Speaking parts in order:

Thomas: Background/Motivation
- Each day in the united states, an average of 7 people die to house fires
  - 30 injured
- In 2018, structure fires resulted in $11.1 billion of property damage
  - Excludes homes lost to wildfires ($12 bn)
- For many homes in the US, the minimum realistic response time is over 5 minutes
  - Up to 10 minute avg response time in some areas
  - Best case scenario with an automatic alarm system
- Our goal with this project was to reduce the risk of loss of property and life by creating an automated in-home system to respond to fires in seconds, rather than minutes.
  - A quicker response makes it more likely to extinguish a fire before it causes any substantial damage and gives occupants time to escape if the fire cannot be extinguished.
- Fire extinguishers are effective at early stages, but require someone to risk their safety to operate them.
- Sprinklers can be very effective, but they can cause severe water damage and are very hard to retrofit into existing homes.
- By creating a system to equip an existing home with quick-response fire suppression, we hope to give homeowners an approachable way to protect their loved ones from the terrifying threat of a dangerous fire.

Natalie: Navigation/Methods

The robot and smoke detectors are connected over wifi, once fire is detected the robot navigates to the room corresponding to a specific smoke detector. The robot navigates using a fixed map created from the house floorplan or built using the robot by planning a path through the fixed map and localizing within the map using the LIDAR and statistics.

Ryan: Prototype
- Ideation and Selection
  - Fire Extinguisher Type
  - Aiming and Activations
- Design Process
  - Main Constraints: Space and mechanical interface with servos
  - Also considered material, mainly looked at aluminum and plastics as relatively low cost options, selected aluminum because they were similarly priced
- Prototyping process: I machined all the parts in Montgomery Machining Mall

Ricky: Servos and aiming
- Together with the custom parts, 2 dynamixel RX-28 robot actuator are used to form the aim and trigger subsystem of the prototype.
- This particular servo is used due to its:
  - High torque rating

- ○ Build-in Proportional type feedback control
- ○ Allowing more accurate aiming capability and reliable trigger system
- They are controlled through a USB communication hub, U2D2, and Robot Operating System (ROS) packages that set up the control environment for manipulating the servo.
- The aim mechanism involves manipulating the servos according to the FLIR IR camera feedback, which is attached onto the fire extinguisher sprayer and sends the hotspot coordination in respect to its view.
- The servo will work together with the robot wheel to do pan and tilt motion, aligning the hotspot with the sprayer head.
- Once the hotspot is aligned, the trigger is then activated, spraying the fire extinguisher that is mounted onto the robot.

Zack: Smoke Detectors
- Smoke detectors are built based on the concept of IOT device.
  - ○ Need low power, low latency design to work in real time and on battery power.
  - ○ Used ESP32 and MQTT protocol to accomplish this.
    - ■ ESP32 is low power, wifi and bluetooth enabled microcontroller with ability to disable all unnecessary processes
    - ■ MQTT is a low power, publisher/subscriber messaging protocol. Any number of devices can publish to or read from topics maintained by a broker. In our case, each of our smoke detectors posts to an MQTT topic that signifies identification of smoke. The robot subscribes to this topic, and can Identify which smoke detector was triggered, within a second of detection
- 1st step in our design process for smoke detectors was to prototype it on a breadboard in order to work out kinks with the smoke sensors, buzzers, and MQTT protocol
  - ○ Then we made a custom printed circuit board, and soldered each of the devices in place.
- The smoke detectors are scalable, you can add as many as needed for full coverage of space

Adrian: Results/How we tested this stuff
- Successful tests in our simulated environment
  - ○ Constrained scope by not considering doors and stairs
  - ○ Successfully navigated the simulated house autonomously and extinguished the fire
- Navigation was not extremely reliable and would be a good target for future improvement
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Deniz: Discussion

- As can be seen from our results, we were able to demonstrate that our robot is able to respond to incipient fires faster than the average response time of firefighters.
  - This means that our robot would not only help reduce property damage caused by fires but also make it safer for people.
- However, given the scope we limited our project to after talking with first-responders, the robot can't navigate upstairs, open doors or reach higher up locations.
  - So these issues would need to be addressed before having a product ready to be used by consumers.
  - An office building (automatic doors) or storage facility (unmonitored) could be good initial applications of our project
- Some other changes that would improve our current design are:
  - Fire extinguisher needs to be redesigned to sit vertically allowing more fire-retardant output.
  - Implementing a robust aiming and sweeping algorithm would maximize fire extinguisher efficiency.

Chris: Future work and considerations
- The biggest improvement we could make to our autonomous robot's functionality and effectiveness in the future would be to integrate an in-home GUI and data transmission to the local fire department.
  - Graphical User Interface
    - Accessible by homeowners and first responders
    - Contain information such as
      - House layout
      - Fire location
      - Smoke levels
      - Time since detection
      - Live video feed from robot
- Full Simultaneous Localization and Mapping (SLAM) algorithm instead of static map navigation. Increase robot mobility and situational adaptability.