concern for me. One of the most devastating impacts of rising temperatures is the increase in wildfires; they destroy forests and threaten homes and lives. Living in British Columbia, I've seen firsthand how devastating wildfires are. In 2023, over 7 million acres were burned in British Columbia alone, making it the worst wildfire season on record (CSP, 2025).

I noticed that even though wildfires were increasing, our technology was not improving. Current detection systems rely on stationary sensors or camera towers, which need human attention or external power, which is a big problem in remote areas where fires are most common. Even solar-powered sensors were inefficient. For example, the DRDC's sensor is stationary, so the sun won't hit it all day, and if a shadow is cast, it becomes useless (DRDC, 2023).

This led me to design a system that wouldn't just detect wildfires but would also be self-sufficient. With this design, the surveillance scope is vastly increased. Remote areas that couldn't be monitored before will now be continually observed. I developed early code, like the light-seeking function, which revealed issues such as running into obstacles. I solved this by using a distance sensor to stop the robot when something was in front of it.

I moved to Arduino parts and a stronger metal frame, adding a solar panel. Through research, I found the optimal solar angle in British Columbia is 35.2° , adjustable for each region. I also added a gas sensor to detect wildfire smoke and a radio frequency module to send alerts, though range remains a limitation. I use Arduino for lower energy usage, reduced environmental impact, and software familiarity.(Appendix A)

After working on this project, I realized some features had potential beyond wildfire detection. The self-charging function could expand robotics into areas like search-and-rescue or agriculture in off-grid fields. In winter, sunlight is limited, but wildfires and farming are also less common then, so the robot likely wouldn't be needed.

During testing, I placed the robot in 10 different positions around a bright spot(Appendix B). In every case, it accurately positioned itself in the brightest area, confirming the effectiveness of the code and design. I also used smoke from burning charcoal to calibrate the gas sensor, which had a threshold of 150-200, compared to the threshold of 80-100 for normal air. Finally, I tested the robot on flat, uneven, and inclined terrain. It was able to move well and still find the brightest area to charge. These results gave me the confidence that this robot can be a practical solution to wildfires that can be deployed in all types of terrain and run without the need for human attention.

Reference:

<https://cdnsiencepub.com/doi/10.1139/cjfr-2024-0092>

(7 Million acres)

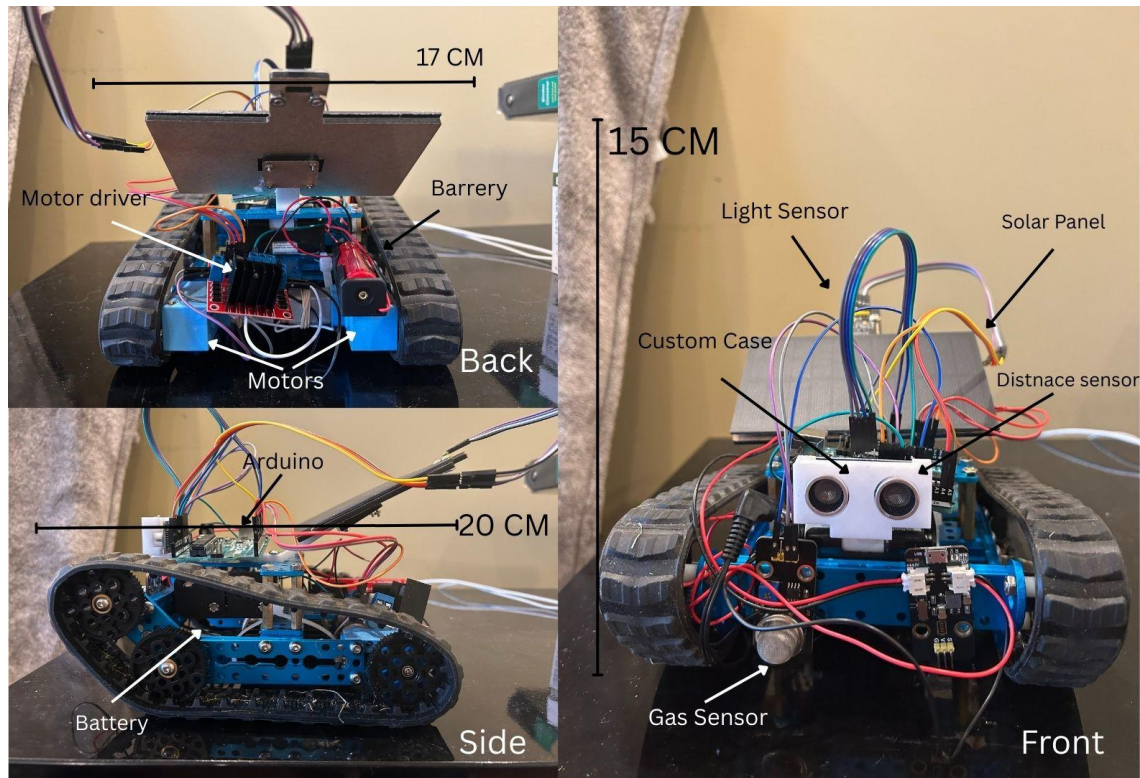
<https://science.gc.ca/site/science/en/blogs/defence-and-security-science/drdc-tests-early-detection-wildfire-sensors>

(current wildfire detection systems)

<https://sunsolartilt.com/pages/calculator>

(Solar panel angle calculator to find the optimal angle)

Appendix A:



Appendix B:

