Research Topic Summary

Speaker Name: Vijay Kumar
Talk Title: Swarms of Small, Flying Robots

Your Name: Bojun Yang

Research Field/Problem:
Describe one (or more) of the research problems the speaker's work addresses.

One concern when designing aerial drones is the weight. Vijay notes that in his tests with drones weighing from 25 grams to 2 kilograms, hovering requires about 200 watts/kilo. The weight, along with vision depth, directly affects the speed and maneuvering of the drone. If there was a brick wall right outside the range of the drone's vision, the drone needs to be able to deaccelerate fast enough to avoid crashing into the wall. Thus, we need to design around payload.

Another area that Vijay addresses is the Perception – Action – Communication loop needed for multi-vehicle teams. The robots in his context are those using only lightweight, low-power cameras. Some problems that need to be addressed are drones not being able to identify each other and every drone might not see every other drone. The drones also want to agree on a common reference frame that doesn't exist. One problem is the lack of large, rich datasets since the interest in small drones in relatively very niche. Datasets with different orientations, backgrounds, and video settings are few. It is also very hard to model communication loops between robots. To figure out what a robot needs to communicate to another robot and what that robot should do once it receives communication is a remarkably hard problem, as said by Vijay.

Approach:
What is/are the novel approach(es) or innovative idea(s) behind the speaker's solution to the above?

For the concern of drone design. The advancements in sensing (cameras, processors, etc) have allowed very lightweight solutions to sensing to be mounted onto a drone.

To address developing a model for the communication loop, Vijay shows that a network that a networked learned off of a model-based control method performs much better than model-based control. He uses Graph Neural Networks to aggregate information at each node from neighboring nodes using graph adjacency properties. An edge represents a robot that can see another robot. The key idea is a Convolution based off of belief states of agents and each agent can run a perception-action loop locally. Another application Vijay mentioned is to think about small robot problems and brute force those problems to train large robot problems.

Takeaways:
What key ideas or new insights did you learn from this talk?

Vijay's approach to learn from a prior method was interesting. It makes me think how I can take a less efficient model to create a better model that uses the less efficient model as a base. I also learned a lot about how small robots can be used in industry. Another interesting thing Vijay mentioned is that academic researchers don't want to research things that big companies are researching. This makes sense since big companies have a lot more resources to throw at a problem than a research lab.

Questions:
List any follow-up questions you have after watching this video.

The drones shown in the video are all about or larger than a hand. There was a brief mention of very small drones and collision. The smaller the mass of the robot, the more speed it can collide with an object and be fine. Since force is mass * velocity, smaller robots don't have to worry about perfect route mapping. What are some possible applications of very tiny robotics?