Video Analytics at the Edge

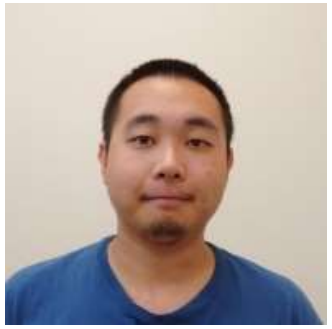
Critical Design Review

Members

Luke M. Barber

Mikel Holmquist

Shawn Sheng



Dr. Yasin Yilmaz

Advisor

Problem statement

Surveillance systems' bandwidth requirements have increased significantly in the past decade. It is of the industry's interest to leverage current advancements while reducing the amount of bandwidth.

One key approach to achieve this is to utilize Edge Computing, in other words, pre-processing and analyzing the sensor data at the sensor node.

Design approach

This design effort aims to demonstrate video analytics with edge computing techniques by using stream processors (NVIDIA Jetson Nano) to detect and identify anomalous objects in the environment with the help of Machine Learning, advanced pre-processing, and automated camera tracking and zooming techniques.

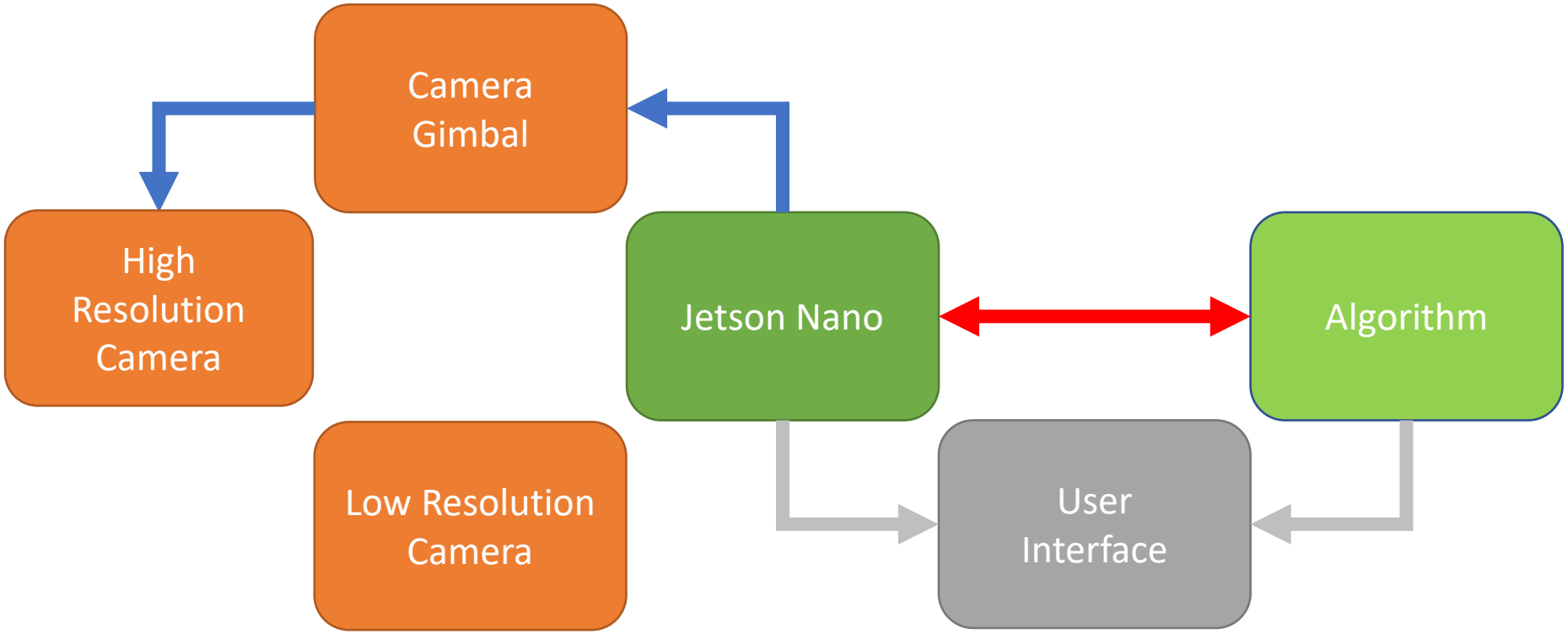
Edge Computing

- Reduces the bandwidth requirement between the sensor and the central computer.
- Robust all-in-one solution designed to operate in congested environments.
- Simplified User Interface (SUI) that will allow users to customize the system as well as giving the users some control and monitoring of the data.

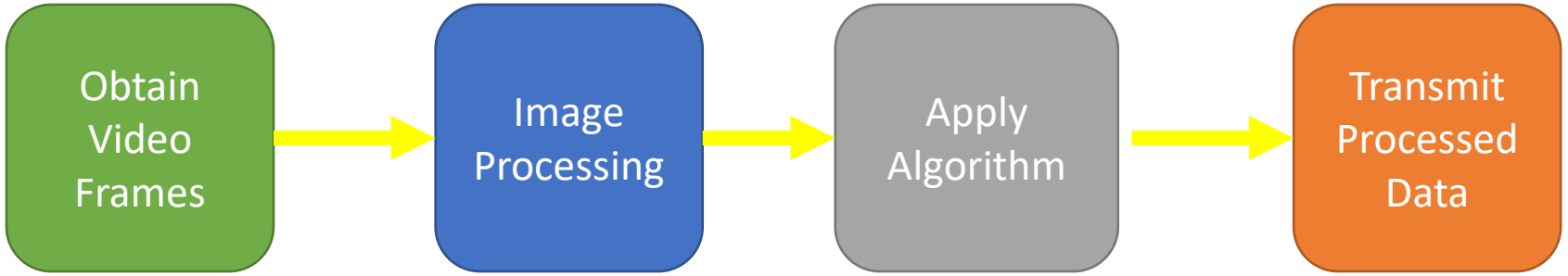
Features

- No less than 20 common objects.
- Track the object when motion is detected.
- Telephoto sensor will capture high fidelity data for anomaly classification.
- Anomalous items will be video recorded for one minute.
- Audio/Visual alarm.

System block diagram

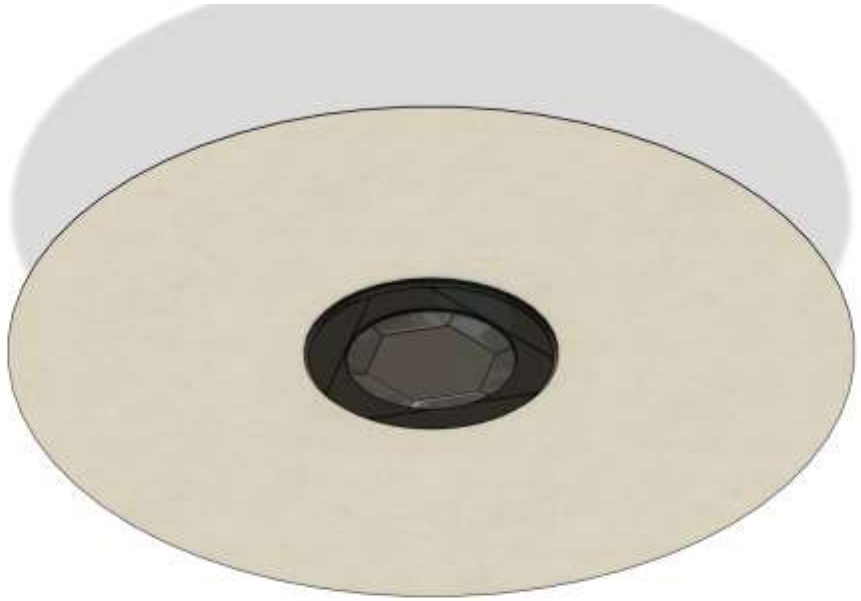


Sequence block diagram



Design Features

- Stream Processor
- Wide and telephoto capability
- Powered gimbal system
- Retractable design

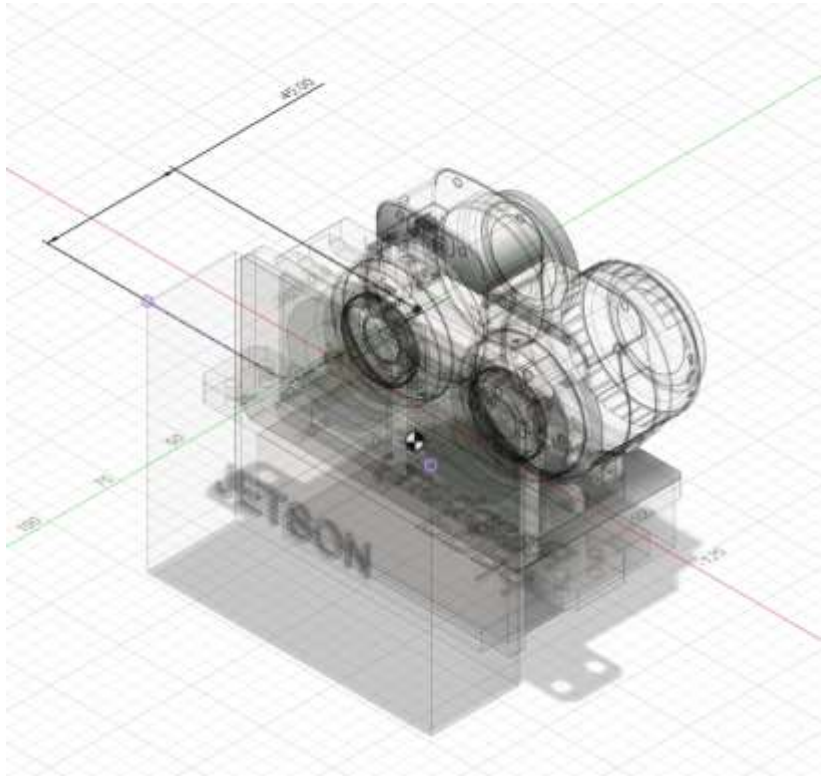


Jetson Nano

- Ubuntu OS: Comprehensive JetPack SDK with accelerated libraries for deep learning and computer vision.
- Performance and capabilities needed to run modern AI workloads, giving a fast and easy way to add advanced AI to the project.
- 128-core NVIDIA Maxwell architecture GPU for fast image processing.

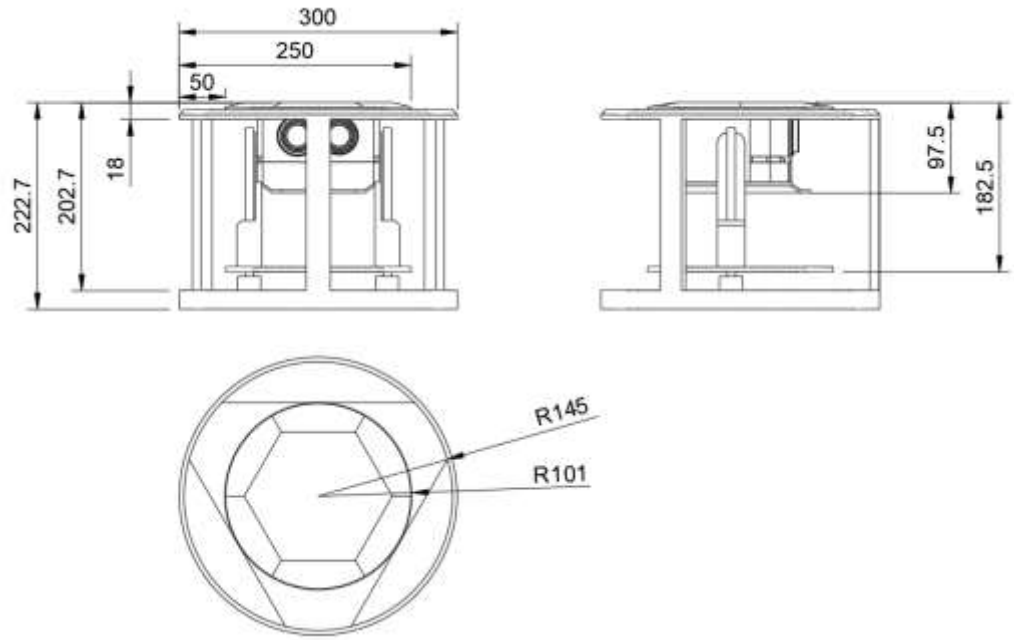
Sensing System

- System uses twin Sony IMX477R sensors with
  - Telephoto Theia TL1250
  - Wide-Angle Theia TL410
- MIPI to interface with an operating system.
- Large sensor size for better noise rejection.
- 4 to 50mm focal distances available, electronically controlled with auto focus.

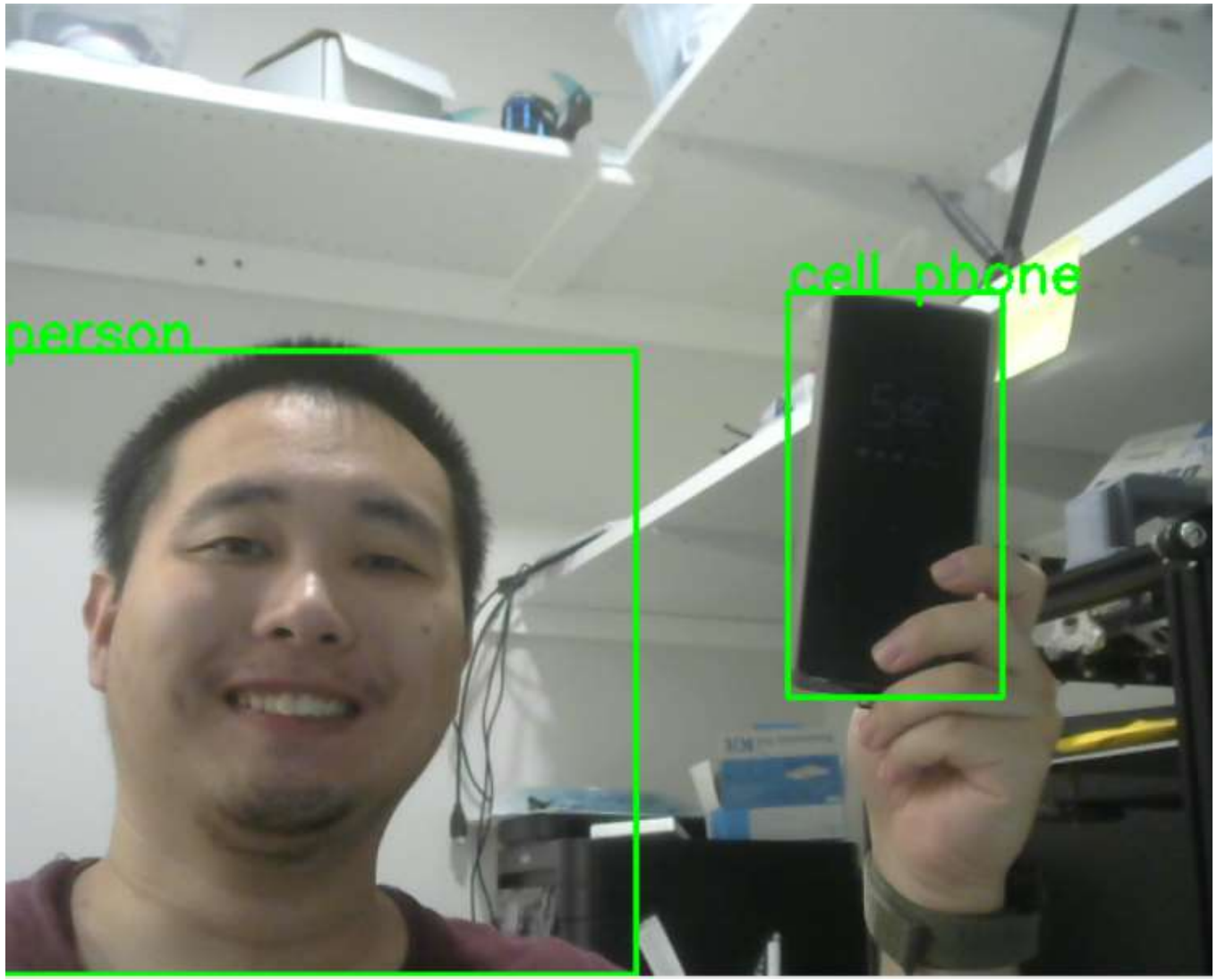


Physical Interface

- Electro –mechanically controlled gimbal.
- Full pan, pitch, tilt design.
- Dedicated compute unit enclosure
- Low observability construction
- Flexible mounting configurations.



Simulation / Calculations performed



Hardware/Software development to date

- Preliminary program is currently inferencing on a Nvidia RTX 3090.
- Currently working on making the program compatible with the Jetson Nano at a sufficient inferencing speed.
- Physical Camera Gimbal is currently in rapid prototyping phase.

Bill of Materials

Index	Description	Qty	Unit price	Cost
1	Jetson Nano SDK Module	1	$149.00	$149.00
2	Sony IMX477R HQ Sensor	2	$50.00	$100.00
3	Theia TL1250 Lens	1	$400.00	$400.00
4	Theia TL410 Lens	1	$400.00	$400.00
5	20 Watt DC Power Supply	1	$12.99	$12.99
6	Jetson Nano Wireless Internet Adapter	1	$18.99	$18.99
7	PLA Filament 2KG	1	$51.00	$51.00
8	Stepper Motors (Threaded Z Axis, Yaw Axis) Nema 17	3	$13.99	$41.97
9	High Torque Servo (Pitch Axis) Savox Sb2290Sg	1	$150.00	$150.00
10	Stepper Motor Driver Set TMC2208	1	$10.00	$10.00
11	High Current 5V Step Down CC Bec Pro	1	$50.00	$50.00
12	Threaded Rods 3/8"-16 36"	2	$6.00	$12.00

Subtotal	**$1,395.95**
Adjustments	**$0.00**
	$1,395.95

Testing plan (1/3)

Title	Requirement	Verification Success Criteria	Verification Method	Phase
Main Image Sensor and lens configuration	A camera shall function and capture live video feed.	Observable live feed .	Demonstration	Preliminary
Verify that the camera is capturing a live feed	Camera (webcam or pi-cam) shall function properly.	Live video feed with appropriate quality and resolution.	Test	Preliminary
Verify the correct resolution mode is set on the camera	Correct resolution shall be set on camera	The right resolution must be displayed when live.	Inspection	Preliminary
Camera Frame Time	Frame time shall be set accordingly	System must be able to capture frames adequately	Test	Preliminary
Camera Focal Length	The Camera shall have a focal length such that a sharp image is produced.	Zoom levels will be adequate	Test	Preliminary
Physical obstacles	Protectors that hold the camera in place during transportation shall be removed prior to powerup of the camera gimbal assembly	No protectors remain in place	Inspection	Preliminary

Testing plan (2/3)

Req#	Function	Requirement	Test Method	Brief Test description
Gimbal Centering	Camera Gimbal shall be able to center during initial powerup.	The gimbal must be centered (or in a neutral position).	Demonstration	Secondary
Gimbal motion	The camera gimbal shall achieve an adequate range of motion in the pitch and tilt axis.	Camera gimbal must be able to rotate accordingly	Demonstration	Secondary
Power input and current carrying capacity	Power source shall be capable of supplying enough current to the system without voltage sags at critical levels	Power levels required by the Jetson Nano, as recommended in the user manual shall be obtained	Test	Secondary
Physical Connections	Physical connections to and from the main communication computer shall be secure.	Proper contact is obtained	Inspection	Preliminary
System mounting	The mounting harness for the main communication computer shall be secure.	System is mounted such that no undesired movement is possible	Inspection	Final
Grounding	There shall be adequate grounding of the main communication computer	Proper Ground (Zero Potential) is maintained	Inspection	Final

Testing plan (3/3)

Req#	Function	Requirement	Test Method	Brief Test description
Image processing capabilities	The image processing capabilities of the system shall be tested.	System is able to process images in real time	Test	Final
Jetson Nano	Jetson shall run required software	Run code to confirm libraries are installed correctly	Test	Secondary
Object Recognition	Object Recognition shall be successfully implemented.	Recognize at least 10 common objects.	Analysis	Final
CSV files	Anomalous objects shall be recorded and logged into a text/CSV file	CSV file will log time, object, and internal file link to recorded video	Demonstration/Test	Final
Audio-Visual Alarm	The system shall notify any anomalies	Once an anomaly is detected, the system should emit an audio- visual alarm.	Demonstration	Final
Gimbal tracking	Camera gimbal shall track anomalous individuals	When anomalous individual is detected, the gimbal should move to track the individual for one minute before returning to neutral position	Inspection	Final
Recording Anomalous	The system shall automatically begin recording anomalous individuals	Once an anomaly is detected, the system should begin recording	Demonstration	Final

Work division

Luke B	Mikel H	Shawn S
➢ Making the program compatible with Jetson ➢ User interface	➢ Building the project website ➢ Training AI model	➢ Refining and adding additional functionality to the program ➢ 3D Modeling of the product

QUESTIONS?