P14251
Underwater Acoustic Communication

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Underwater Acoustic Communication

Agenda

- Introduce Team
- Project Background
- Problem Statement
- Project Deliverables
- Real World Uses
- Customer Requirements
- Engineering Requirements
- Draft of Project Plan

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Member	Role
Greg Davis	Team Lead/Mechanical Engineer
Chris Monfredo	Electrical Engineer
Chris Johnson	Electrical Engineer
Jon Holton	Computer Engineer
Scott Hambleton	Mechanical Engineer

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Project Background

- Boeing in conjunction with RIT will this year begin the design and production of an underwater unmanned robot.
- This project will be divided between many multidisciplinary design teams over multiple years.
- Our section of the robot involves a limited bandwidth communication system.

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Problem Statement

- Development an acoustic communication system between multiple robots
- The system will be used for short range communication
- The system must be able to function underwater
- Showcase RIT's technological and production facilities

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Use Cases

- Communication between boat on the surface and underwater robot

- Future Path: Intelligent robotic swarm communication

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Customer Requirements

Customer Rqmt. #	Importance	Description
CR1	9	Send signal
CR2	9	Send signal at a rate of kb/s
CR3	9	System must function underwater
CR4	9	Reliable communication scheme
CR5	9	Communications must resist frequency contamination
CR6	9	Must have 2-way communication capabilities
CR7	9	Must be able to operate in frequency contaminated environments
CR8	3	Low power consumption
CR9	3	System must be function in seawater
CR10	3	System must be pressure resistant
CR11	3	System must be able to operate in ambient water temp.
CR12	3	System must be easy to integrate into larger system
CR13	3	Power integration
CR14	3	Thermal integration
CR15	3	Internal communication
CR16	3	System size should be small (Height, width, length)
CR17	3	The signal should have as much encryption as possible
CR18	1	Light system weight

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Engineering Requirements

Rqmt. #	Importance	Source	Engr. Requirement (metric)	Unit of Measure	Tolerance Value (+/-)	Nominal Value	Comments/Status	Test (how are you going to verify satisfaction)
S1	9	CR1	Signal Range	m	5/5	30		Pool Test
S2	9	CR2	Signal Rate	kb/s	5	15		Pool Test
S3	9	CR4	Bit error detection	Y/N		Y	Needs Research	Unknown
S4	9	CR4	Bit error correction	Y/N		Y	Needs Research	Unknown
S5	9	CR3,CR10	System must be pressure resistant	kPa	0/0	98		Deep Water Test
S6	9	CR3,CR9	Water resistant/sealed	Y/N		Y		Hose test
S7	9	CR9	Housing resists corrosion	Y/N		Y	Need to check a way to measure this	Fatigue testing (Picasso)
S8	9	CR5,CR7	Non-naturally occurring underwater frequency	Y/N		Y		Research
S9	9	CR6	Each module must have receiver and transmitter	Y/N		Y		Design Check
S10	3	CR8	Low power requirement	Watt	0/5	15		Energy Audit
S11	3	CR16	System Length	m		-	Unspecified by customer	Measurement
S12	3	CR16	System Width	m		-	Unspecified by customer	Measurement
S13	3	CR16	System Height	m		-	Unspecified by customer	Measurement
S14	3	CR11,CR12,CR14	System heat sink capability	Watt		5 to 15		Thermal Test
S15	3	CR12,CR13	System power integration	Y/N		Y		Design Check
S16	3	CR12,CR15	System internal communication capability	Y/N		Y		Design Check
S17	3	CR11	Operating Temperatures	deg. F	25/25	55		Variable Temperature Testing
S18	3	CR17	Signal Encryption	Y/N		Y	As strong as possible, given time	Code Testing
S19	1	CR12	Low weight	kg		-	We will revisit this	Scale
S20								
S21								

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Customer Requirements	Signal Range	Signal Rate	Low power requirement	Low weight	Bit error detection	Bit error correction	System Length	System Width	System Height	System heat sink capability	System power integration	System internal communication capability	System must be pressure resistant	Water resistant/sealed	Operating Temperatures	Signal Encryption	Housing resists corrosion	Non-naturally occurring underwater frequency	Each module must have a signal receiver and emitter
Send signal	X	X																	
Send signal at a rate of kb/s		X																	
Low power consumption			X																
System must function underwater													X	X					
System must be function in seawater														X			X		
System must be pressure resistant													X						
System must be able to operate in ambient water temp.										X					X				
System must be easy to integrate into larger system										X	X	X							
Power integration											X								
Thermal integration										X									
Internal communication												X							
Light system weight				X															
Reliable communication scheme					X	X													
System size should be small (Height, width, length)							X	X	X										
Must send messages using uncommonly used frequencies observed underwater																		X	
Must have 2-way communication capabilities																			X
The signal should have as much encryption as possible																X			
Must be able to operate in frequency contaminated environments																		X	

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Customer Constraints

- Acoustic communication scheme
- Max power consumption of 15 Watts
- Total project budget of $1750

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Project Deliverables

- Two communication modules
  - A waterproof housing
  - Speaker and hydrophone
  - Internal processing circuitry
  - Communication lines to computer for debug
  - User-end and micro-controller programming

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Electrical

		Week 3		Week 4		Week 5		Week 6		Week 7		Week 8		Week 9		Week 10		Week 11		Week 12		Week 13		Week 14		Week 15	
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Task		T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R
Design Reviews								SDR						SSDR						PDDR					DDR		
Electrical																											
Benchmarking: Data Rates	CM/CJ																										
Benchmarking: Functional Schemes	CM/CJ																										
Communication Scheme Functional Decomp	CM/CJ																										
Engineering Facilities Analysis	CM/CJ																										
Top Level Block Diagram	CM/CJ																										
Sub-level Block Diagram	CM/CJ																										
Subsystem Design	CM/CJ																										
Mic and Speaker Testing	CJ																										
Schematic Design	CM																										
Subsystem Testing	CJ																										
Component Selection and BOM	CM																										
PWB Design	CM																										
PWB Fabrication Review	CM																										
Full System Review	CM/CJ																										

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Mechanical

		Week 3		Week 4		Week 5		Week 6		Week 7		Week 8		Week 9		Week 10		Week 11		Week 12		Week 13		Week 14		Week 15	
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Task		T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R
Design Reviews								SDR						SSDR						PDDR					DDR		
Mechanical																											
Benchmarking Material Research	SH																										
Functional Decomp	GD																										
Morph Chart	GD																										
Risk Assessment	SH																										
Thermal Analysis	GD/SH																										
Component Selection and BOM	SH																										
Housing Design	SH																										
Structural Analysis	SH/GD																										
Solid Modeling	SH																										

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Computer

		Week 3		Week 4		Week 5		Week 6		Week 7		Week 8		Week 9		Week 10		Week 11		Week 12		Week 13		Week 14		Week 15	
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Task		T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R
Design Reviews								SDR						SSDR						PDDR					DDR		
Computer																											
Microprocessor Research/Analysis	JH																										
Hardware Functional Decomp.	JH																										
Software Functional Decomp.	JH																										
Hardware Block Diagram	JH																										
Software UML Diagram	JH																										
Comm Protocol Algorithm Design	JH																										
Comm Protocol Algorithm Testing	JH																										
Error Check/Correct Algorithm Design	JH																										
Error Algorithm Testing	JH																										
Encryption Algorithm R&D	JH																										
Compression Algorithm R&D	JH																										
Additional Algorithm Testing	JH																										
Full System Review	JH																										

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Issues & Corrective Actions

Dimensions for the housing are still unknown
-Corrective action: Get electrical components and figure out dimensions after

We still need a method to measure corrosion
-Corrective action: Research ASTM or ASME standards for aquatic application

We would like to have more information about the planned power system of the whole robot
-Corrective action: Talk to robotics club, thermoelectric team, or Kevin Meredith