# Project Title: Autonomous Firefighting Vehicle Vision System

August 2025

## 1 Project Overview:

Develop a vision system that will eventually be integrated with the current Autonomouf fire fighting vehicle. This includes training a DNN to recognize fires from rgb images, investigating and using the Flir SDK and possibly fusing the Flir IR data with the neural net localization, designing a proof of concept navigation system with the Picar-X.

## 2 Scope of Work:

1. Design and Development:

   (a) Design a deep learning solution for RGB fire recognition and localization. One option is to perform transfer learning on YOLO. Helpful datasets:
      - DBA-Fire Dataset
      - Fire Detection on Kaggle
      - Fire and Smoke Detection on Roboflow
      - other fire and smoke datasets on Roboflow

   (b) Design fire tracking capability for the Flir A50 and servo turret so that the Flir can move and track a fire source. Simulated fire sources include an incandescent bulb tree and a heat gun. Helpful materials may include:
      - Spinnaker SDK
      - Flame 2 Dataset
      - DFire Dataset

   (c) Design a proof of concept vision system with the Picar-X and a Raspberry Pi 5 with the AI Hat+. Robot should recognize a printed fire image placed in the IEEE robot arena and navigate to it. A more advanced implementation should include object avoidance, in the form of randomly placed PVC pipes.

(d) (optional) - devise a data fusion method for combining data from the rgb camera and the IR camera. This could be of the form of training one neural network on paired images, or fusing navigation data such as averaging location of the fire from both sources, or using a kalman filter to fuse the fire location from both sources.

2. Testing and Validation:

   - A test plan should be devised, documented and run to verify the above deliverables work correctly.

3. Documentation and code:

   - Provide detailed documentation including circuit diagrams, firmware code, and a user manual.
   - Include instructions for assembling and using all project components.
   - Create and maintain a repository on the AFV organization Github page. All code and documentation should be current and up to date at the end of the semester.

# 3   Deliverables:

- Fire recognition and localization using rgb images and an rgb video stream (preferably through a deep neural net).

- Navigation to a fire image printout in IEEE robot arena using the picar-x and your fire recognition and localization model.

- Fire tracking capability with the Flir A50 and turret system.

- Documentation and code up to date on the new repo you create on the Github Organization page.

# 4   Acceptance Criteria:

- The picar-x can move to scan the IEEE playing field for fire from any placement within the playing field. Once the fire is located the robot should navigate to within a distance of roughly 30cm of the fire image and stop.

- Flir IR camera and turret can move to scan surroundings stopping to center on simulated fire. After the fire is located, the turret rotates to keep the fire centered if the simulated fire is moved.

- Repo created on Github Organization. Code and project documentation on the repo is complete and accurate.