LiSa boat
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Abstract

This work is summarising development process of an autonomous vehicle.

Dedication

Hardworking group of students that decided to become tigers, (o)hm pardon, engineers

Acknowledgements

Chapter 1

Introduction

1.1 Preliminary ideas

A brainstorming chart was created to get an insight into each idea suggest for evaluation. 15 ideas were listed and described by these categories: mechanical challenges, electronics challenges, software challeges, components, potential market, cost, machine learning, sponsorship potential, user safety.

Each cathegory consisted from 1 to 5 informations that were relevanant for it. It was a qualitative analysis that helped the team to understand the apllication, define potential market and sponsors. Narrow the estimations of required time, budget and range of skills.

	weight	Snowcat	Weeder	War	Danfoss	Water	Dog	Lablador	Eva
Originality	20%	5	6	6	1	7	6	8	5
Budget	5%	1	8	4	8	7	2	8	6
Software	10%	3	2	2	8	7	1	5	1
Electrical	10%	6	5	3	8	5	3	5	4
Mechanical	10%	5	5	5	8	3	2	7	5
Scalability	5%	1	7	1	2	5	2	7	5
Availability	5%	6	5	6	1	7	6	8	5
Demanding	5%	3	3	3	8	3	3	3	1
Relevant	30%	5	3	4	7	8	5	4	2
Tolal		66	98.5	72.5	70	118	75.5	111.5	79.5

Table 1.1: Evaluation of preliminary ideas

Eight out of the initiall fifteen ideas were chosen for the evaluation. The choice was based on the relevancy of the idea to the semester project requirments and time required to complete it. Those two were considered the most important as both, not finished or irrelevant projects will decrease a score of the project.

1.2 Market research

Before the requirments and workcycle was determind there was an analysis of 4 different companies that are producing unmanned life saving boats or buys. The analysis is consisting of short description and a table comparing technical specification. All the data will be used during the requirement writing, so that the product is capable of potential competition on the market.

1.2.1 Emilly boat

It is 127 cm long boat with a buy covering the top of the boat. It controlled by RC and a rope can be attached to it in order to get it back on shore after being deployed. It has 4 other modifications, police, sonar, man over board and swift water. It is powered by one motor that is also used for steering.

1.2.2 Hover Ark H3

It is Remote controlled Lifesaving buoy controlled by RC with the function of an automatic return in case of lost signal. It has and upgraded version with lights for better visibility. It is capable of transporting the rescued person back to the shore,but he/she has to be able grab on it.

1.2.3 Orca H9

Livesaving watercraft that is the most powerful from all the products listed. It is manned vehicle that can carry a single lifeguard and carry or drag the victim back to the shore.Its is powered by one water jet engine.Compared to the jetski is more compact and needs less power.

1.2.4 Dolphin 1

The look and usage of this lifesaving buoy is similar to Hover Ark H3. Except that it has an extra camera in the front and is a bit larger.

1.2.5 Water Rescue Stretcher Bed

It is the extended and more powerful version of Dolphin 1. Between its two propellers is located the stretcher bed onto which the person can be placed and does not have hold it during the transportation.

Product/Parameters	Size[mm]	weight[kg]	power[w]	runtime@speed[km/h]	payload[kg]	control
EMILY	1230x355x355	12		13min@37	700	RC+rope
Dolphin 1	1190x850x200	13	1800	30min@12	225	RC
Stretcher bed	1680x730x260	30		30min@15	200	RC
Orca H9	910x53x32	23	4500	80min@16	300	manual
Hover Ark H3	1030x630x20	13.8		45min@18	200	RC+autoreturn

Table 1.2: Comparison of products

1.2.6 Conclusion

After the investigation was concluded that all of the products has to be navigated by person to the victim. Only Hover ark is capable of an automatic return. Therefore there is a space for extended functionality of navigation to the victim or to a lifeguard as an assistance.

1.3 Product requirements

After evaluation of user requirements , university requirements, given time and budget, project requirements were created and divided into 2 groups. Need to have requirements are formulated in a way that the final product should be a fully working downscaled prototype. They are giving detailed insight into the techical characteristics and functionality. Nice to have requirements are decribing the full scale prototype with extensions that fulfills all the user requirements.

1.3.1 Need to have requirements

1. Body shape

   (a) Should contain a stretcher bed between the two kiels.
   Reason: help the lifeguard wit the transportation

   (b) Should have 2 handles on the back and 1 on each side.
   Reason:useful when loading person and serving as buoy

   (c) Should be painted in a bright visible colour regulated by the law.
   Reson: better visibility and law restrictions

   (d)

1. Speed and endurance

   (a) Minimum speed to the person should be 1.1 m/s
   Reason: maximum distance/3sec

   (b) Should be able to run for 10 minutes withou recharging
   Reason: The weight and price of the battery

   (c) Should be able to carry 50 kg load on the way back
   Reason: the maximum payload 150 kg / 3. Using 1/3 of the motorpower

1. Navigation

   (a) Should use a gps with presision of 3 m
   Reason: price of the models with the highest precision

   (b) Should be able to receive signal in range of 200 m
   Reason:largest distance desired by user

   (c) Should have a compass to determine the orientation
   Reason: determine the orientation of the boat

   (d) Should be able to detect obstacles with sonar
   Reason: requirement by the university

1.4 User research

In order to make the boat useful and interesting for the future customers a questionaire was created. It was send to lifegurd, whose input provided us with feedback and improvements, that they think, will increase the usefullness of the boat.

The questionaire addressed particular properties of the boat. Such as the shape, maximum load, maximum speed, operation time, colour and accesories. All the questions are evaluated below. It has a polish and english version and was answered by 5 proffesional lifeguards.

1. The autonomous assistance boat can be a helpful tool for saving people overboard.
   Yes (100%)
   No (0%)

2. The autonomous assistance boat can be a helpful tool for a lifeguard.
   Yes (100%)
   No (0%)

3. Shape: (single choice)

   (a) The person should be able to grab on it, similar to safety ring. (20%)

   (b) The person should be able to grab on it and lay on it, like a stretcher. (80%)

   (c) There should be a platform on a boat, that allows the lifeguard to start saving the sufferer after getting to them on the water. (20%)

4. Accesories: (multiple choice)

   (a) Camera - documet the mission (20%)

   (b) Warning lights (100%)

(c) First aid kit (40%)

(d) Warning sound (80%)

(e) Showing temperature of water (0%)

(f) 5-min oxygen bottle (40%)

5. Is it important that the boat/buoy is helping the lifeguard to get to the person?
   Yes (100%)
   No (0%)

6. Does it make sense that there will be something that holds the lifeguard to the boat so he can take care of the drowning person during coming back to the shore?
   Yes (100%)
   No (0%)

7. Does the colour of the boat matter?
   Yes (60%)
   No (40%)

8. If the colour matters, what colour should it be? (Specify if required by law)
   Written answer by interviewees:

   (a) Bright, regulated by rules for coutry's regulations.

   (b) Bright, visible, red would be the best.

   (c) Bright, fluorescent.

9. From your experience what is the average distance [m] from shore to the victim? (multiple choice)
    (a) 100 (75%)
    (b) 200 (25%)
    (c) 300 (0%)
    (d) 400 (0%)
    (e) 500 (0%)
    (f) Other: (0%)
10. What is the maximum time [min] in which the lifeguard should get to the drawning person so the suferer can be saved in order to survive? (multiple choice)
    (a) 1 (0%)
    (b) 2 (20%)
    (c) 3 (20%)
    (d) 4 (20%)
    (e) 5 (20%)
    (f) 6
    (g) More than 6 (20%)
11. What is the biggest distance [m] from the shore that the suferer is saved at?
    Written answer by interviewees:
    (a) It depends on the time of apnoea, not the distance.
    (b) 90.
12. What was the longest time [min] it took you to complete a rescue (time spent in water)? (multiple choice)
    (a) Up to 10 (40%)
    (b) Up to 20 (40%)
    (c) Up to 40 (20%)
13. Other suggestions and features that you would like to have on your autonomous assistant.
    No given answers by interviewees.

Conclusion

The sum up of the user input gives the feedback of the fact that the autonomous life saver boat can be useful project used in real life.

- Shape of the boat: the person should be able to grab on it and lay on it, like a stretcher.
- Accesories of the boat: camera - documet the mission, warning lights, first aid kit, warning sound, 5-min oxygen bottle.
- Help with getting to the drwoning person.
- Holder to the boat for the lifeguard.
- Colour of the boat: bright, clearly visible colour, regulated by country's regulations.
- The boat should be able to achive at least 200 m distance from the shore.
- The logest time of getting to the drowning person should not go beyond more than 6 min.
- The longest time the boat should be able to work on the water without recharging should total 30 min.

1.5 Theoretical analysis

1.6 What to consider before choosing GPS module

List of needed requirements	
Type of requirement	specific of the requirement for the project
size wristband	max 30 mm x 30 mm
size boat	max 60mm X 60mm
update rate	1-10 Hz
power requirements	3.3/5V - we make a voltage regulator
number of channels	?
time to first start	?
antenna	best if included
accuracy	the more precise the better, budget limitation , at least 3 m horizontal accuracy
microcontroller compatible with	Arduino

1.7 Considered options and their specifications

1. Spark Fun RTK-SMA
   The SparkFun RTK-SMA GPS module is very precise, up to 0.01m in horizontal accuracy. However, the price is 250 $ which is out of the semster project budget. The module is advancted and can do RTK. However, it is not needed for the prototype of the project. link to the datasheet: `https://cdn.sparkfun.com/assets/f/8/d/6/d/ZED-F9P-02B_DataSheet_UBX-21023276.pdf?_gl=1*150sgcj*_ga*MTAxMTI1MDc4OS4xNjgxNzE5ga_T369JS7J9N*MTY5Njg3NjM0Mi40LjEuMTY5Njg3NjU1OS42MC4wLjA`

2. NEO - 6
   Due to its low price relative to the functionalities it offers and compatibility with arduino, this module is indisputable choice for those who want to learn how GPS works.This module is based on NEO-6M chip from U-blox. It has a Pover Save Mode that makes it suitable for a wristband locator. It is also the smallest chip amnog the others listed in a Table 1.3 It includes antenna with sensitivity patch of 161dBm.

3. BN-220
   The needed requirements are fullfilled despite the price. Which for 1000 krones budget is too high if the shipping price is added. link to datasheet: `https://files.banggood.com/2016/11/BN-220%20GPS+Antenna%20datasheet.pdf` [1]

1.8 Comparison

requirement	Spark Fun RTK-SMA	NEO - 6	BN-220
size	X	X	X
update rate	X		X
power	X		X
desired number of channels			72
time to first start (cold/warm)	-148dBm/-157dBm		26s/25s
antenna			
accuracy of min 3 m	X	X	X
compatible with Arduino	X	X	X
budget	not in the budget		about 150 krones but expensive shipping

Table 1.3: GPS modules comparison

Bibliography

[1] Donald E. Knuth. *The TEX Book*. Addison-Wesley Professional, 1986.