

Autonomous Vehicle for Gathering Oceanographic Data in Littoral Regions

EX485M - Multidisciplinary Engineering Design

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System Requirements Review
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<https://www.alexandriava.gov/uploadedImages/tes/gbr/StormwaterRunoffChesapeake.jpg>



http://eoimages.gsfc.nasa.gov/images/imagerecords/52000/52169/ChesapeakeBay_tmo_2011256.jpg



What is the Problem?



Buoys



<http://www.noanews.noaa.gov/stories2008/images/smartbuoy2.jpg>

Boats

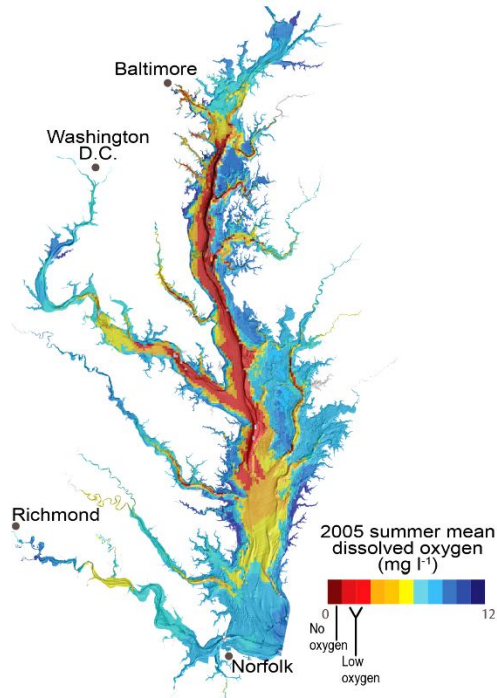


http://neptune.gsfc.nasa.gov/uploads/images_db/geo-cape2.jpg



Current Methods





<http://www.virginiaplaces.org/chesbay/graphics/deadzone.png>

- Computational Models
- Local awareness
- Scientific observation/record
- Understanding of processes
- Local policy
- National legislation



End Use





Huge Area to Survey





<http://amma-international.org/implementation/sites/ocean/journal/ronbrown.htm>

Problem Statement





CDR Andy Gish, USN, PhD
USN NAOE Department

https://media.lidn.com/mpr/mpr/shrinknp_400_400/p/2/000/190/3c4/3adadab.jpg



Prof. Joe Smith, PhD
USN Oceanography Department

<https://www.usna.edu/Users/oceano/jpsmith/>



Customers



A Successful Design Should:	Priority
Take measurements and make them available to the user	5
Be cheap	5
Cover a specified search area in a reasonable time, autonomously	4
Be man-portable and launchable	3



Customer Requirements





SeaQPR2.0 from the class of 2015



Stingray AUV

Barngrover et al., *The Stingray AUV: a small and cost-effective solution for ecological monitoring*, OCEANS 2011 , vol., no., pp.1,8, 19-22 Sept. 2011



Wang, Jianhua, Wei Gu, and Jianxin Zhu. "Design of an autonomous surface vehicle used for marine environment monitoring." In *Advanced Computer Control, 2009. ICACC'09. International Conference on*, pp. 405-409. IEEE, 2009.

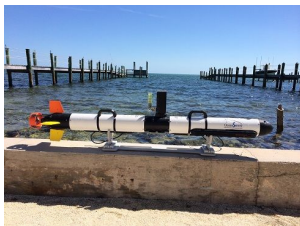


Dunbabin, Matthew, Alistair Grinham, and James Udy. "An autonomous surface vehicle for water quality monitoring." In *Australasian Conference on Robotics and Automation (ACRA)*, pp. 2-4. 2009.



Trade Study





Iver3 Nano AUV

<http://www.iver-auv.com/iver3Nano.html>



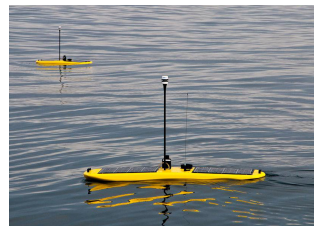
Remus 100

[http://www.km.kongsberg.com/ks/web/nokbg0397.nsf/AllWeb/61E9A8C492C51D50C12574AB00441781/\\$file/Remus-100-Brochure.pdf?OpenElement](http://www.km.kongsberg.com/ks/web/nokbg0397.nsf/AllWeb/61E9A8C492C51D50C12574AB00441781/$file/Remus-100-Brochure.pdf?OpenElement)



Slocum Glider

http://www.webbresearch.com/pdf/Slocum_Glider_Data_Sheet.pdf



Wave Glider SV3

<http://info.liquidr.com/specification-sheets?submissionGuid=11c382ee-c4c5-4449-bb07-5bc630ef6a43>



MIT SCOUT

Joseph Curcio, John Leonard, and Andrew Patrikalakis, *SCOUT - A Low Cost Autonomous Surface Platform for Research in Cooperative Autonomy*, Marine Technology Society (OCEANS) Conference, 2005

Benchmark	Type	Length (m)	Mass (kg)	Sensors	Op. Time (h)	Speed (kts)	Cost (\$USD)
Iver3	AUV	1.7	18 kg	T,p,c,bathymetry, +	5	2.5	50,000 (est.)
Remus 100	AUV	1.6	37	T,p,c,sonar, +	22	3	50,000
Slocum Glider	AUV	1.5	54	T,p,c, hydrophone, +	12 months +	0.7	100,000
Wave Glider SV3	ASV	3	150	T,p,c,etc.	12 months	3	300,000
MIT Scout	ASV	3	82	T,p,c,etc.	8	3	500



Benchmarks



Customer Requirements	Prof. Smith			CDR Gish		
	REMUS 100	MIT SCOUT	Slocum Glider	REMUS 100	MIT SCOUT	Slocum Glider
Take measurements and make them available to the user	5	5	3	5	5	5
Be cheap	1	5	1	1	5	3
Cover a specified search area in a reasonable time, autonomously	5	5	1	5	3	5
Be man-portable and launchable	5	5	5	5	5	5



Customer Assessment of Competing Products



Customer Requirements	Engineering Characteristics	Units	Direction of Improvement	Rank Order
Be cheap	cost	\$USD	↓	1
Take measurements and make them available to the user	samples stored/ transmitted	#	↑	2
Cover a specified search area in a reasonable time, autonomously	search area	m ²	↑	3
Cover a specified search area in a reasonable time, autonomously	search rate	m ² /s	↑	3
Cover a specified search area in a reasonable time, autonomously	area coverage	%	↑	5
Be man-portable and launchable	mass	kg	↓	6



Engineering Characteristics



- Operate autonomously
- Conform to all applicable codes
- Comply with safety regulations
- Comply with environmental standards
- Does not look like a weapon
- Reflect positively on the U.S. Naval Academy



Constraints



<u>Code/Standard</u>	<u>Description/Coverage</u>	<u>Comments</u>
ASTM Volume 15.11	Governs unmanned vehicle systems	<ul style="list-style-type: none"> * Comms requirements/underwater acoustic * Intended to influence the “design and development process” * Recommends other applicable standards * Sensor data formats * Safety
OSHA 1920.106	Personal and lifesaving equipment	
Local, state, and federal	Unmanned underwater/surface vehicles operating in Chesapeake Bay	Applicable regulations are based on the ultimate form of the design.
IEEE 802.11	Communications standard	Applicable if system uses WiFi



Codes and Standards



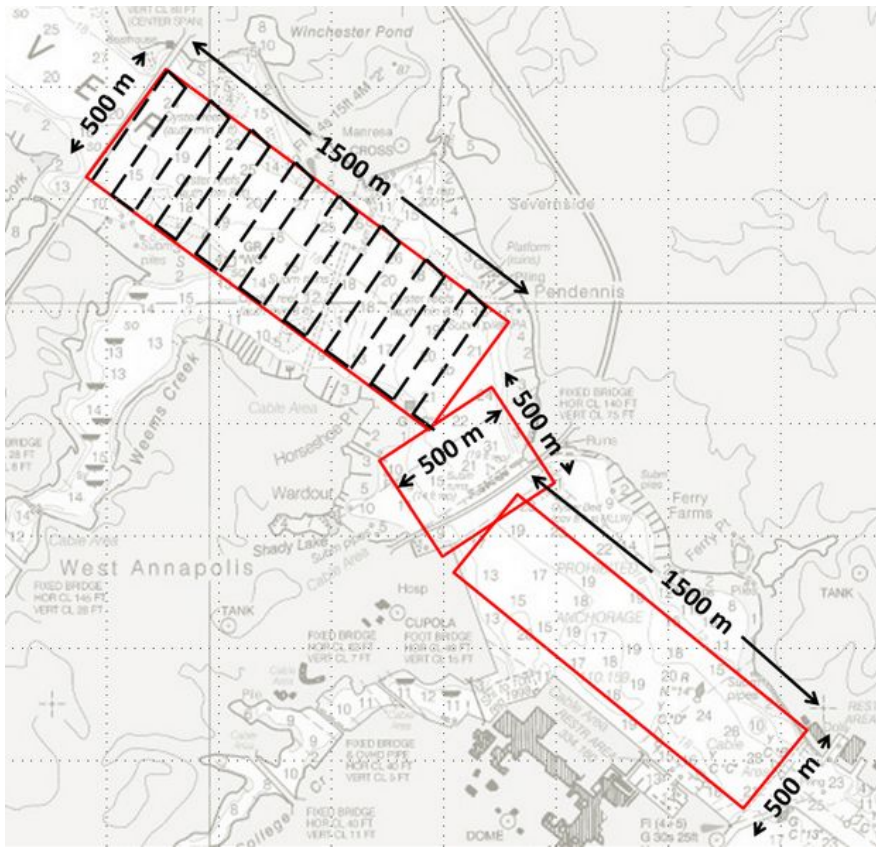
Nautical Chart
12280
*Chesapeake Bay
Severn and
Magothy Rivers*

Total area:
1.8 km²



Proposed Search Area





Survey Area: 1.8 km²
 Track Length: 156 km
 Survey time @ 1 m/s: 44 hrs

Survey speed @ 6 hrs: 7.2 m/s (14 kts)

of vehicles needed to search the area in 6 hrs: 10
 in 1m/s

Power required*: 240 W

Batteries required @ 12V (12 V, 100 Ah, 1 m/s): 6

* Methodology in Curtain, et al. 1993



Engineering Model

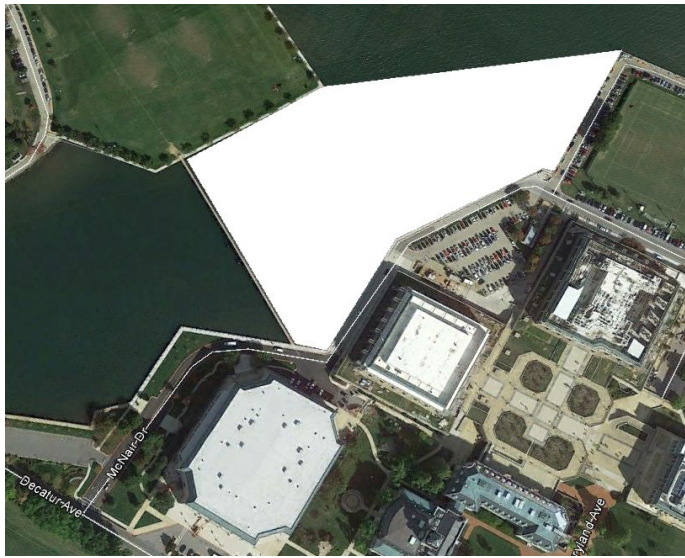


Engineering Characteristic	Samples Stored/ Transmitted	Cost	Area Coverage	Search Area	Search Rate	Mass
Units	#	\$USD	%	m²	m²/s	kg
REMUS 100	many	50,000	high	medium	low	37
MIT SCOUT	many	500	high	low	low	82
Slocum Glider	many	100,000	low	very high	low	54
Targets	20,000	1000	50	18,000,000	12	25



Technical Assessment and Targets





**Final Prototype
Intermediate Prototypes
Final Design Report**

Customer Requirements	Engineering Characteristics	Units	Direction of Improvement	Rank Order	Target
Take measurements and make them available to the user	samples stored/transmitted	#	↑	2	300
Be cheap	cost	\$USD	↓	1	1,000
Cover a specified search area in a reasonable time, autonomously	area coverage	%	↑	5	50
Cover a specified search area in a reasonable time, autonomously	search area	m ²	↑	3	33,000
Cover a specified search area in a reasonable time, autonomously	search rate	m ² /s	↑	3	9
Be man-portable and launchable	mass	kg	↓	6	25



Deliverables



Gantt Chart



Project Management





AY15 SeaQPR 2.0 budget:
\$3000 (\$1200 used)



MIT Scout advertised cost:
\$500

Requested budget: **\$3,000**



Budget



Questions?



Chesapeake Baywatch

“‘Baywatch’ has enriched and in many cases helped save lives.” - David Hasselhoff





Slide Title

