

Social Interactivity Mentor for Youth with Autism using the NAO Robot (SIMYAN)

Design Review

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Project Recap

Objective:

Create a framework for the NAO robot to support future implementation of ASD treatment/intervention activities designed by medical professionals and researchers.

Social Interactivity for Youth with Autism using the NAO robot

- Core SDK
 - Supports advanced social interactivity behaviors
 - Framework for building Activity Modules
 - Orchestrates Activity Module execution
- Social Interactive Drawing Module
 - PoC Activity Module
 - Guides human subject through a drawing exercise
 - Incorporates social interaction

Presentation Overview

- **Proposal Background**
- **Design Trade-Offs**
 - Hardware
 - Software
- **Hardware Selection**
- **Requirements Updates**
- **Design**
 - Schematics and Parts
 - Software
- **Software Progress**
- **Project Schedule**
 - Schedule Updates
 - Remaining Work
 - Gantt Chart
- **Budget**
- **Knowledge Integration**

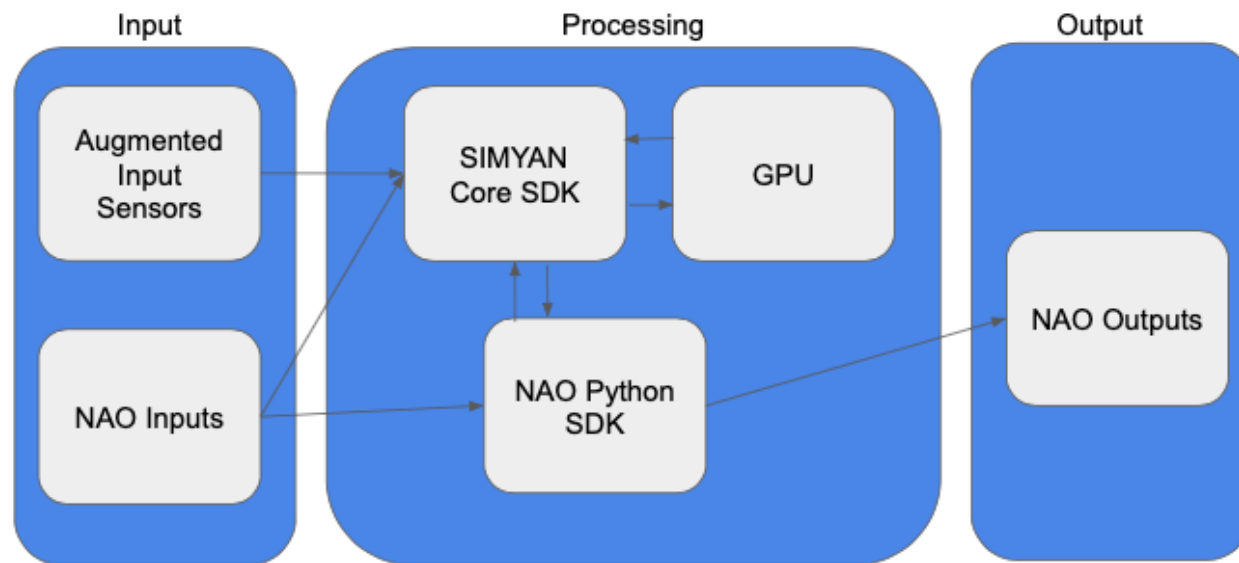


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Proposal Background

System Design

- Hardware System Design
 - Use of Nvidia Jetson Nano to do all real-time image processing
 - Use of LiDAR depth sensor or Xbox Kinect
- Software System Design
 - Using core SDK and existing functionality from NAOqi framework



Proposal Background

Test Plan

1. Unit Testing
2. Integration Testing
3. Demonstration Plan

Development Strategy

Agile Development

Test Driven Development

Paired-Programming

Hardware Design Trade-Offs

Configuration	NAO (no GPU)	NAO + Jetson Nano
Pros	<ul style="list-style-type: none">No additional integration neededSimplifies softwareNo additional hardware to manage	<ul style="list-style-type: none">Can handle image processing loadCan handle machine learning workloadsCan handle additional peripheral video/camera inputsOff-load tasks from NAO processor
Cons	<ul style="list-style-type: none">Cannot handle sufficient image processing loadCannot handle additional peripheral video/camera inputs	<ul style="list-style-type: none">Additional integration requiredRequires software to function in a distributed systemAdds hardware management concerns (power, bandwidth, etc.)

Software Design Trade-Offs

Configuration	Wrap NAOqi SDK	Extend NAOqi SDK
Pros	<p>Condense code needed for SIMYAN activity modules</p> <p>Improve code readability</p>	<p>Decreased team workload</p> <p>Keeping SIMYAN Core SDK simple leaves smaller region for testing and validation</p>
Cons	<p>Increase the size of the SIMYAN Core SDK</p> <p>May require development of modules that are not useful beyond current project</p>	<p>Less modular design</p> <p>Requires activity implementors to know NAOqi SDK</p> <p>Mixing of calls & responsibilities between SIMYAN SDK and NAOqi SDK</p>

Hardware Selection

- **Need two additional pieces of hardware for design**
 - A depth sensor to augment NAO's vision capabilities
 - A GPU/Developer kit to handle all the image/graphics processing
- **Selected depth sensor: Xbox Kinect**
 - Existing examples of it being used with NAO robot
 - Much cheaper than the other options
 - Will be testing to make sure the Kinect can integrate with NAO and provide additional camera accuracy
- **Selected GPU: Jetson Nano**
 - Free from advisor Bill Michael
 - 4GB of ram and 128 GPU cores which will allow us to run complex vision detection algorithms
 - We will be testing GPU using a separate camera feed making sure it can detect objects outside of NAO's camera initially

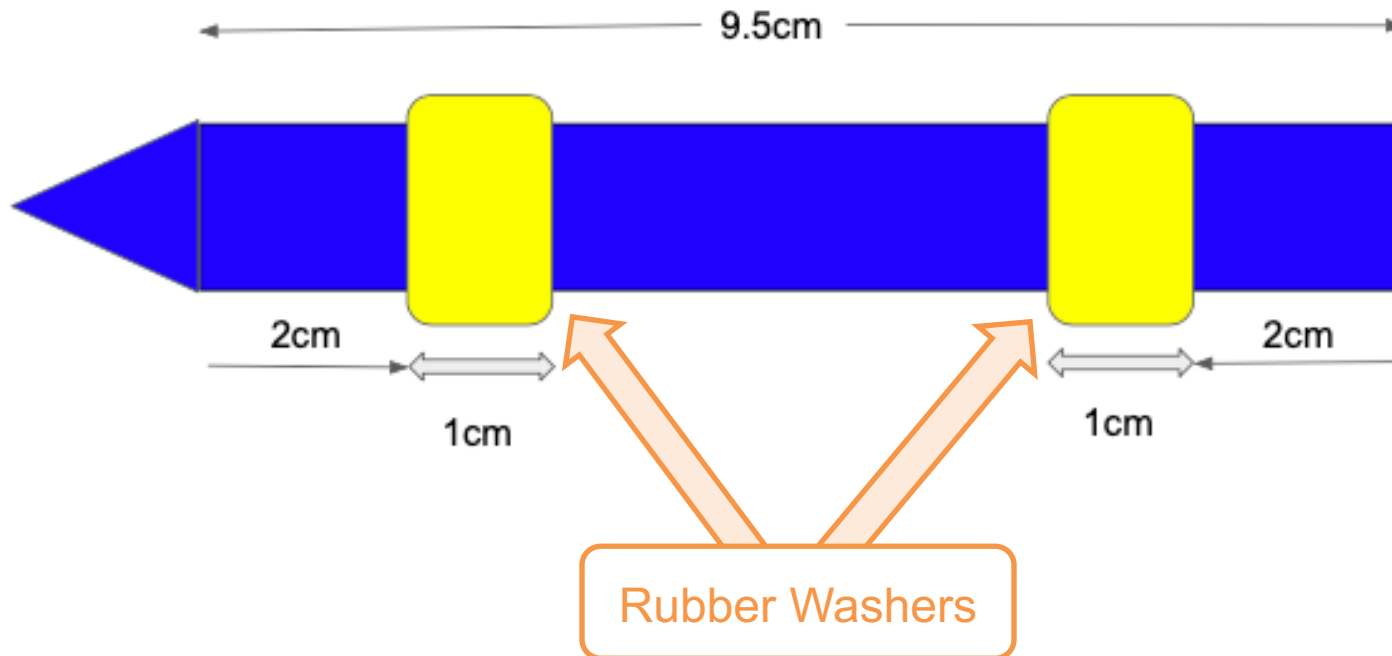
Requirements Updates

- **Eliminated extensions**
 - Most extension features removed
 - Automated Object Drawing Specification Generator added to core feature set
- **Reduced robot autonomy**
 - Marker collection
 - Mobility
- **Wireless connection to Jetson Nano**
 - Power supply needs

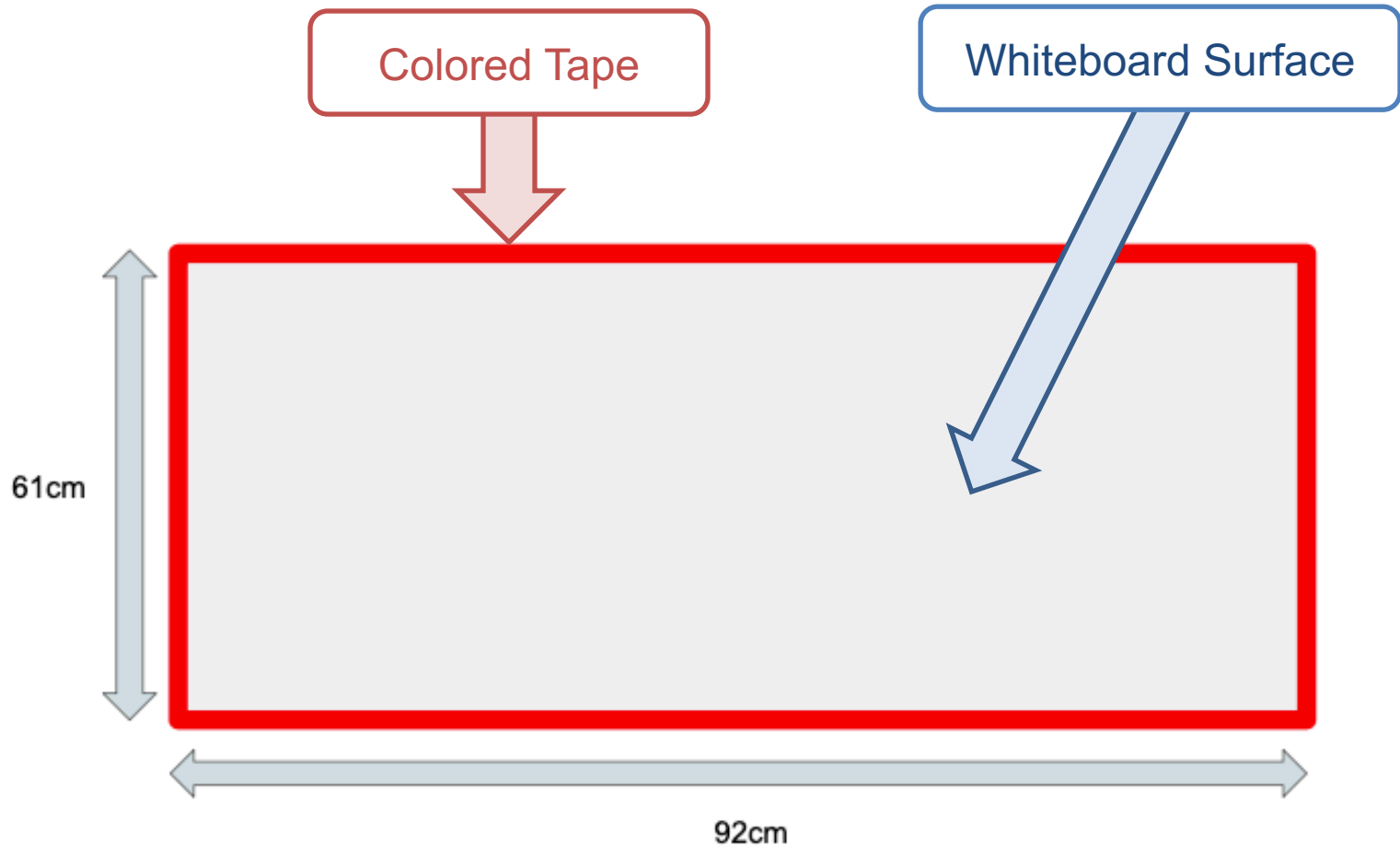
Specification Updates

- **Wireless communication with Jetson Nano**
 - Minimum Transmission Rate: 25 Mbps
 - Wifi card for Jetson Nano
 - No need for GPU "backpack"
- **OpenCV for object detection / tracking**
 - Canny Edge Detection
 - GOTURN
 - CSRT
- **Kinect integration with SIMYAN only – not strictly required for drawing activity**

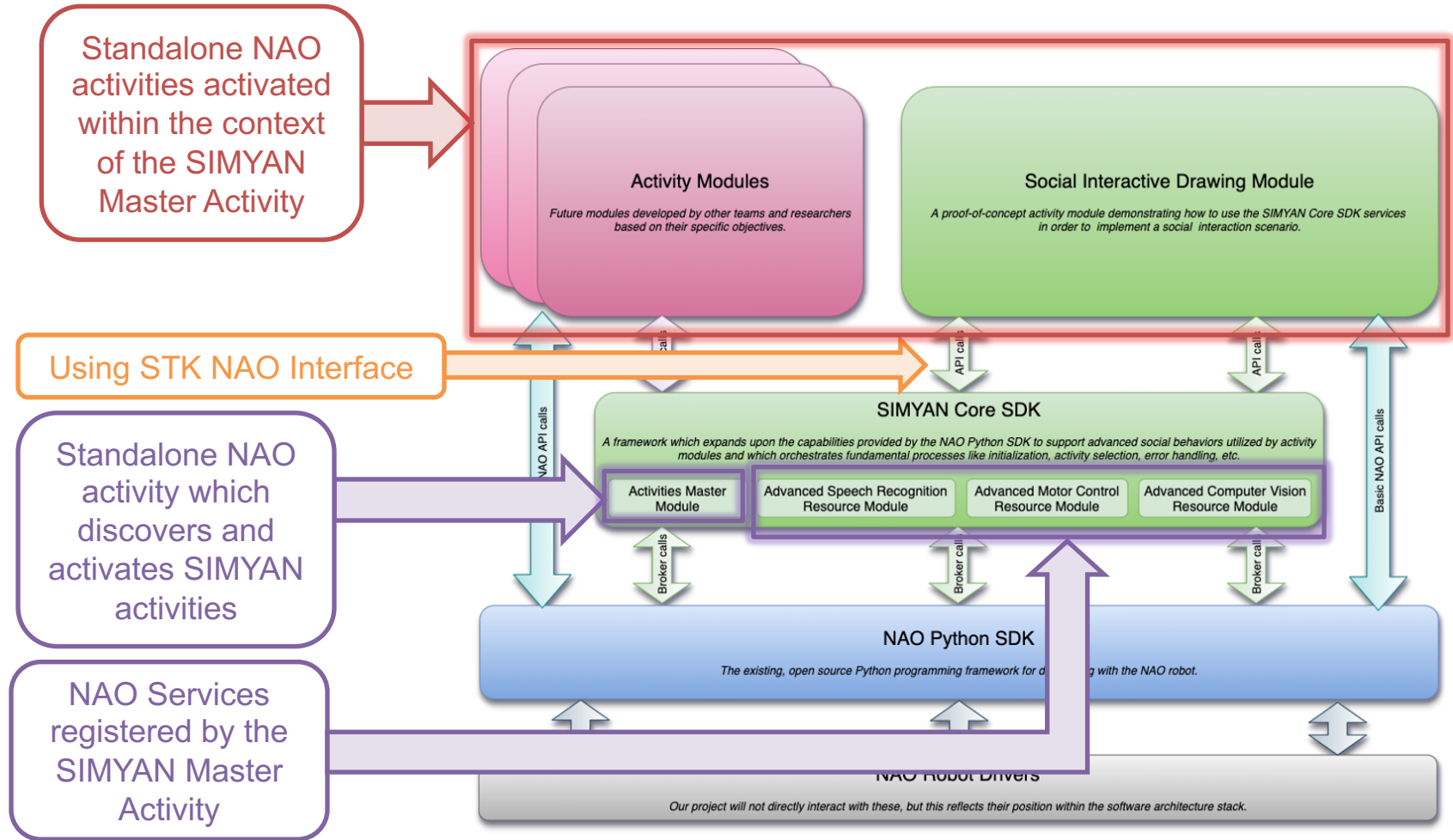
Marker Schematic



Whiteboard Schematic



Software Design



Software Progress

- **Development Tools**

- ***Robot Jumpstarter***

- A repository containing NAO/Pepper project templates, utilities for creating named projects using the templates, and ability to add custom templates

- ***Studio Tool Kit (STK)***

- A set of python scripts which provide a simplified interface for accessing NAOqi resources

- ***qibuild***

- A python-based command line package for bootstrapping, building, and deploying packages to the NAO robot

- **Created, built, and deployed a test Application**

- Application template from Robot Jumpstarter
 - Uses STK
 - Built and deployed using qibuild

- **Core SDK development in progress**

Core SDK Development	Social Interactive Drawing Module Development
Activities Master Module^B <ul style="list-style-type: none"> ➤ Activity Module Loader ➤ Activity Module Manager ➤ Command Recognition Manager Speech Recognition Resource Module^A Advanced Motor Control Resource Module^{AB} Advanced Computer Vision Resource Module^{CW} <ul style="list-style-type: none"> ➤ Jetson Nano GPU Integration^C 	Drawing Activity Command Recognition^A Marker Detection^C Marker Collection^W Marker Handling^B Drawing Surface Detection^C Drawable Object Loader^B Object Drawing Manager^{CW} Social Interaction Manager^{AB} Automated Object Drawing Specification Generator^{BC}

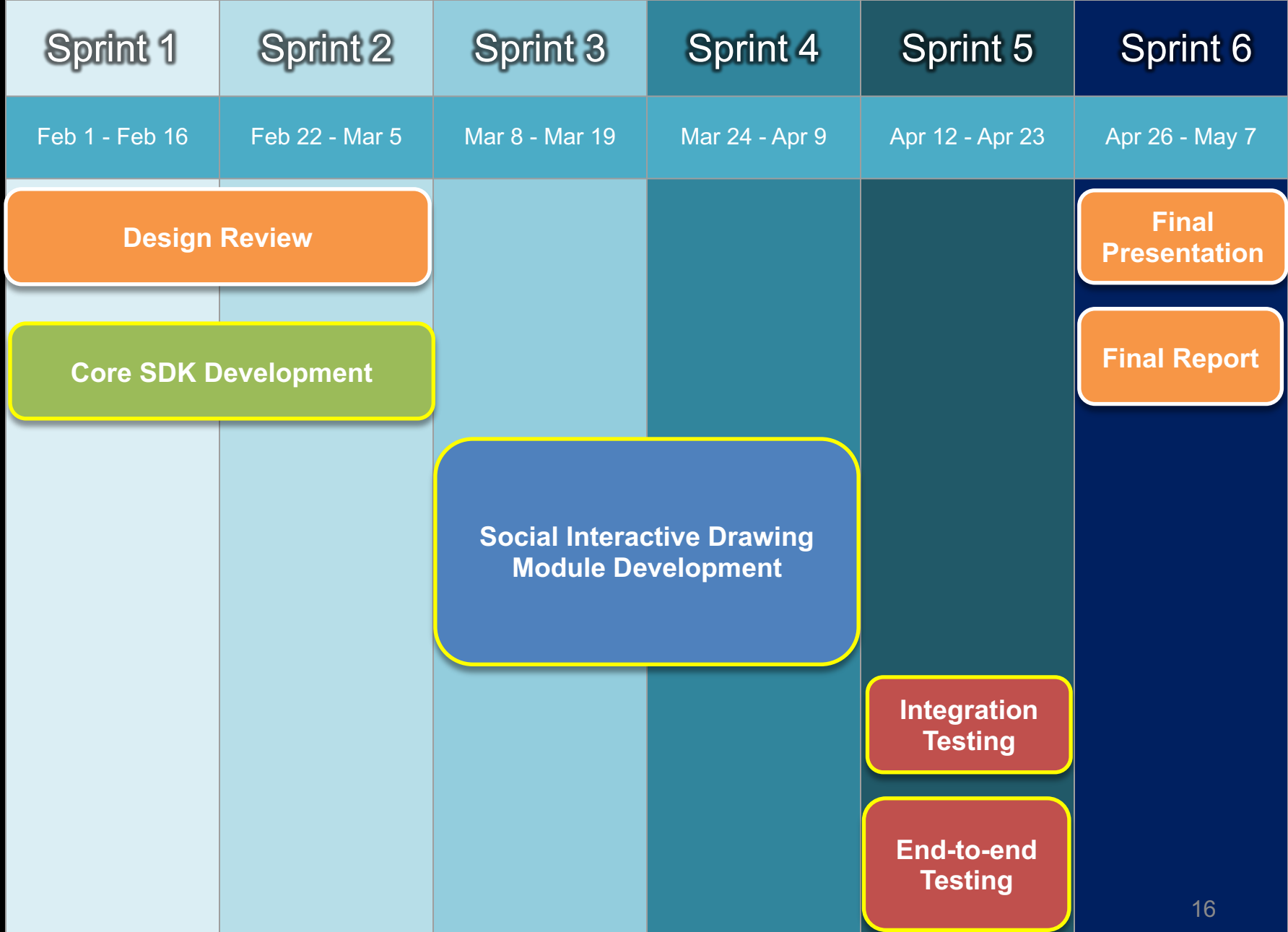
Changes:

Core SDK Extensions and Social Interactive Drawing Module Extensions Epics Dropped (consistent with scope reductions)

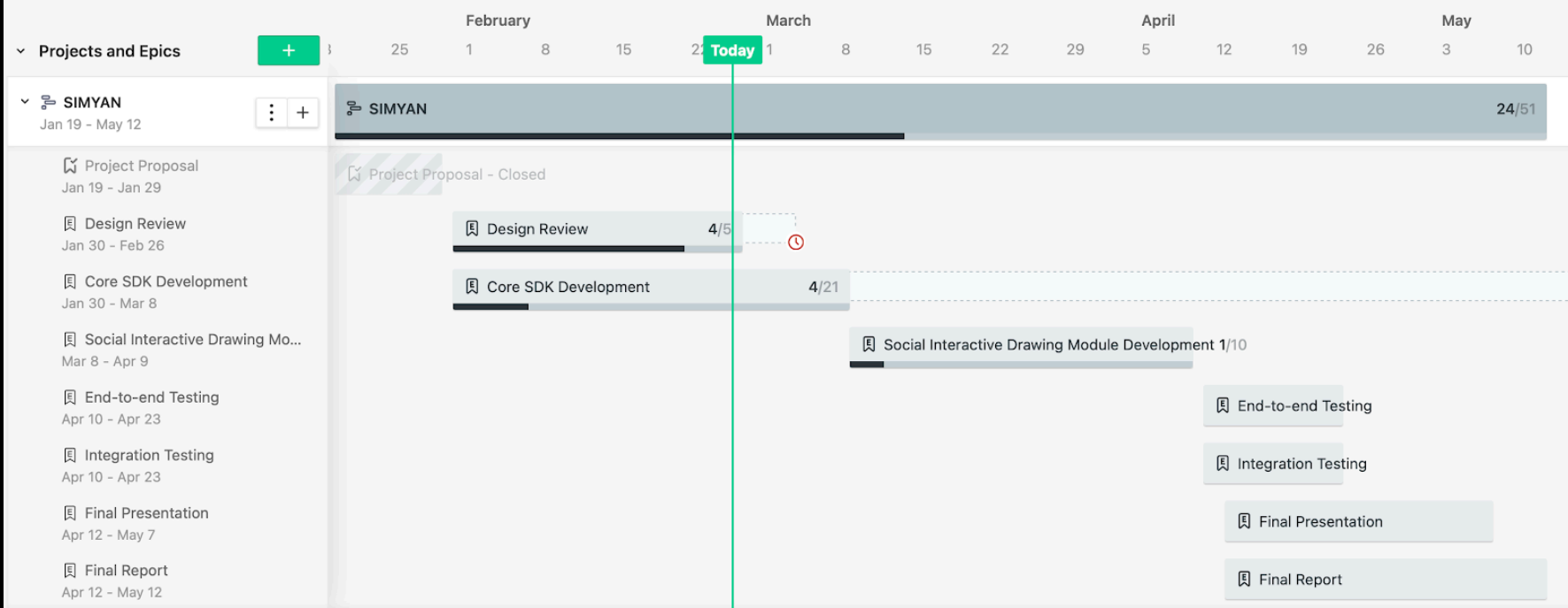
Automated Object Drawing Specification Generator Epic moved to Social Interactive Drawing Module Development

Integration Testing	End-to-end Testing	Final Presentation	Final Report	LEGEND
Run Integration Test Cases *	Run End-to-end Test Cases *	Prepare Final Presentation *	Prepare Final Report *	* – All A – Andrew B – Bryce C – Colton W – Will <i>Italic – In-Progress</i> <i>Superscript = Primary Owner(s)</i>
Fix Failures *	Fix Failures *	Prepare Demonstration *	Deliver Final Report *	
Re-Test Failed Cases *	Re-Test Failed Cases *	Deliver Final Presentation *		

Schedule Updates



Gantt Chart



Core SDK Development extended through end of Sprint 2 (3/5)

Start of Drawing Module Development moved to Sprint 3 (3/8), extended through Sprint 4 (4/9)

Budget

Item	Quantity	Cost per Unit (\$)
Jetson Nano GPU	1	0 (borrowed from advisor Bill Michael)
Realtek RTL8187L Chipset 2000mW Wireless USB Wifi Adapter 54Mbps Card	1	24
Xbox Kinect	1	50
Markers	1+	0 (provided by team)
Whiteboard	1	0 (provided by team)
Rubber Washers	2	5
Total		84
Allowance		400

Knowledge Integration

- **Agile Development**
- **Test Driven Development**
- **System Design and Analysis**
 - Problem Decomposition
 - Requirement Identification
 - Architecture
 - Systems Engineering
- **Machine Learning**
 - Computer Vision
 - Natural Language Processing

Conclusion

- **Deliver a solution that is extensible and will expand the existing capabilities of the NAO robot**
 - SIMYAN Core SDK fulfills this goal
- **Apart from this, we will be using our core SDK to enact a scenario involving drawing with a human**
 - Demonstrate functionality of Core SDK
 - Demonstrate a situation that will promote social interaction between a human and NAO
- **Overall, we are supplementing the NAO architecture to make it more powerful and easy-to-use in future endeavors**

Any Questions?



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