Autonomous multi-camera system for filming and tracking a moving athlete

Background

NAPPLab, lead by Prof. Micah Corah, is developing a robotic videography system
for filming team sports and social behaviors.
This system will consist of a network of pan-tilt-zoom cameras controlled by a
centralized computer.
Ultimately, we would like this sytem to be able to autonomously film groups of
moving people or athletes according to human inputs such as by selecting
aesthetically pleasing views of players passing a ball or obtaining multiple
views of a runner that could later be used to reconstruct their motion.
For this field session the task will be to develop a system that is able to
track a single person and autonomously film their motion (e.g. obtaining views
from multiple angles and zooming in while keeping the subject fully in view for
purpose of a reconstruction task).
Because this field session project represents a component in a larger research
task, we expect the team to complete this project by building simple and
configurable modules based on existing tools for robotics research.
Specifically, the team should use ROS2 (Robot Operating System) to build modules
(nodes) that interface with the broader system by sending and receiving
standardized messages.
Computing and camera equipment will be provided by NAPPLab though the team may
be expected to select items for purchase.

Project Description

The group will be divided into two teams that will cooperate to accomplish the
project goals:
1. The tracking and detection team will develop a module that is able to detect
the subject in camera views and estimate their 2D or 3D position in a common
Euclidean frame

a. The system should report the subject's bounding box in each camera frame (e.g.
based on detections from an existing machine learning model)
b. The system should use detections from one or more cameras to estimate and report the position of the (potentially moving) subject in the viewing area in a shared Euclidean frame
2. The control team will be responsible for operating the cameras according to
the hypothetical operator specification
a. Cameras should produce zoomed-in views of the subject from multiple angles
b. The control team may wish to use the outputs of the detection and tracking system as inputs to a separate controller module

Notes:
Teams may wish to use dedicated cameras for the separate tracking and filming
tasks.
Both teams may wish to interface with cameras via existing ROS2 driver nodes.
The group may also wish to use open source tools to perform intrinsic and extrinsic calibration of the multi-camera system.

Project Goals

1. Setup and calibrate the multi-camera system
2. Produce a module that detects and estimates the position of a moving subject
3. Control cameras to obtain zoomed in views of the subject from multiple angles
for a hypothetical reconstruction task
4. Demonstrate the functionality of the complete tracking and filming system
5. Provide thorough documentation for use in continued development of this
system

Skill Set

* Experience with Linux & Unix environments, especially Ubuntu
C/C++
Scripting language and scientific/mathematical programming
* Python with numpy
* Julia
Robotics skills (preferred or to be developed during field session)
* ROS/ROS2 experience
* Experience with computer vision algorithms and/or coordinate frames and rigid body transforms

Preferred Team Size

3–5 students

Outcomes and Opportunities with NAPPLab

Please reach out to Prof. Micah Corah if you are interested in continuing to
work on robotics research with NAPPLab.
Opportunities may include: independent study, hourly RA-ship, Summer Undergraduate Research Fellowship (SURF), or Mines Undergraduate Research
Fellowship (MURF).

This project may contribute to future research publications in robotics
conferences or journals.
If so, student contributors will be acknowledged for their contributions.
If you wish to contribute as an author to publications stemming from this
project, you must reach out to Prof. Corah directly to discuss how to do so and
what kinds of contributions would merit authorship.

Intellectual Property

This project is a component of ongoing research in NAPPLab.
We suggest adoption of the BSD 3-Clause license to facilitate continued use of
products of this field session in our research program.

Location of Work:

Mines Campus

Client Liason

Micah Corah
micah.corah@mines.edu

Carole Bouy
cbouy@mines.edu