VIDEO ANALYTICS AT THE EDGE

PDR PRESENTATION

MEMBERS

- Luke M. Barber
- Mikel Holmquist
- Shawn Sheng

- Advisor: Dr. Yasin Yilmaz

INTRODUCTION

Our product is camera solution able to remotely sense and detect objects based on trained data sets. It will host a web UI interface server that allows the user to manually control the system via low resolution video streaming.

The end user would be able request the server for a high-resolution photo or they can correct said object if it isn't correctly labeled by our machine learning computer running on the platform.

USE CASE EXAMPLE: ITEM PROCESSING

AI (Artificial Intelligence) can detect an anomalous item (e.g., spoiled fruit, defective electric components) and instruct a robotic mechanism to remove that item from an assembly line or functionally similar mechanical construction

USE CASE EXAMPLE: SURVEILLANCE SYSTEM

AI processing to detect behavior that coincides with the behavior patterns commonly observed in individuals planning/committing/escaping criminal activity

VIDEO ANALYTICS REQUIREMENTS

- **Inspection** - using one or more of the five senses (especially sight), simple physical manipulation, and mechanical/electrical gauging and measurement
- **Demonstration** - the actual operation of an item to provide evidence that it accomplishes the required functions under specific scenarios
- **Test** - application of scientific principles and procedures to determine the properties or functional capabilities of items.
- **Analysis** - the use of established technical or mathematical models or simulations, algorithms, or other scientific principles and procedures to provide evidence that the item meets its stated requirements.

VA REQUIREMENT 1: INSPECTION

- **Requirement:** Port connectors provided on the front panel. One can verify this requirement through inspection. That is, we will look at the switch and observe where the port connectors are located.
- **Requirement:** Provides at least 32 10/100/1000BASE-T ports In addition, for anything that is beyond the capabilities to test, vendor documentation be relied on as reference. We also considered these inspection methods.
- **Requirement:** Operates in temperatures between 32 and 104°F Companies would put the item in a temperature chamber and cycle the temperature while conducting performance tests.

VA REQUIREMENT 2: DEMONSTRATION

- Consider this requirement manageable locally using console access Plug a local console device into the item and demonstrate it can perform a sampling of management functions.

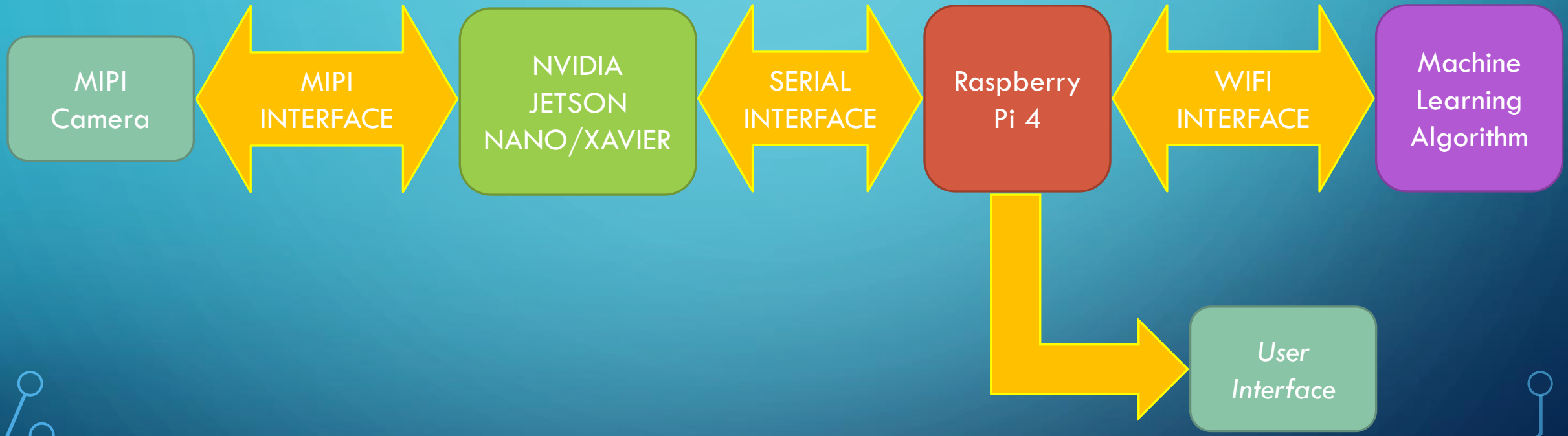
VA REQUIREMENT 3: TEST

- Test is similar to demonstration, but is more exacting, generally requiring specialized test equipment, configuration, data, and procedure to verify that the item satisfies the requirement.
- Use of specialized test equipment (SmartBits Data Sheet) one will connect it to the item in a particular way, configure the control software just so, and run specific data through it according to a repeatable procedure from which we will get a binary result indicating whether the item did, or did not satisfy the requirement.

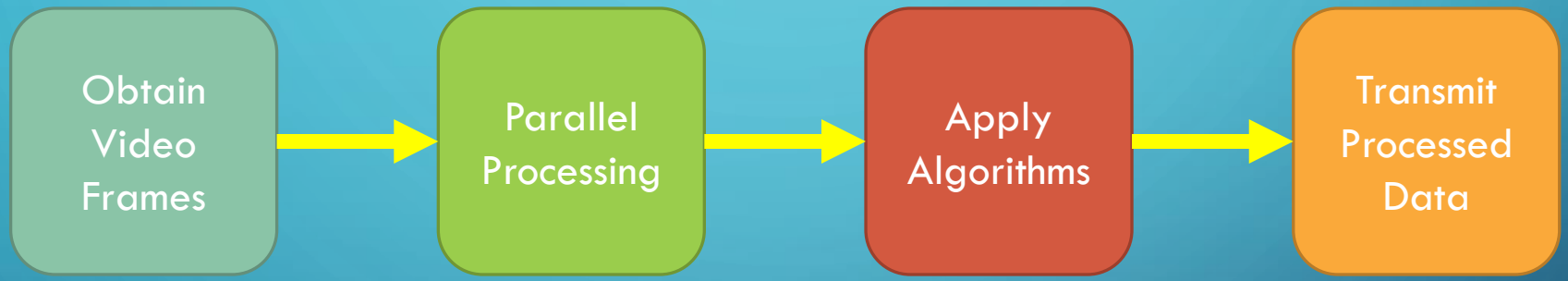
VA REQUIREMENT 4: ANALYSIS

- As test was like a more involved version of demonstration, so analysis is like testing on steroids. In analysis, many tests may be performed, but the results of any given test do not give a pass or fail indication, rather all of the results must be taken in concert, and we must perform some further operation in order to determine whether the item satisfies the requirement.

SYSTEM OVERVIEW

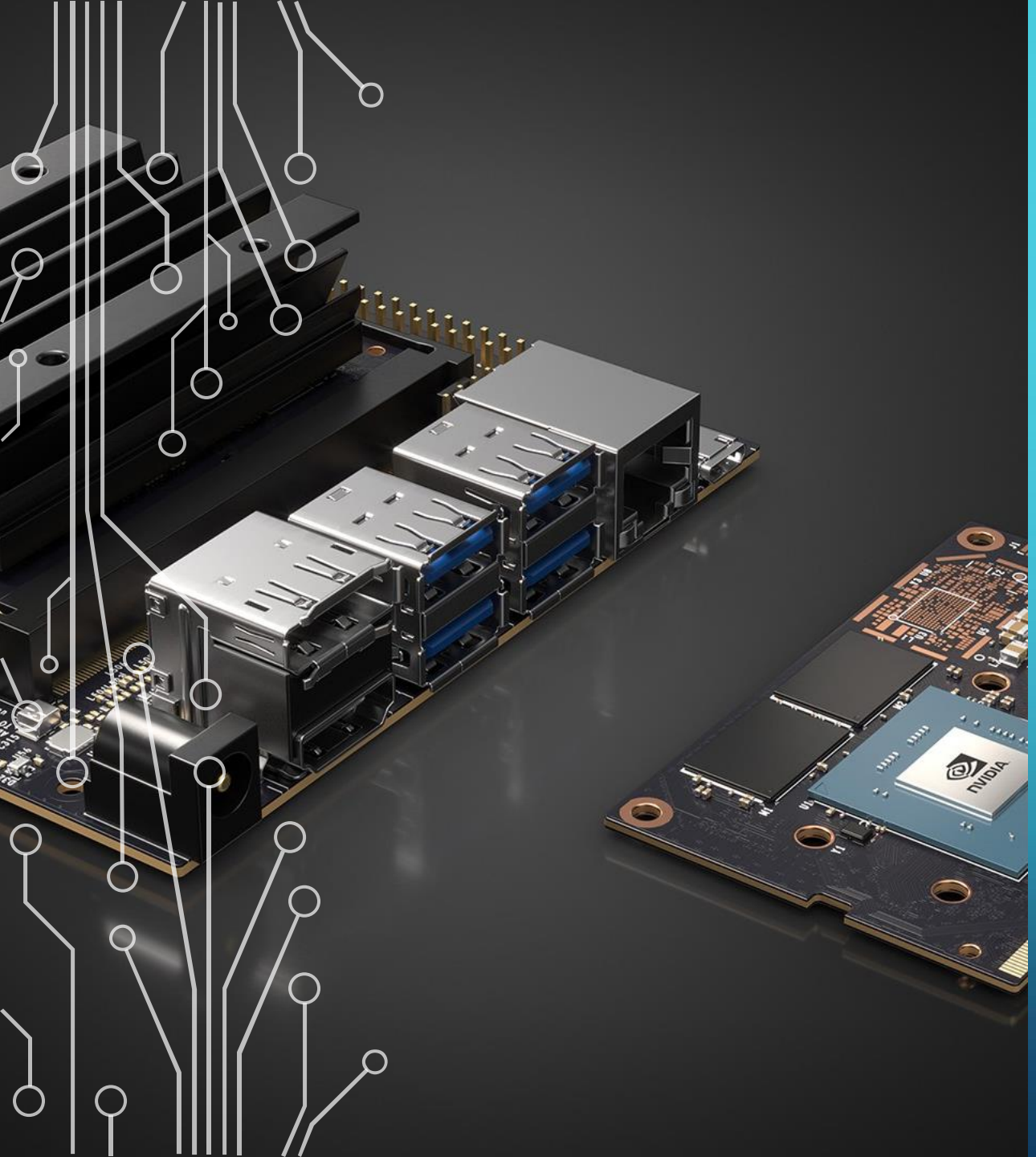


SEQUENCE DIAGRAM



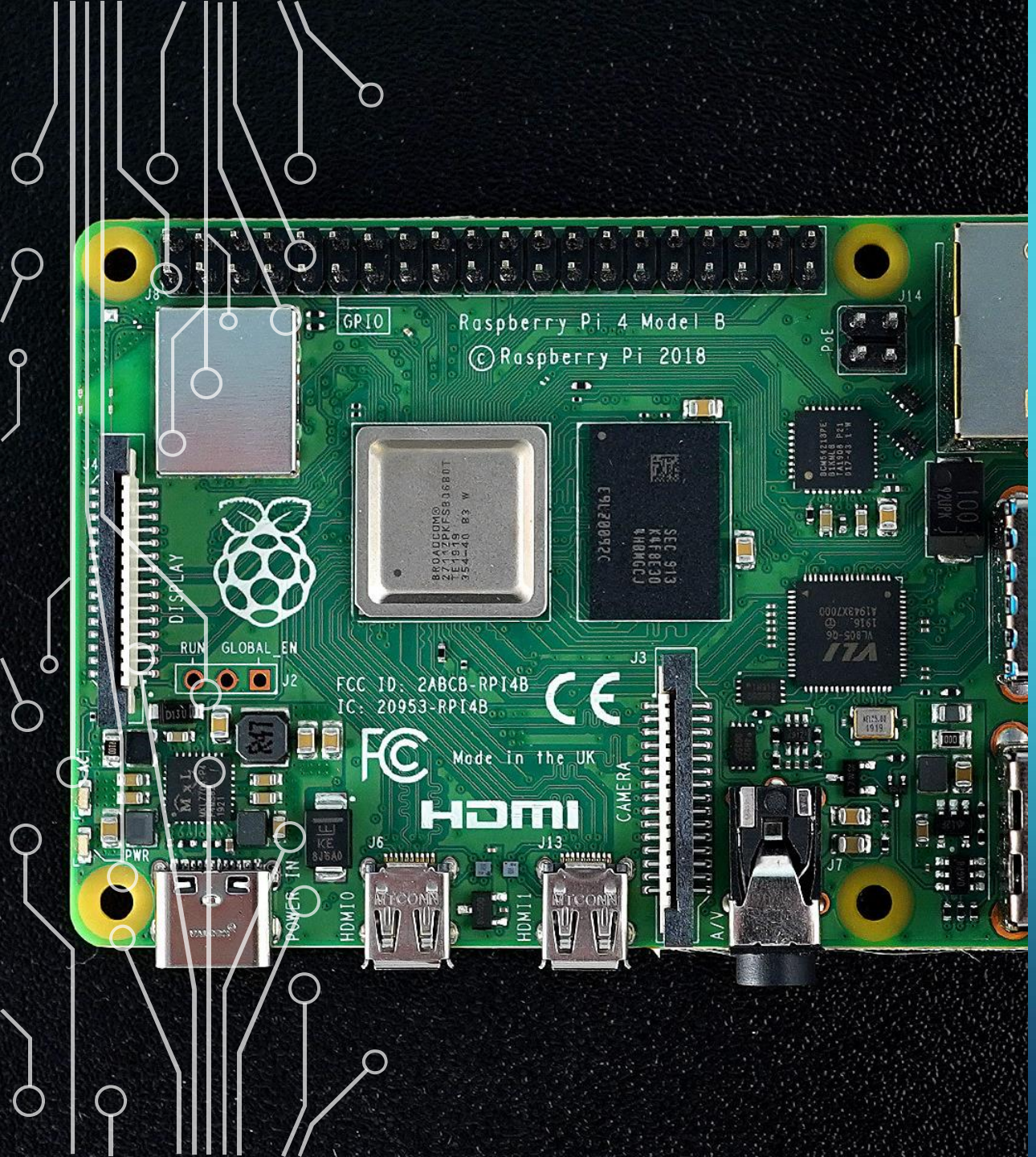
MIPI CAMERA

- MIPI Cameras use MIPI to interface with an operating system
- Typically have low resolution, which makes computing faster, as less space is used to store the photo/frame



JETSON NANO/XAVIER

- Linux OS: Comprehensive JetPack SDK with accelerated libraries for deep learning, computer vision, graphics, multimedia, and more.
- 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
- The Jetson will be used for intermediate processing, as it is much faster than the Raspberry Pi



RASPBERRY PI 4

- Linux (Debian) Operating System
- 64-bit quad core processor running at 1.5GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 5.0/BLE, true Gigabit Ethernet
- More GPIO Pins for electronics control than present on Jetson Nano or the Jetson Xavier
- The Raspberry Pi will be utilized for High level processing

ARTIFICIAL INTELLIGENCE ALGORITHMS

- **Artificial Intelligence** - will be used to detect anomalies (objects out of the ordinary) detected in the video feed
- **Object Recognition** – using pre-existing libraries, detect objects of interest within the video feed
- **Object Type** – objects of interest will be classified accordingly. Anomalous objects will be identified and marked
- **Speed Type** – the speed of objects will be observed. Objects moving at atypical speeds will be marked as anomalous

USER INTERFACE

- Minimal User Interface
- Physical User Interface: the physical user interaction between the physical equipment and the operator. The physical user interface shall feature ethernet, digital, power, and physical inputs that are clearly labeled and be directly accessible to the operator.
- Graphical User Interface: the predominant user interface during the operational stage of the prototype unit. The graphical user interface shall consist of a virtual button panel (VBP), a monitoring panel, and a dynamic input panel.

TEST PLAN

THE OPERATION OF THE SYSTEM SHALL BE CONFIRMED USING A TEST CHECKLIST

TEST REQUIREMENTS

Req#	Function	Requirement	Test Method	Brief Test description
1	Software	The system must detect and differentiate objects from one another	Test	Compare real-time images with control images to recognize anomalies related to the figures shown (ex. strange objects)
2	Software	The system must detect and compare motion by determining their speed	Test	Compare real-time images with the pre-recorded video and compare their velocities to detect anomalies (ex. objects moving at higher speeds than usual)
3	Software	System must display the percentage in certainty when detecting an object / body	Inspection	We will be able to see how accurate the product is when detecting anomalies
4	Software	When the product is plugged in, it must turn on the camera and the detection software	Test	The product must start working as soon as it gets plugged in (since it was previously trained, no internet connection is required)

TEST REQUIREMENTS

Req#	Function	Requirement	Test Method	Brief Test description
5	ME	Raspberry pi board (with USB 3.0 port)	Inspection	We will look at the board and make sure it has at least one (1) USB 3.0 port to plug the camera in
6	ME	Product must stay in place	Test	We will place the product on a steady surface to avoid distortion while analyzing the images
7	ME	All connections must be wired	Inspection	We will visually identify all connections and make sure all wires are plugged correctly
8	EE	Product must provide digital feedback when anomalies are detected	Demonstration	We will send a message with video-proof of the anomaly, including the exact time and date it happened

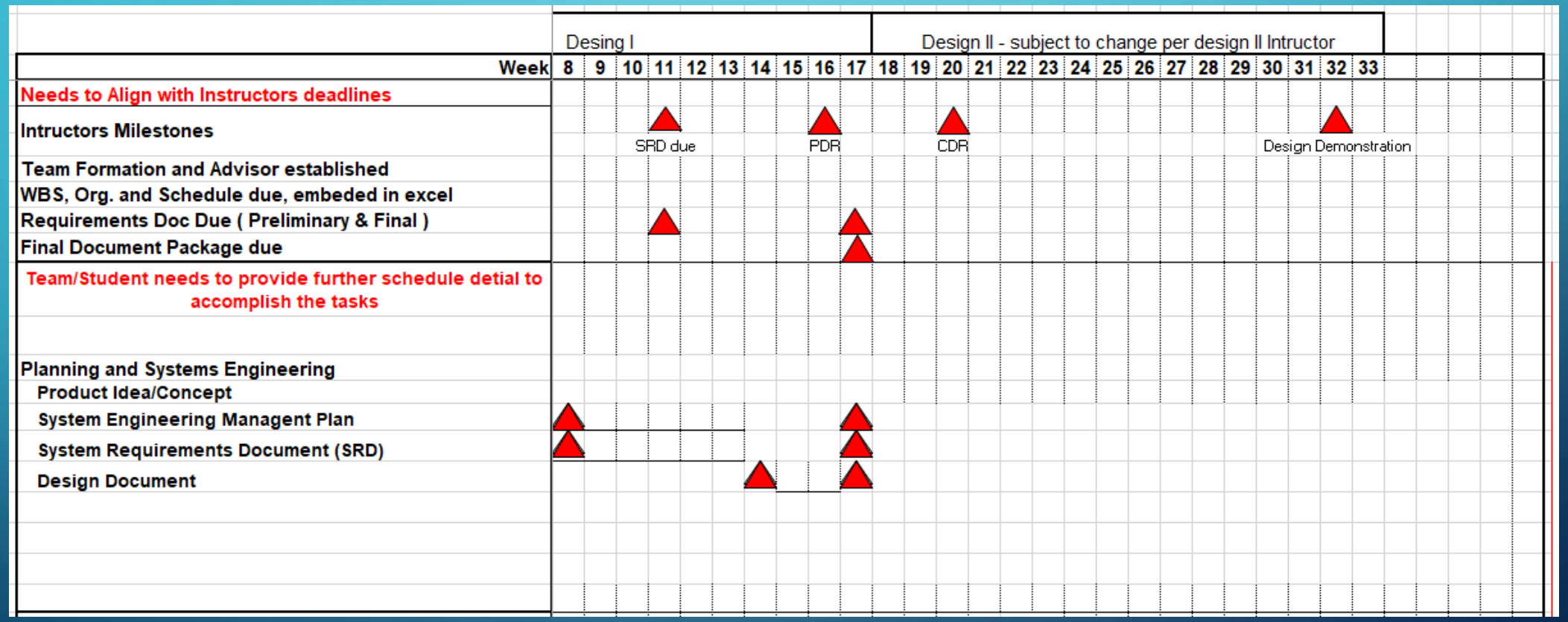
PROJECT RISK FACTOR

- **Risk 1** – Camera Interface – potential issues with data transmission
- **Risk 2** – Computer Processing Power Another risk that this project could encounter is having a computer incapable of performing high speed video processing algorithms.
- **Risk 3** – Computer Memory A final risk to consider is the possibility that a computer will not have the memory space required to perform video analytics.

RISK MITIGATION

- **Risk 1** – Any potential issues with data transfer can be addressed by changing file type.
- **Risk 2** - The Jetson has a proven record of being able to process images and videos at high speed. Resolution may be reduced if the component is observed to have trouble
- **Risk 3** – The memory of both Jetson and Raspberry Pi can be expanded by adding a microSD card of larger size

PROJECT SCHEDULE



BILL OF MATERIALS

Index	Component Name	Quantity	Cost
1	Jetson Nano Dev Kit	1	$149.00
2	Raspberry Pi	1	$119.95
3	PI cam	1	$29.95
4	HDMI Monitor	1	$99.99
5	HDMI Cable	1	$6.50
6	USB Cable	1	$6.99
7	USB Keyboard	1	$10.77
8	USB Mouse	1	$5.99
9	5V/3A Power Supply	1	$7.99
10	5V/4A Power Supply	1	$12.99
11	128gb MicroSD	2	$35.30
12	Jetson Nano Wireless Internet Adapter	1	$18.99
13	Jumper Wires Pack	1	$6.98
14	Ethernet Cable	2	$8.99

REVIEW OF ACTION ITEMS (1/2)

#	Date Created	Originator	Description	Assignee	Original Due Date	Status	Updated Due Date	Status and Closure Comments
1	9/8/2022	Shawn	Arrange Meeting with faculty advisor	ALL	1/23/2018	Closed	1/23/2018	Meet Advisor 2:30 ENB his office
2	9/8/2022	Luke	Meet Faculty advisor	ALL	9/8/2022	Closed	9/8/2022	Introduction to machine learning and new tasks on familiarizing the subject before going forward.
3	9/8/2022	Dr. Yilmaz	Familiarize with Pytorch, Neuro Networks, and classical machine learning approaches	ALL	9/15/2022	Open		Currently all member working on becoming more familiar with NN
4	9/15/2022	Mikel	Establish weekly teleconference/meeting	ALL	9/15/2022	Closed	9/15/2022	Team agreed to meet on weekends online and meet with faculty advisor on Thursdays.
5	9/22/2022	Dr. Yilmaz	Continue learning programming and theory behind AI	ALL	9/29/2022	Closed	9/29/2022	Currently all member working on becoming more familiar with NN
6	9/29/2022	Dr. Yilmaz	Continue learning programming and theory behind AI	ALL	10/6/2022	Closed	10/6/2022	Currently all member working on becoming more familiar with NN
7	10/6/2022	Dr. Yilmaz	Continue learning programming and theory behind AI	ALL	11/4/2022	Closed	11/4/2022	
8	10/6/2022	Shawn	Establish Bill of material	Shawn	11/4/2022	Closed	11/13/2022	Initial list of materials
9	10/6/2022	Luke	Meet to create a definite plan for project	ALL	11/4/2022	Open	11/27/2022	
10	10/6/2022	Mikel	Become familiar with some libraries utilized in Machine Learning Algorithms	Mikel	11/4/2022	Closed	11/11/2022	There are several options that we could use, but we will focus on using Pytorch
11	10/17/2022	Luke	Complete parts 4,7,9,10 of SRD	Luke	10/24/2022	Closed	10/24/2022	
12	10/17/2022	Luke	Complete parts 6, 8 of SRD	Shawn	10/24/2022	Closed	10/24/2022	
13	10/17/2022	Luke	Complete parts 2,3 of SRD	Mikel	10/24/2022	Closed	10/24/2022	

REVIEW OF ACTION ITEMS (2/2)

14	10/17/2022	Luke/Shawn	Get Jetson Nano up and running	Shawn	10/21/2022	Closed	10/17/2022	Jetson Nano OS loaded
15	10/17/2022	Mikel	Explore possibility of utilizing Raspberry Pi	Mikel	10/17/2022	Closed	11/11/2022	Raspberry Pi should be responsible for doing server work and will communicate with the jetson directly
16	10/24/2022	Luke	Load a basic program onto the Jetson Nano	Luke	11/4/2022	Closed	11/11/2022	Loaded basic OpenCV program
17	11/6/2022	Mikel	Explore different cameras and architectures	Mikel	11/12/2022	Closed	11/19/2022	Any USB camera could be used for training the algorithm, but a MIPI camera would be ideal for this project
18	11/6/2022	Luke/Shawn	Create programs and test on Jetson Nano	Shawn	11/21/2022	Open		Pipeline from USB Camera to OpenCV running on linux complete, next step is throwing it into ML
19	11/10/2022	Shawn	Check and service aerial platform	Shawn	11/18/2022	Open		Serviced autopilot, checked motor function
20	11/10/2022	Shawn	Design Camera Enclosure in Fusion/Inventor	Shawn	11/18/2022	Open		
21	11/10/2022	Shawn	Drawing and render for camera Enclosure and	Shawn	11/18/2022	Open		
22	11/10/2022	ALL	Work on PDR and finalize SDR	ALL	11/20/2022	Open		
23	11/16/2022	Luke	Perform image filtering with color masking	Luke	11/20/2022	Closed		
24	11/20/2022	Luke	Get PI CAM	Mikel	11/23/2022	Open		
25	11/20/22	Mikel	Update Bill of Materials	Mikel	11/20/22	Closed		Added more materials and links to websites
26	11/20/2022	Mikel	Start training AI model	Mikel	12/7/2022	Open		Train first AI model to get used to programming language (Python) and libraries (Pytorch)


Questions?