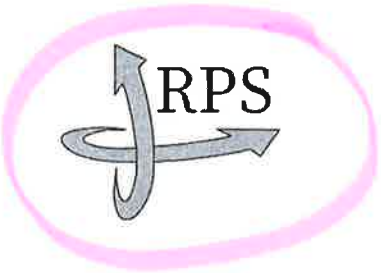
Old Version

Team Objective and Development Overview

19 Sep 2019
Revision 1.1

Tracker for In-Flight Air Vehicle

Project Sponsor:
IMSAR



Capstone Team 15: RPS

Ira A. Fulton College of Engineering
Brigham Young University

Revision History

Revision	Date	Description
1.0	11 Sept 2019	Initial Release
1.1	18 Sept 2019	First Draft for Review

Approval Signatures

The undersigned certify that they have read the stage approval package and approve of the requirements and key success measures contained in it.

Autumn Twitchell	Date
Daniel Sharp	Date
Garret Gang	Date
Jesse Krage	Date
Joe Hansen	Date
Nicholas Merriman	Date
Larkin Hastriter - Team Coach	Date
Daniel Gunyan - IMSAR	Date
Mark Catanzaro - IMSAR	Date
Brian Jensen - Project Instructor	Date

Contents

1 Contact Information

Name	Title	Cell Phone	Email
Autumn Twitchell	EE Student	801-388-5666	atwitch@gmail.com
Daniel Sharp	EE Student	801-888-6053	danielsharp.a@gmail.com
Garret Gang	CE Student	520-333-0168	garretgang@gmail.com
Jesse Krage	EE Student	619-878-4245	jessekrage5@gmail.com
Joe Hansen	ME Student	208-850-7781	1joehansen@gmail.com
Nicholas Merriman	ME Student	385-240-3759	nicholas.merriman95@gmail.com
Larkin Hastriter	Team Coach	937-979-3481	larkinhastriter@yahoo.com

IMSAR Contact Information

Name	Title	Office Phone	Email
Daniel Gunyan	VP Engineering	801-798-8440	dgunyan@imsar.com
Mark Catanzaro	Field Tester	801-798-8440	markc@imsar.com

2 Project Background

IMSAR is a local company based out of Springville, UT, that specializes in making compact radar systems more affordable and accessible for use in small air vehicles. Since their conception in 2004, they have fulfilled multiple contracts with the Department of Defense and have developed radar systems with applications ranging from fighting fires to detecting enemy troop movements.

One of the systems currently produced and sold by IMSAR is a computer-controlled tilt and pan positioner that maintains a communication link with radar units installed on air vehicles. The current design employs a tilt and pan positioner that has become obsolete. The goal of this project is to replace the tilt and pan positioner, install an onboard computer, and to improve upon the current design. The current design requires that the data processing be done remotely on an external machine and has a barely passable user interface. Our final design will eliminate the need for external data processing. Challenges include integrating a new onboard control computer, control system oscillation, and proper handshaking between subsystems. The new system will be tested against IMSAR's drones flying in the vicinity and be validated by tracking the drone with a camera mounted to the tracking system.

Figure added

3 Project Objective Statement

The team will design, prototype, and test a radar positioning system that can track in-flight vehicles while maintaining visual contact by March 30th for under $1,500 USD and 1,500 man hours.

4 Project Approval Matrix

Development Stage	Expected Completion Date	Artifacts Required for Approval	Budget
Opportunity Development	19 Sept 2019	Team Objective and Development Overview, System Requirement Matrix with sections A-D completed, Requirement Validation	$5
Concept Development	4 Dec 2019	Written and Visual Definition of Concept, Concept Selection Report, Requirements Matrix with Target Values, Revised TODO, Concept Testing Reports	$400
Architecture Review	10 Jan 2020	System Architecture Document, System Requirements Matrix, Architecture Justification Document	$5
Subsystem Engineering	14 Feb 2020	System Design Package, System Requirements Matrix, Measured and Predicted Performance Summary	$400
System Refinement	27 Mar 2020	Written and Visual Description of Design, Performance Summary, System Requirements Matrix	$200
Final Reporting	2 Apr 2020	Fully Transferable Design, Functioning Prototype, Final Capstone Report	$300

An additional $190 is left as a discretionary fund to be applied as needed.

5 Key Success Measures

Measure	Stretch Goal	Excellent Performance	Good Performance	Fair Performance	Lower Limit	Ideal	Upper Limit
Pointing Update Rate	N/A	5 Hz	4 Hz	3 Hz	2 Hz	> 2 Hz	N/A
Percent of time drone is in field of view	100%	>98%	>95%	>93%	>90%	100%	N/A
Interface ease of use	N/A	Use is self-evident to technician	Usable with minor training	Usable, requires consulting notes	Usable but somewhat difficult	Self-evident to the technician	N/A
Health message broadcast rate	N/A	8 Hz	5 Hz	2 Hz	1 Hz	2 Hz	10 Hz
On-board computer	N/A	On-board computer stores data and handles all functions. Can be accessed through ethernet cable.	N/A	N/A	On-board raspberry pi sends and receives data from external computer.	On-board computer stores data and handles all functions. Can be accessed through ethernet cable.	N/A

The key success measures shown above were chosen to help determine the desirability of the radar posititioning system. The team decided on these measures by discussing and determining which of the requirements in the requirements matrix are most vital to project success. The primary objective of this project is to maintain a communications link with the drone in flight. This will be tested using a camera and determining the percent of time the drone is in the field of view. This measure has been identified to be the most important and has therefore been assigned a stretch goal.

6 Summary of Requirement Validation

In order to validate our requirements matrix we maintained close contact with IMSAR. We discussed our first draft with Daniel Gunyan (VP of engineering, IMSAR), received feedback from him and established the primary requirements. We discussed our 3rd draft with Mark Catanzaro (Verification Engineer) and did some major revisions on the Requirements Matrix.
After those revisions we sent Mark an email of our 4th draft. Mark and Daniel went over our 4th draft, added a couple of minor requirements, adjusted the wording and limits of a couple of the requirements. We now have our current requirements matrix approved by Daniel and Mark. Our Key Success measures were taken from the requirements matrix. See REQ-002.

7 Change Management Procedure

When it is determined that the TODO requires a revision, an engineering change order must be filled out. See ECO-000.the proposer will be the ECO owner. The proposer should include a description and justification of the proposed changes. The class of change should be indicated as "A".

A completed copy of the ECO and TODO will be presented to the members of the team. When team feedback is implemented a completed copy will be sent to contacts at IMSAR for approval. For the proposed changes to be approved and implemented three signatures are required: The capstone team leader, the capstone pod instructor, a representative from IMSAR. Once the ECO is approved the proposed changes will be made to the TODO, and the revision history table filled out. If the ECO is rejected, no changes will be made.

Primary Artifacts

RM-001 Requirements Matrix
RV-001 Requirement Validation
CHA-001 Team Charter

Artifact ID	Artifact Title
RM-001	Requirements Matrix

Revision:	Date:
1.4	9/18/2019

Team: 15

Prepared By: Mark

Checked By: Daniel Gunyan

	Market Requirements		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Market Ratings: Rating	Market Ratings: Artifact ID
	Performance Measures		Receives LLA (from Radar) and GPGGA from ethernet	Percent of time in FOV (Excluding wrap time, and rates of angular change e	Health Message Broadcast Rate	Pointing Update Rate	Simple and Complete UI	Hardware Fits Inside of Current Weather Resistant Case	Control Processor, capable of acting as a server	Meaningful Control of Status LED Indicators	Meaningful Control of Error LED Indicators	Follows IMSAR's Coding Standard	Fits In Communication Link Mount	Input Acceptance Rate	Save and read configuration settings to/from onboard non-volatile memor	Automatically resume proper operation upon power being restored						
	Units		P/F	%	Hz	Hz	N/A	P/F	P/F	P/F	HZ	N/A	P/F	Hz	N/A	N/A						
1	ethernet		X																			
2	Keep drone in camera field of view			X																		
3	Health message updates				X																	
4	Position Updates target location Based on Input					X								X								
5	Easy user interface						X															
6	Weather Resistant Protective Hardware Case							X														
7	On-board Computer								X													
8	LED Status Update									X	X											
9	Follow IMSAR Coding Standard											X										
10	Properly damped			X																		
11	Camera Mount Adapter												X									
12	Storeable configuration														X							
13	Survive power outages															X						
	Importance (optional)	5																				
	Ideal Values: Lower Acceptable Limit		N/A	90%	1 Hz	2 Hz	N/A	Design New Box	N/A	N/A	N/A	N/A	N/A	2 Hz	N/A	N/A						
	Ideal Values: Ideal		P	100%	2 Hz	N/A	TRUE	Yes	TRUE	TRUE	TRUE	TRUE	TRUE	2Hz	TRUE	TRUE						
	Ideal Values: Upper Acceptable Limit		N/A	N/A	10 Hz	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						
	Target																					
	Stretch																					
	Real Values: Predicted: Artifact																					
	Real Values: Predicted: Value																					
	Real Values: Measured: Artifact																					
	Real Values: Measured: Value																					

Revision History

Rev.	Date.	By	Approval	Description	ECO
1.0				Initial release	
1.1	9/11/2019	Nick		Added 5 additional market requirements	
1.2	9/13/2019	Joe	Garret	Added additional market specifications	
1.3	9/17/2019	Garret	Joe	Update After Face to Face With Mark and Daniel	
1.4	9/18/2019	Mark	Daniel Gunyan	Reviewed and edited by IMSAR	

Artifact ID:	Artifact Title:
REQ-002	Requirements Validation Email
Revision:	Revision Date:
01	19 SEP 2019

Prepared by:	Checked by:
Garret	Daniel

Purpose:
Show the approval from IMSAR of our current requirement matrix

Revision History			
Revision	Revised by	Checked by	Date
01	A.Garret	B. Daniel	19 SEP 2019

Gmail

Garret Gang <garretrgang@gmail.com>

Updated Requirements Matrix

Daniel Gunyan <dgunyan@imsar.com> Wed, Sep 18, 2019 at 3:07 PM
Reply-To: dgunyan@imsar.com
To: Garret Gang <garretrgang@gmail.com>
Cc: Mark Catanzaro <markc@imsar.com>

We made some adjustments, additions, and revised it to 1.4. Here is the latest. Two new market requirements were added, and minor modifications to existing requirements, measures, and limits.

-
Daniel Gunyan

Team 15 Requirements Matrix(2).xlsx
18K

*no changes were made to team charter

Team Charter for RPS

BYU
CAPSTONE

Based on CATME Team charter, www.catme.org

Artifact ID: CHA-001	Artifact Title: Team Charter		
Revision: 1.1	Revision Date: 17 SEPT 2019		
Prepared by: Garret Gang		Checked by: Daniel Sharp	
Purpose: Set rules of operation for the team.			

Revision History			
Revision	Revised by	Checked by	Date
1.0	Garret Gang	Daniel Sharp	17 SEPT 2019
1.1	Garret Gang	Daniel Sharp	19 SEPT 2019

Team Member Names	**Contact Information (e-mail, cell, Facebook, etc.)**	**Preferred Contact Method / Limitations (ex. no calls after...)**
Autumn Twitchell	atwitch23@gmail.com 801-388-5666	Text/call/email whatever/whenever!
Daniel Sharp	danielsharp.a@gmail.com 801-888-6053	Text, call if necessary. Email if documents are included.
Garret Gang	GarretRGang@gmail.com 520-333-0168	Call if it needs my immediate attention. Otherwise text/email whenever.
Jesse Krage	jessekrage5@gmail.com 619-878-4245	Call/text/email unless after 9pm
Joe Hansen	1joehansen@gmail.com 208-850-7781	Call, text, email whenever
Nick Merriman	nicholas.merriman95@gmail.com 385-240-3759	Call if emergency. Text/email whenever.

Team Member Names	Strengths related to teamwork and the team's assigned task.	Weaknesses related to teamwork and the team's assigned task.
Autumn Twitchell	Organization, inclusive	Easily distracted, go-with-the-flow personality
Daniel Sharp	Organized, views big picture before jumping in, hard working, open communication.	Easily stressed if unorganized.
Garret Gang	Programming, Debugging, System Analysis	Difficulty Giving up on my own Ideas. A little too introverted
Jesse Krage	Take critique a instructional/motivating	Give in to other's ideas before my own
Joe Hansen	Personable and good at interacting with others. Team player.	Organization / Motivated by deadlines
Nick Merriman	Finishing tasks ahead of time, detail oriented	Willingness to delegate tasks

1. What are your team's goals for the collaboration?

These should relate to the team's performance on the project as well as the processes that the team will follow to complete the project. What are your team's expectations regarding the quality and timeliness of the team's work?

Strive for excellence – no excuses.
Make it work – then make it pretty.
Share your opinion.
Accept all feedback.
Team success trumps individual pride.
Judge ideas by quality not quantity of support. (Just say no to group think)

2. Who is responsible for each activity? What roles will each member have?

Don't forget to include logistical tasks, such as arranging meetings, preparing agendas and meeting minutes, and team process roles, such as questioning (devil's advocate), ensuring that everyone's opinion is heard, etc.

Autumn Twitchell – Coordinator/Scheduling
Garret Gang – Scribe/Weekly Updates
Joe Hansen – Team Rep/Sponsor Communication
Daniel Sharp – Team Leader/Keeps in touch with group
Nick Merriman – Co-Leader
Jesse Krage – System Engineer

3. What is your timetable for activities?

(Due dates, meetings, milestones, deliverables from individuals, if appropriate)

Weekly standup meeting to report on progress every Tuesday at 8 am.
Agenda goes out the day before meeting from Co-Leader. Edits to agenda need to be submitted by the day before the agenda goes out.

4. What are your team's expectations regarding meeting attendance (being on time, leaving early, missing meetings, etc.)?

All members of the team will attend meetings unless prior notice is given (2-3 days).
Team members will arrive on time, and stay for the duration.

5. What constitutes an acceptable excuse for missing a meeting or a deadline? What types of excuses will not be considered acceptable?

Personal Emergency - with notification as soon as possible.
Prearranged absence – does not excuse a missed deadline.
Missing a deadline for non-emergency meetings, is not acceptable.
Non-Emergency excuses are a not acceptable.

6. What process will team members follow if they have an emergency and cannot attend a team meeting or complete their individual work promised to the team (deliverable)?

Send a text out on the group chat ASAP.

7. What are your team's expectations regarding the quality of team members' preparation for team meetings and the quality of the deliverables that members bring to the team?

Deliverables should work, and be easy to integrate into their subsystem.
Ask for help if you need it getting a deliverable in.

8. What are your team's expectations regarding team members' ideas, interactions with the team, cooperation, attitudes, and anything else regarding team-member contributions?

Each team member should feel free to share their ideas, especially if they go against the general consensus, but they should list in what ways their suggestion is better.

9. What methods will be used to keep the team on track?

How will your team ensure that members contribute as expected to the team and that the team performs as expected? How will your team reward members who do well and manage members whose performance is below expectations?

Agile Milestones On Trello. Subdivide tasks into tickets, assign each ticket to a person.

Assign Subsystem Leads, Subsystems Leads follow up with subsystem team members. Team Lead follows up with Subsystem Leads.

Supporting Artifacts

REQ-001 Requirement Justification Breakdown
ECO-000 Engineering Change Order

Artifact ID:	Artifact Title:
REQ-001	Requirement Justification Breakdown
Revision:	Revision Date:
1.0	13 SEPT 2019
Prepared by:	Checked by:
Garret Gang	Jesse Krage
Purpose:	
Explain the meaning and reasoning behind each requirement	

1. Revision History

Revision	Revised by	Checked by	Date
1.0	Garret	Jesse	13 SEPT 2019

2. References

Artifact ID	Revision	Title
RM-001	1.4	Requirement Matrix

3. Requirement Breakdown

Requirement	Breakdown
Receive LLA inputs from radar	IMSAR's current Radar health message provides updates on its targets positioning through LLA (longitude, latitude, altitude) updates. Our system must be able to use LLA inputs to target the correct location
Receive GPGGA from ethernet	GPGGA is a standard communication protocol for providing longitude/latitude/altitude information. IMSAR uses this method for their clients to provide LLA information to their system. Therefore our system needs to be able to interpret GPGGA messages and extract the LLA information in order to properly update the positioners target location.
Drone in field of Vision	We are creating a communication positioning link in constant communication system which allows drones/airplanes to stay in touch with a ground based platform over a long distance. As this can be difficult to verify, we are using a camera with a limited field of view(FOV) to simulate the limited FOV of the communication antenna.
Pointer vector status message updates every ½ a second	The radar system sends a status message every ½ second that contains a vector of where the positioning system is pointing.
Motor updates according to input every ½ second	Due to the average distance the positioning system is used, and the limitations of the gimbal, trying to update the facing of the communication link more than 2x a second is not recommended.
Easy User Interface	This system will be accessed by the User once to set it up. The setup interface therefore needs to be simple and easy to use so that our user can get it done right the first time.
On-board Computer-Rasberry Pi	IMSAR wants the positioning system to be capable of determining where it should face from a given LLA, using an

	onboard computer, instead of an external computer as they currently use.
LED Status Update	Having LEDs that let the user know the system is working can be helpful.
All Weather Case compatibility	IMSAR currently has an all-weather case and would prefer that we design our hardware to fit inside of their current case.
Follow IMSAR Coding Standard	By following IMSAR's coding standard our project becomes easily transferable to them.
Well Damped PID controller	We will use a proportional-integral-derivative (PID) feedback loop to predict where the radar system needs to point. So that we position the radar to point at where the airplane is rather than where it was. If the feedback loop is overdamped, the positioning system will always lag behind the target, which is an undesirable behavior. If the feedback loop is overdamped the positioning system will bounce back and forth constantly, which is also undesirable behavior.

ENGINEERING CHANGE ORDER

ECO #: _____ **EFFECTIVE DATE:** _____

ECO OWNER: _____ DATE: _____

PRODUCT: _____ DESC: _____

ENG CHANGE NOTICE (ECN) REQUIRED? ☐ YES ☐ NO
IS CUSTOMER APPROVAL REQUIRED? ☐ YES ☐ NO
IS REGULATORY APPROVAL REQUIRED? ☐ YES ☐ NO

Pre-Production ECO: ☐ YES
Release ECO: ☐ YES

DOCUMENT #	FROM REV	TO REV		PART #	FROM REV	TO REV

REASON FOR CHANGE AND IMPACT:

DISPOSITION CODES

CLASS OF CHANGE		EXISTING PARTS		EFFECTIVITY	
A	RECORD	1	USE	E	NEXT BUILD
B	2 WAY INTERCHANGEABLE	2	REWORK	F	NEXT PURCHASE
C	1 WAY INTERCHANGEABLE	3	RETURN TO VENDOR	G	PER SALES ORDER
D	NON-INTERCHANGEABLE	4	SCRAP	H	MANDATORY
				I	MANDATORY W/RETURN

CODE: DESCRIPTION OF CHANGE:

C1F Implement when existing stock has been consumed ← Example Code

ECO APPROVAL:

☐ ECO Board Rep.: _____
☐ Manufacturing Rep.: _____
☐ Procurement Rep.: _____
☐ Sales Manager: _____
☐ Supplier: _____

☐ Engineering Rep. _____
☐ Quality Rep. _____
☐ Purchasing Rep _____
☐ Sustaining Manager _____
☐ _____

New Version

Team Objective and Development Overview

2 Oct 2019
Revision 1.5

Tracker for In-Flight Air Vehicle

Project Sponsor:
IMSAR

Capstone Team 15: RPS

Ira A. Fulton College of Engineering
Brigham Young University

Revision History

Revision	Date	Description
1.0	11 Sept 2019	Initial Release
1.1	18 Sept 2019	First Draft for Review
1.2	30 Sept 2019	Second Draft, Updated based on feedback from Design Review
1.3	1 Oct 2019	Updated based on feedback from Brian Jensen
1.4	2 Oct 2019	Fixed Typos, and made major updates to requirements matrix, rewrote key success measures based on feedback
1.5	3 OCT 2019	Rewrote Key Success Measures based on a phone meeting with Mark

Approval Signatures

The undersigned certify that they have read the stage approval package and approve of the requirements and key success measures **contained in it.**

Autumn Twitchell	3 Oct 19 Date
Daniel Sharp	3 Oct 19 Date
Garret Gang	3 Oct 19 Date
Jesse Krage	3 Oct 19 Date
Joe Hansen	3 Oct 19 Date
Nicholas Merriman	3 Oct 19 Date
Larkin Hastriter - Team Coach	3 Oct 19 Date
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Mark Catanzaro	Verification Engineer	801-798-8440	markc@imsar.com

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One of the stationary ground systems currently produced and sold by IMSAR is a computer-controlled tilt and pan positioner that maintains a communication link with radar units installed on air vehicles. The operational situation for these units is to be in a stationary position 2 to 20 miles away from the target in-flight vehicle. The current design employs a tilt and pan positioner that has become obsolete. The goal of this project is to replace the tilt and pan positioner, install an onboard computer, and to improve upon the current design. The current design requires that the data processing be done remotely on an external machine and has a barely passable user interface. Our final design will eliminate the need for external data processing. Challenges include integrating a new onboard control computer and proper handshaking between subsystems. The new Radar Positioning System (RPS) will be tested against IMSAR's drones flying in the vicinity. We will validate system functionality by tracking the drone with a camera mounted to the tracking system. IMSAR will provide the positioning gimbal, and as such designing a positioner is not within the scope of our project.

Figure 1: Current IMSAR Positioning System

3 Project Objective Statement

The team will design, prototype, and test a Radar Positioning System (RPS) that can track in-flight vehicles while maintaining visual contact by March 30th 2020 for under $1,500 USD and 1,500 man hours.

4 Project Approval Matrix

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Final Reporting	2 Apr 2020	Fully Transferable Design, Functioning Prototype, Final Capstone Report	$300

5 Key Success Measures

Measure	Stretch Goal	Excellent Performance	Good Performance	Fair Performance	Lower Limit	Ideal	Upper Limit
Time to Train User	N/A	5 minutes	10 minutes	20 minutes	N/A	5 minutes	30 minutes
Percent Increase in Target Aquistion Time from Minimum Aquistion Time	10%	20%	30%	40%	N/A	0%	50%
Initial Setup Time	2 minutes	5 minutes	7 minutes	9 minutes	N/A	2 minutes	10 minutes
Reaquisition Time After Power Outage and Comunication Link Reboots	10 seconds	20 seconds	40 seconds	120 seconds	N/A	0 seconds	180 seconds

The key success measures shown above were chosen to help determine the desirability of the radar posititioning system. They will distinguish our design from a basic, functioning design. By achieving excellence in our key success measures we expect to exceed the customer's expectations. The team feels that these goals define our highest quality of work. Our key success measures account for the major flaws in IMSAR's current system. The user interface and setup time have caused the most issues for IMSAR and as such they drive our key succes measures. Reasoning for our defined measurements is given below.

The interface is currently barely usable and by running a survey and testing the interface with market representatives we intend to deliver an interface that does not require extensive training. It also takes a long time (10 minutes) to setup the RPS on site, due to the complexity of entering the data to control the RPS. We aim to reduce this by making it easier to enter the information and by improving the usage of non-volatile memory. The usage cases of IMSAR's radar units specify that every second matters when reacquiring the communication link. We intend to greatly reduce this time by implementing predictive tracking that can operate, even if the RPS has a loss of power. Mark was supportive of these key success measures and he participated in a team call in which we decided these key success measures (see NOTE-003).

6 Summary of Requirement Validation

The requirements matrix (see REQ-001 artifact) is a result of direct feedback from IMSAR's VP of Engineering, Daniel Gunyan, and Project Engineer Lead, Mark Catanzaro. In our first meeting with Daniel, we learned more about the scope of the project, and generated a rough outline of market requirements and some performance measures. After that meeting, we drafted the first iteration of our requirements matrix that we presented in person to Mark the following week. As part of this meeting with Mark, we were able to see the current system in use, and address a variety of questions (see NOTE-001). After our discussion, Mark made minor changes to our performance measures, and gave us approval for the matrix via email (see REQ-002).

Since gaining Mark's initial approval, we have made changes to both the market requirements and the performance measures for improved clarity and measurability. We have stayed in contact with Mark via phone calls and emails during the revision process. In our most recent discussion with Mark, we went over our key success measures and he approved of them (see NOTE-003).

7 Change Management Procedure

When it is determined that the TODO requires a revision, an engineering change order must be filled out (See ECO-000). The proposer will be the ECO owner. The proposer should include a description and justification of the proposed changes.

A completed copy of the ECO and TODO will be presented to the members of the team. When team feedback is implemented a completed copy will be sent to contacts at IMSAR for approval, after IMSAR's approval we will send the revision to Dr. Jensen for approval. For the proposed changes to be approved and implemented three signatures are required: The capstone team leader, the capstone IMSAR's a pod instructor, and a representative from IMSAR. Once the ECO is approved the proposed changes will be made to the TODO, and the revision history table filled out. If the ECO is rejected, no changes will be made.

Primary Artifacts

RM-001 Requirements Matrix

REQ-002 Requirement Validation

CHA-001 Team Charter ← only included in old version since there were no changes made

Artifact ID	Artifact Title
RM-001	Requirements Matrix

Revision:	Date:
1.8	10/2/2019

Team:
15

Prepared By:
Nick

Checked By:
Garret

Definitions:

Onboard: This defines that an object is housed locally on the radar unit. The object is attached directly to the unit. Or in the case of software, it is run without any external processing.

Trigger: Refers to an event which is intended to cause an LED to flash. These include system health status indicators, successful data transmissions, and error indicators.

System: This refers to the entirety of our deliverable, i.e. the onboard computer, the positioner, the camera mount, and the software.

Market Requirements	Importance (optional)	1	2	3	4	5	6	7	8	9	10	11	13	14	15
Performance Measures		Input acceptance rate of LLA and GPSGAL	Percent of time in FOV (Excluding wrap time and acquisition time)	System health message output rate	Gimbal pointing update rate	Time to train a user how to use the user interface	Total computer hardware length	Total computer hardware width	Total computer hardware height	Percent of false/missed triggers presented by LEDs	Percent increase in target acquisition time from minimum acquisition time.	Processing is done onboard	Settling time of positioner	Offset measured at drone caused by camera mount tolerances	Initialization time after reboot (including power failure)
Units		Hz	%	Hz	Hz	min	mm	mm	mm	%	%	T/F	s	%	s
1	System computer communicates through Ethernet	X		X											
2	System tracks in-flight vehicle		X		X						X		X		
3	System provides frequent status updates			X						X					
4	User interface is intuitive and requires minimal training					X									
5	Onboard computer fits in existing housing						X	X	X			X			
6	Computer stores previously configured settings										X	X			X
7	Camera can be mounted to antenna mount													X	

Ideal Values		1	2	3	4	5	6	7	8	9	10	11	13	14	15
	Lower Acceptable Limit	2	100%	2 Hz	2 Hz	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Ideal	10	100%	2 Hz	10 Hz	5	N/A	N/A	N/A	0	0	T/F	0.1	0	10
	Upper Acceptable Limit	N/A	N/A	N/A	N/A	30	6.5	6.5	1.2	5	50	N/A	0.5	1	60
Real Values	Target														
	Stretch														
Predicted	Artifact														
Predicted	Value														
Measured	Artifact														
Measured	Value														

Market Ratings		
	Rating	Artifact ID
1		
2		
3		
4		
5		
6		
7		

Revision History

Rev.	Date.	By	Approval	Description	ECO
1.0				Initial release	
1.1	9/11/2019	Nick		Added 5 additional market requirements	
1.2	9/13/2019	Joe	Garret	Added additional market specifications	
1.3	9/17/2019	Garret	Joe	Update After Face to Face With Mark and Daniel	
1.4	9/18/2019	Mark	Daniel Gunyan	Reviewed and edited by IMSAR	
1.5	9/24/2019	Garret	Nick	Updated based on feedback from initial TODO submission	
1.6	9/26/2019	Nick	Autumn	Revised based on feedback from design review	
1.7	9/30/2019	Daniel	Joe	Finished up final values and wording	
1.8	10/2/2019	Nick	Garret	Fixed typos, reworded performance measure #10	

Artifact ID:	Artifact Title:
REQ-002	Requirements Validation Email
Revision:	Revision Date:
1.2	2 OCT 2019
Prepared by:	Checked by:
Jesse Krage	Garret Gang
Purpose:	
Show the approval from IMSAR of requirement matrix v1.4	

1. Revision History

Revision	Revised by	Checked by	Date	Description
1.0	Garret Gang	Daniel Sharp	19 SEPT 2019	Initial Version
1.1	Garret Gang	Daniel Sharp	30 SEPT 2019	Specified version of matrix approved.
1.2	Jesse Krage	Garret Gang	2 OCT 2019	Additional info for Validation, added reference to NOTE-003

2. Reference

Artifact ID	Revision	Title
NOTE-001	1.0	Meeting Notes With IMSAR
NOTE-003	1.0	Phone Meeting Notes

3.

Gmail

Garret Gang <garretrgang@gmail.com>

Updated Requirements Matrix

Daniel Gunyan <dgunyan@imsar.com> Wed, Sep 18, 2019 at 3:07 PM
Reply-To: dgunyan@imsar.com
To: Garret Gang <garretrgang@gmail.com>
Cc: Mark Catanzaro <markc@imsar.com>

We made some adjustments, additions, and revised it to 1.4. Here is the latest. Two new market requirements were added, and minor modifications to existing requirements, measures, and limits.

-
Daniel Gunyan

Team 15 Requirements Matrix(2).xlsx
18K

We conversed with Mark on who the market representatives are. He mentioned that the main userbase work at IMSAR. He communicates with the representatives who operate out of IMSAR's facility. He has been checking our requirements and key success measures with those market representatives. During a phone call with the team, Mark

used their feedback and his own personal experience to help us to define our key success measures and requirements (see NOTE-003).

Supporting Artifacts

REQ-001 Requirement Justification Breakdown
ECO-000 Engineering Change Order
NOTE-001 IMSAR 1st Visit Notes
NOTE-002 Design Review Notes
NOTE-003 Phone Meeting Notes

Artifact ID:	Artifact Title:
REQ-001	Requirement Justification Breakdown
Revision:	Revision Date:
1.1	28 SEPT 2019
Prepared by:	Checked by:
Garret Gang	Joe Hansen
Purpose:	
The purpose of this artifact is to explain the reasons for each of our market requirements.	

1. Revision History

Revision	Revised by	Checked by	Date
1.0	Garret Gang	Jesse Krage	13 SEPT 2019
1.1	Garret Gang	Joe Hansen	28 SEPT 2019

2. References

Artifact ID	Revision	Title
RM-001	1.7	Requirement Matrix
NOTE-001	1.0	IMSAR 1st Visit
NOTE-002	1.0	Design Review Notes

3. Requirement Breakdown

Requirement	Breakdown
System tracks in-flight vehicle	The goal of this project is to help IMSAR to replace their current (out of production) gimbal with a new gimbal, and to expand the functionality of their current positioning system. Their current positioning system is capable of keeping a drone/airplane in it's field of view once the target has been acquired. Our system must be capable of doing the same if it is to replace their existing system.
System computer communicates through Ethernet	IMSAR's current antenna system sends received information via Ethernet. For compatibility with their existing control system, we will design a system to be able to receive GPGGA messages from the existing antenna. In addition, our designed control system will need to send its status update messages through Ethernet so that the turret's functionality can be monitored from a downstream server.
System provides frequent status updates	These status update messages exist to let the user know that our positioning system is still functioning. Important

	statuses include antenna pointing position, relative drone location, current selected radar unit, and status of other equipment.
User interface (UI) is intuitive and requires minimal training	One of the expected use cases for this positioning system is that the user will setup the positioner and leave it running at length without any further configuration. Because the user will rarely need to interact with the UI, it is important for the UI to be simple, intuitive, and complete. IMSAR's current user interface is not user friendly and requires additional software that they are forced to distribute so that their system can be used. Our design will eliminate the need for this additional software. By changing how users connect to the device and making it easier to use, the user will have a much better experience, and be more inclined to use this positioning system in the future.
On-board computer fits in existing housing	The expected use case for the communication link positioner is that the system will be placed outside, configured, and left out year-round. With this market requirement in mind, our hardware needs to be entirely weather-resistant. IMSAR currently has a weather-resistant case that they use to house the hardware for the current design. It would simplify our design to select an onboard computer that fits in IMSAR's existing weather-resistant case. This is not a critical design feature. We will design a larger weather-resistant case if necessary.
System is resistant to power outages	One of the problems this system will face is an unexpected loss of power due to potential power outages or unintentional unplugging of the system. Our control system needs to recover from a power outage without requiring additional setup. The faster it can recover the better.
Camera can be mounted to antenna mount	IMSAR has asked us to design a camera mount that would allow us to place a camera onto the positioning system to make validating the performance of our positioning system simple.

ENGINEERING CHANGE ORDER

ECO #: _____ **EFFECTIVE DATE:** _____

PROPOSER: _____ **DATE:** _____

PRODUCT: _____ **DESC:** _____

ENG CHANGE NOTICE REQUIRED?	☐ YES	☐ NO
IS CUSTOMER APPROVAL REQUIRED?	☐ YES	☐ NO
IS REGULATORY APPROVAL REQUIRED?	☐ YES	☐ NO

DOCUMENT #	FROM REV	TO REV

REASON FOR CHANGE AND IMPACT:

ECO APPROVAL:

☐ IMSAR Rep.: _____

☐ Pod Instructor: _____

☐ Team Leader: _____

* new to this document *

Artifact ID:	Artifact Title:
NOTE-001	IMSAR 1st Visit Notes
Revision:	Revision Date:
1.0	28/SEPT/2019
Prepared by:	Checked by:
Joe Hansen	Nick Merriman
Purpose: The purpose of this artifact is to record any relevant project information learned from our facility visit with Mark C. and Daniel Gunyan on Tuesday, September 17th 2019.	

1. Revision History

Revision	Revised by	Checked by	Date
1.0	Joe Hansen	Nick Merriman	28 SEPT 2019

2. References

Artifact ID	Revision	Title
N/A	N/A	N/A

3. Notes

- The camera should mount directly to the antenna mount
  - This bracket design will be the responsibility of RPS
- A Raspberry Pi is a fantastic selection for the on-gimbal computer
- We asked about performing market research, and both Daniel and Mark agreed that it would not be necessary because of the nature of the product
- The weatherproofing enclosure may include Gortex in the design and a "wheat vent" to improve drainage. A completely sealed enclosure has presented serious issues in the past.
  - Ultimately, we decided that we would use the current enclosure system (an existing and successful enclosure) for protecting the on-gimbal components
- The antenna's angle of effectiveness is "approximately 7 to 8 degrees"
- A budget of 1500 USD is sufficient for the project
  - We will not be responsible for purchasing the gimbal
  - IMSAR will likely not have the final gimbal until January 2020
- Document transfer will happen via IMSAR's cloud storage
  - We will get information about login credentials in the future
- The UI should be web-based
- The UI should allow user control of the following parameters: LLA, heading, pan, tilt, and radar source select
- Mark suggested that we apply a step function to the system and evaluate rise and settling times to determine that it is properly damped
- LED indicators should include at least the following: Network traffic, data link acquired, processor activity
- Tilt and pan positioner will operate with Pelco – D protocol
- We will not have access to final tilt and pan positioner until "December or January"
  - In the mean time, IMSAR will purchase an inexpensive positioner for us to use in design

new to this document

Artifact ID: NOTE-002	Artifact Title: Design Review Notes
Revision: 1.0	Revision Date: 28/SEPT/2019
Prepared by: Joe Hansen	Checked by: Nick Merriman
Purpose: The purpose of this artifact is to record relevant feedback from our design review with Dr. Jensen, Coach Kevin Paulsen, and Coach Dorothy Taylor on September, 25th 2019.	

1. Revision History

Revision	Revised by	Checked by	Date
1.0	Joe Hansen	Nick Merriman	28 SEPT 2019

2. References

Artifact ID	Revision	Title
N/A	N/A	N/A

3. Notes

- Include a picture of the current positioner in the OD packet
- Clarify the following details:
  - Positioner is a ground unit
  - System is validated with a camera (camera is not included in final deliverable)
  - "On-board computer" should be clearer e.g. "On-gimbal computer"
- Review the section "Product - Focused Requirement Statement on page 294 of the capstone textbook
- Quantify the "Ease of Use" requirement with time to train a new user
- Consider including a quick startup time as a market requirement
- "Resume operation after power outage" should be a market requirement
- Revisit excellent, fair, and good performance for health message rate / pointer update rate
- Describe approval process in conjunction with attached approval email
- IMPORTANT -- Keep in mind for Key Success Measures: "What can we do that will make the customer say "this is what I've *always* wanted."

new to this document

Artifact ID: NOTE-003	Artifact Title: Phone Meeting Notes
Revision: 1.0	Revision Date: 3/OCT/2019
Prepared by: Joe Hansen	Checked by: Garret Gang
Purpose: Notes from our team phone conversations with Mark Catanzaro on 2 OCT and 3 OCT 2019.	

1. Revision History

Revision	Revised by	Checked by	Date
1.0	Joe Hansen	Garret Gang	3 OCT 2019

2. References

Artifact ID	Revision	Title
N/A	N/A	N/A

3. Notes

- Some data link acquisition systems that he has worked with take up to 10 minutes to set up. It will be very important for setup to be as simple and as streamlined as possible to make for quick setup.
    - We talked about saving parameters to non-volatile memory to make common installations faster.
- The current system has memory leaks that require a power cycle for operation to continue about once every week
    - We can't have any memory leaks for an excellent product
- Data transfer from the radar unit is maximized by maintaining the drone within a 7-8 degree window.
- Data acquisition is much like connecting a device to a wifi router. As soon as the antenna is pointed at a broadcasting radar, the system begins to receive GPGGA packets, and can begin tracking.
- Acquisition time can be best defined as the time after it commits to the time it takes to find the drone in the camera's field of view
- The most important part of the camera mount is that it points the camera consistently. The camera could be pointed a little bit off, but as long as it "isn't wobbling," it will be great.
- The market representatives include Mark and other employees of IMSAR that use the current tracking system. Mark has been speaking with them about their experiences with standard use cases and relaying that information to us. The experiences of the customers were an integral part in the development of our requirements and key success measures.
- We talked about the varied use cases to help identify the most useful measures.
    - Set-up on top of a building with little to no interaction for 3+ years
    - Set-up in remote locations with unreliable power sources
- The current positioner takes ~17 seconds to make a full 360 degree turn.

- We discussed how a previous key success measure was "a little bit lost off in the weeds." Much of our conversation was driven by determining the crucial requirements that we could include as key success measures.
- It will be valuable to design the positioner such that it can recover from a sudden loss of power while in use.
- Once we determined our key success measures, he said that he loved the direction that we were heading.
- Mark will be free to sign off on the packet today or tomorrow