Control of an Autonomous Catamaran

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SPID - Robotic Option
CI-2019

Internship from 04/06/2018 to 24/08/2018

Supervisor:
Doctor Jian WAN, Lecturer, University of Plymouth - AMS

Tutor:
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Open Source

All the code associated to this report is open-source and available on the net. You will find the project at the following URL: `https://github.com/Plymouth-Sailboat`

My code at following URLs:

-Ros part URL: `https://github.com/Plymouth-Sailboat/SailBoatROS/tree/master/sailboat_ws/src/sailrobot_custom_msg/msg`

-Data extraction part URL: `https://github.com/Plymouth-Sailboat/SailBoatROS/tree/master/sailboat_ws/src/sailrobot_modules/src/ais_decode_node`

Acknowledgement

This internship would not have been possible without Doctor Jian WAN and his advice and reactivity.
I am grateful to Professor Luc JAULIN, thanks to whom I may not have found this workplacement.
Thanks to Ulysse Vautier for his help about the software and hardware of the boat.
Also, I would like to thank Bob WILLIAMS for his help and technical support he provided by printing in 3D and giving me some precious advice for the catamaran hulls.
Lastly, I thank Richard Cullen for spending a lot of time helping me stick the hulls.

CLAVIER Evann

Abstarct

This report is part of my second year of engineering school. It summarizes the work I did during those three months.
In this report, first of all, I will detail the construction of the catamaran kit and the adaptations put in place to accommodate the doctoral student's hardware. Then I will explain the part of the communication mode on which I had to work and implement so that it was functional in the laboratory's boat fleet.

Keywords : Automatic, catamaran, AIS, sailing boat, robotics

Résumé

Ce rapport s'inscrit dans le cadre de mon stage de deuxième année d'école d'ingénieur. Il résume le travail que j'ai effectué durant ces trois mois.
Je commencerai tout d'abord par détailler la construction du kit du catamaran et les adaptations mises en place pour accueillir l'hardware du doctorant travaillant aussi sur ce projet. Par la suite, j'expliquerai la partie du mode de communication sur lequel j'ai travaillé et que j'ai implémentée pour qu'il soit fonctionnel dans la flotte de bateau du laboratoire.

Mots-clés : Automatique, catamaran, AIS, bateau à voile, robotique

Contents

Chapter 1

Introduction

I performed my internship at the University of Plymouth. This University was founded in 1862 and today it hosts more than 23,000 students each year.

Figure 1.1: University of Plymouth

My supervisor was Doctor Jian Wan, a lecturer in control systems engineering and member of the Autonomous Marine Systems (AMS) Research Group. I also worked in collaboration with a Phd student, Ulysse Vautier, whose work consists in sailing boat automation.

The laboratory wanted to show which type of boat is more stable, in order to do some hydrography measures. For the test to be valid, the hardware must be the same. For that reason, the Phd student and a post-doctoral created a system to be put in each type of sailing boat. Then they have four types of boats for the test: a one-meter mono-hull, a two meters' mono hull, a catamaran and a trimaran. In my case I worked on a catamaran.

I built a catamaran kit and adapted its structure to the Phd student's hardware. Between two drying times, I worked in collaboration with another ENSTA student (Goutorbe Charlie) on the AIS communication. For the laboratory, this communication will allow to have a fleet of boats that can sail together without colliding. In addition, the laboratory was approached by a South African company interested in this type of communication.

I would like to specify that the construction of the catamaran was done with the help of Charlie Goutorbe because some of the tasks to be performed could not be done alone. Whenever possible, we divided up the tasks.

Chapter 2

My Work

2.1 The Catamaran

When I arrived at the university, on my first day, Mr Wan showed us the catamaran kit. It was composed of 4 semi-hull, sails, wood pieces, carbon tubes and some fasteners for the mast and sails. We needed to order a carbon mast because it was not present in the basic kit. While waiting for the mast, we began to work on the hulls.

Figure 2.1: My Catamaran

2.1.1 Hulls, Sails, Mast and Central part

Hulls

When we received the hulls, they were not assembled, but the problem was that we didn't know how to glue them and if they'd be waterproof. After discussion with technicians and a doctor in glue, we met Richard Cullen who gave us the solution to our problem. He said we needed to laminate the two parts.

So I used epoxy and added two bands of fabric glass inside the hull and just one outside. Each one of the manipulations took a night for the glue to cure. In fact, the two hulls took more than two weeks to be finished.

After the epoxy, I applied, following the advice of the doctor in glue, a fabric that does not stick to the epoxy, in order for the glass fabric to be glued perfectly on the tip of the hull. However, this fabric left microporosities and made the shells non-smooth, which reduced the slippage of the shells. So I applied epoxy-filer that plugged these micro-holes and after long minutes of sanding, the shells were smooth.

Figure 2.2: Catamaran hulls before epoxy filer

Figure 2.3: Catamaran hulls after epoxy filer

Central part

The central part is composed of four composite wooden parts, a plastic box and four carbon tubes.
The four wooden parts are for:
- The servo motor to direct the rudder and sails,
- The mast foot and the keel,
- The two carbon tubes fixed to the hulls.

Figure 2.4: Wooden pieces

The four carbon tubes, which are the base of the central part, linked these four wooden parts.

But everybody knows that wood in water rots. So, I used the same method to waterproof the pieces: epoxy. With a paintbrush, I laid out some epoxy on all the surface of the wood to waterproof perfectly the pieces. As all pieces had holes, I took a fil and put the fil between two stems to dry them. The following day, holes were clogged because of the epoxy. I filed the holes so that the wooden parts and the carbon tubes could easily be clamped together.

The next step was to set the mast foot in the central part, to set the rudder to two metal stems and then to the central part and also the keel to two metal stems and also to the central part.

Figure 2.5: Central part

To see what the boat will endure during the test, we must have a camera on the boat. So I designed a piece to set the camera on the front of the boat. I chose the front because the top of the mast did not look straight ahead but up to the sky. I was inspired by the wooden pieces connecting the carbon tubes in the central part. Jian Wan bought for boats little boxes adapted for the raspberry-pi camera and also two-meter cables.

The plastic box is a waterproof compartment to protect the electronic boards and sensors. I drilled 4 holes to pass the carbon tubes on it. I also cut a wooden piece to fix the IMU, the GPS and the servo motor to direct the sails. I stuck this piece to the carbon tubes so that the inertial central did not move and did not send erroneous data. GPS, cards and battery were all fixed with some Velcro. The box had multiple holes to pass thread sails and sensor cables. I made sure that the components outside the box were easy to remove of the boat to allow me to permanently fix the cables to the box. That way we could easily open the box and access the components.

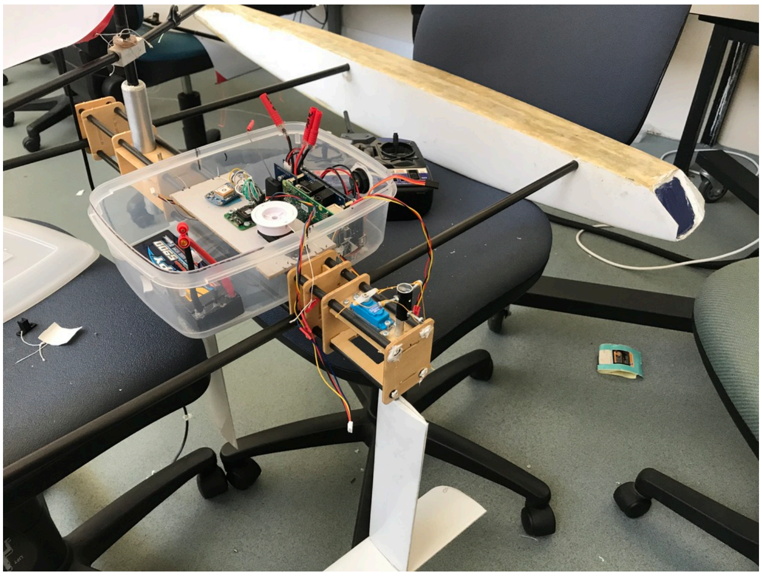

Figure 2.6: Central Box

I also designed a 3D piece to put the camera on the boat because an option of navigation uses the camera to avoid obstacles.

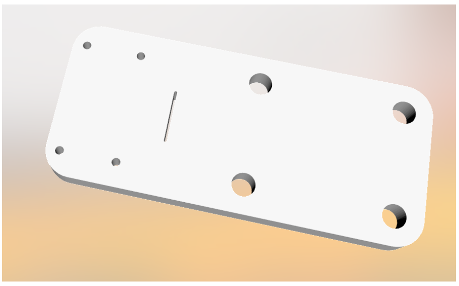

Figure 2.7: Adaptor camera

Sails and mast

As I said, the mast was not in the kit, we received two-meter carbon tubes for the mast. After calculation, I decided to shorten the height of the big sail and reduce the force exerted on the bottom of the mast. It limited the catch in the wind of the boat and thus decreased the risk of the boat turning over.

The boat needed an anemometer and a wind sensor to work. I therefore imagined a system to put the wind sensor on the top of the mast, so that it was not disturbed by any other part of the boat and thus have as much wind as possible coming from all sides. I designed a piece with a hook shape. To do this, I reused the initial piece of the wind sensor to simplify the 3D piece.

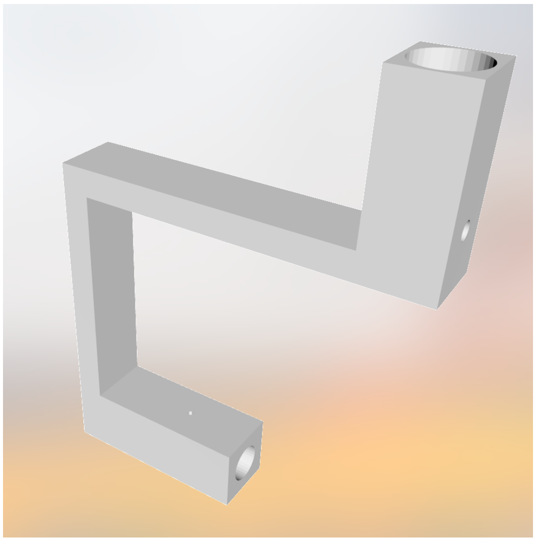

Figure 2.8: Adaptator wind sensor - 3D piece

I needed another 3D printed piece because the mast and the metal part were not the same dimension. The mast has a 12mm diameter and the metal piece a 15mm diameter.

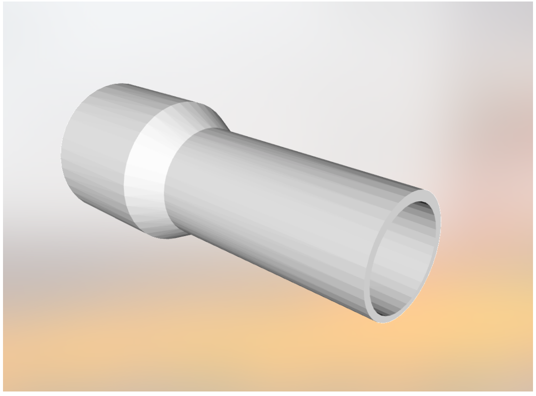

Figure 2.9: Adaptor mast - 3D piece

As you can see on the assembly instructions attached, a piece of carbon fibre is there to fix the top of the small sail. I had to make another 3D part to adapt the fact that the sit part is 15mm in diameter and the mast is 12mm. It was not a mistake that the mast was 12mm, it was not possible to order the carbon fibre mast in 15mm diameter.

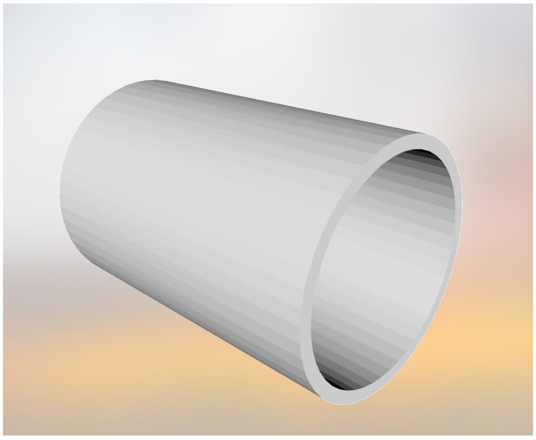

Figure 2.10: Top of the little sail - 3D piece

To assemble the sail, I followed the assembly instructions. At the beginning, the mast moved and sails were fixed to the mast. At the end of the assembly, Ulysse noticed that the wind sensor must not move because it needed to have a fixed direction to give the right angle of the wind.

To solve this problem, as the wind sensor was fixed on the mast, I decided to fix the mast and make the sails able to turn. To do that, I put a small piece of tape on a plastic part to avoid the friction of this piece and thus to make turn the mast. Then I widened the hole in the metal piece allowing the sails to be held to the mast, which means that the sails were no longer fixed directly to the mast. And finally, on the top of the sail there is a metal stick which allows to stretch out the sail and give more, this piece must move at the same time of sails. So I imagined a sort of platform which can support this piece, therefore I created a platform with a small piece of wood and a plastic tube which is used to make a roll and which rotates around the mast. Finally, the mast, like the wind sensor which is on top, it does not move. The sails move with the wind force and the slack is given by the servo motor.

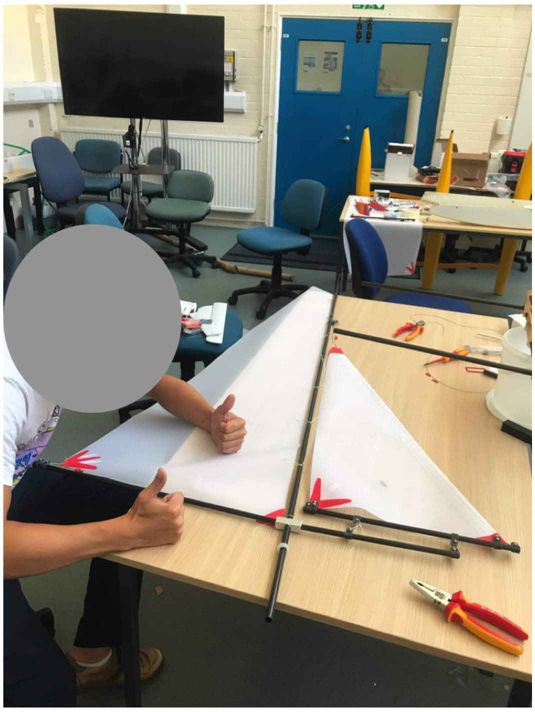

Figure 2.11: Sails and Mast

2.1.2 Components

The catamaran is an autonomous boat, as I said before. The control part is composed of a raspberry pi board, an Arduino mega board and two boards to connect the raspberry pi and the Arduino Mega.

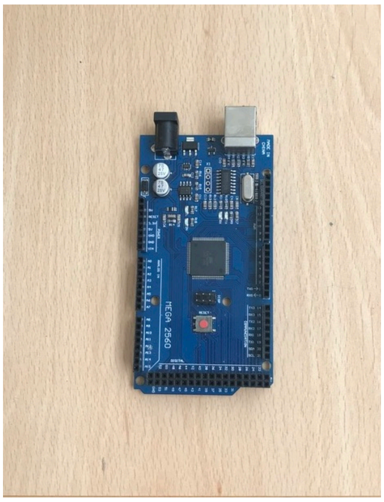

Figure 2.12: Arduino Mega

The laboratory wanted to change the adaptor boards. When we received the new boards, I soldered all the components on three cards because all boards on all boats were changed.

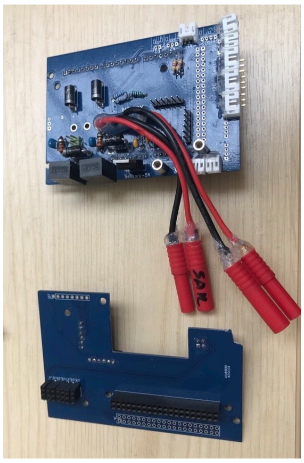

Figure 2.13: Adaptor Cards above

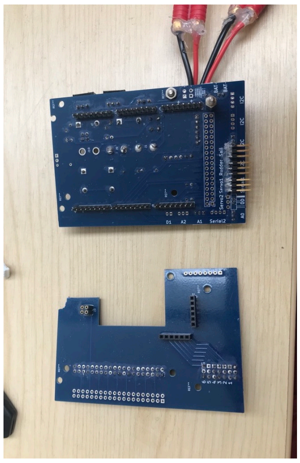

Figure 2.14: Adaptor Cards below

The old boards were not very efficient and they had problems. I asked Ulysse to show me how to design and create a board. So I learned some rules like for example never make a right-angle with an electronic circuit, because of the current power may burn the angle of the circuit. Also with those boards, I cut some corner to let component pass. Boards were not perfect but it is difficult to think of every problem that may arise.

Also, the catamaran has a camera, 2 servo motors and an inertial central given by Xsens company. It is a partnership with this company so the Xsens IMU was given for free because it costs about £300.

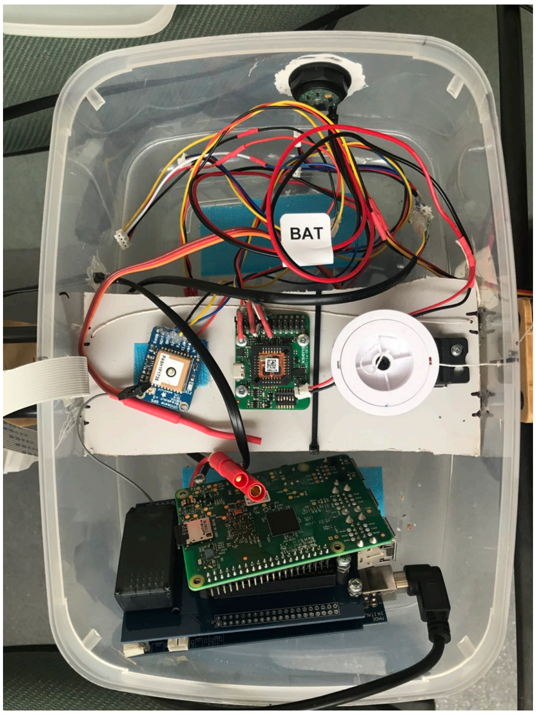

Figure 2.15: Box with all the components

2.2 Ais communication

2.2.1 Presentation

The Automatic Identification System (AIS) is a system for the automated exchange of messages between vessels, operated by radio, that allows vessels and traffic monitoring systems to know the identity, status, position and course of vessels in the navigation area. AIS uses the two VHF frequencies 161.975 MHz and 162.025 MHz that have been reserved worldwide for this application. The packets contain 168 bits or 440 bits and they are preceded by a 24-bit preamble to synchronize the receiver and last only 30ms. In addition, AIS allows ships to be identified when visual or radar recognition is no longer possible and to avoid collisions.

Figure 2.16: Ais antenna

However, the effectiveness of AIS is limited because the radio's range is about 50 miles, which corresponds to approximately 80 kilometres. Therefore, the receiver must be closer than this distance to receive the information. With an application “CubicSDR” you can see the different frequencies that can be picked up by the antenna.
Then you can show every boats' position after displaying them, being in the action area of the antenna, on a map thanks to another "OpenCPN" application or on google maps.

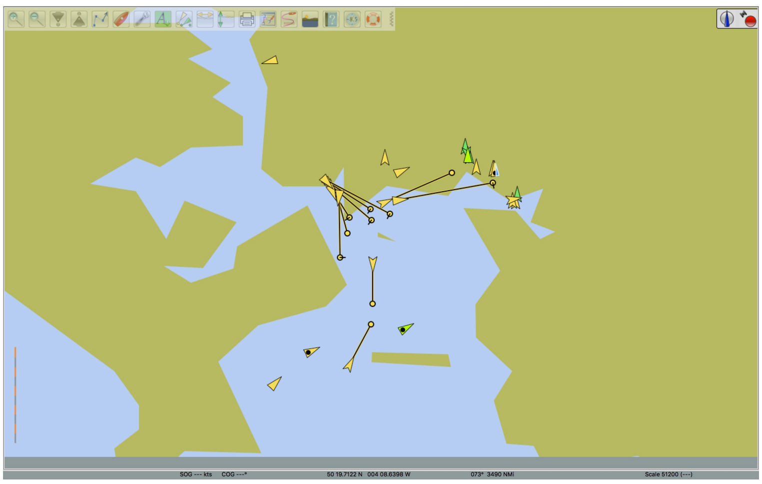

Figure 2.17: OpenCPN map of plymouth harbor

Chapter V of the SOLAS Convention requires ships engaged on international travels to be equipped with this device since July 2007. During my internship, a person from a South African laboratory came to the university. He was interested in the autonomous boat project that the laboratory was currently developing. He wanted to adapt the system to use it with the AIS radio.

Exemple of a Ais frame: !AIVDM,1,1,,B,13PRrB0000OvbS@NhA9=oPbr0<0u,0*58

DataPayload = 13PRrB0000OvbS@NhA9=oPbr0<0u

In an AIS message after extraction of data, it is possible to know this information about the boat:

1. Message type;
2. Repeat indicator;
3. MMSI = Marine Mobile Service Identity;
4. Navigation Status;
5. Rate of turn;
6. Speed over ground;
7. Position accuracy;
8. Longitude;
9. Latitude;
10. Course over ground;
11. True heading.

2.2.2 Data exctraction

I did not work on all the transmission chain of the AIS message, my work was to decode data which is present in the tram of the AIS message. So my code does not receive all the AIS message but just the data payload string. The string is composed of multiple data payload separated by comma. Then I separated this string to put each tram in a table.

As I mentioned previously, the drying time of the hulls or the time to wait for the opening of the glue room was sometimes quite long. It allowed me to discover the C++ language which is widely used in robotics. That's why I decided to use this code in the internship and make it even more informative.

I used the C++ language to do my code. This language is very useful when you want to make object-oriented code. So I used this code facility to create an object called "Message", containing all the information that can be sent by an AIS signal.

I decided to make this object to simplify decoding, so it is not necessary to go through the ROS middleware to decode code errors. In addition, the code can be reused for other purposes and it simplifies the access to the information contained in the message.

During my free time I also implemented a code which take the GPS coordinates of the catamaran (and the boats in the vicinity) to determine the distance between the boats. I had to be able to use this distance to carry out move of avoidance, because, for the catamaran (measuring 1 to 2 meter-long), a liner would have been fatal to him. Actually the catamaran is using a camera to avoid obstacle at a short distance, those obstacles are short and easy to prevent. But at the human scale with some boats or cruiser ships, it is not possible to perform an avoidance manoeuvre in a few meters.

This part was not asked and unfortunately, I did not finish this work. I had just the distance of each boat. I hope it will be useful for the team and for their future projects.

2.2.3 Middleware Ros

The string of multiple data payload is sent by a ROS message, more specifically a std_msgs String. After parsing and decrypting the messages, I had to send them so that the user could use them as he wants.

To communicate with all components and the user, the catamaran uses the middleware ROS. I worked on the communication of the AIS data. I tried to apply what I learned during classes. ROS does not have a AIS type of message in its datacenter. So I had to create my own message to send the data. I started from the base of the object that creates the code and I implemented this message. However, the antenna does not pick up one but several frames at the same time. So I implemented another message that contains an AIS message table so the user receives a table of decoded AIS messages. Each time, a message containing the tram is received, an AIS array is sent to the user. You understand that this code is not a mode that uses the data transmitted by the antenna, but it just decrypts the data so that the user can use them.

It was easy to implement the code on the Phd student's structure one, because the AIS-node did not communicate with the other nodes. After retrieving the details, the user just needs to subscribe to the AIS array message.

2.3 Test at Roadford Lake

The test day was scheduled to test the other boats in the laboratory in preparation for the World Autonomous Boat Championship which the laboratory was participating in.

Figure 2.18: Catamaran on the lake

For us it was a way to test the buoyancy of our boats. Our primary goal in the course was for the boat to float for later use. As I was the first to have assembled my catamaran and as everything worked correctly, with Ulysse Vautier we decided to test the reactivity of the code. Once the catamaran was launched, we were able to successfully observe that the boat was floating and therefore that the waterline was not reached. However, we had a problem with the code. We tested the part followed by the line, which consists in giving two points to the boat and the boat follows this line created by these two points. Once back on land, we found that the problem was the orientation of the wind sensor (it was in the wrong direction). As a result, the boat thought it was upwind and therefore wasn't following the right direction.

During that day, I could see and notice that the problems related to the test were quite recurrent and that a good preparation beforehand made it possible not to waste time when we were on the test site.

Figure 2.19: Catamaran at the test day

Chapter 3

Conclusion

3.1 Improvements

To improve my work, I think it would have been nice to paint the catamaran because of marks due to the epoxy.

The boat is really heavy with all the exopy I put on the hulls. To improve the system, it will be necessary to reduce the weight of the catamaran, which will make it possible to increase its speed or even its stability. Moreover, the sails were not very tight and therefore the wind grip was not optimal. I made a box containing all the electronic components in urgency and with not much time. In the future, this box could be designed in 3D for a better maintenance of the components inside the box.

At the component level, I don't think we can have better. However, I think a cheaper inertial central will be better because the project is made open source. Not everyone is able to afford an inertial central that costs £300. That's why I started to integrate the IMU Razor SEN-14001 with an I2C link. Unfortunately, I couldn't finish the integration in the time I had left.

3.2 What I learned

During this internship I learned many things. I learned a new language that we hadn't been able to learn too much during the school year. I have also discovered a new form of communication which is the AIS. AIS is very interesting and useful, I strongly think I will start a personal project around this antenna.

I also discovered that the assembly of the model was not that simple and that you have to think about all the problems you may encounter. This will undoubtedly help me in any future project I undertake outside school or in my professional career.
Attending the meeting with a potential collaborator from the laboratory showed me the importance of preparing a meeting to convince and start a new collaboration.
I am sure that everything I have done or seen during these three months of internship in Plymouth University will serve me next year and even more in my future professional activities.
As far as the organization is concerned, I discovered that I had to work differently in order to better anticipate possible mistakes before I start. This is the main reason why the code I created is not yet optimal (I also took a long time to correct errors when compiling the code).
We could have used a “PERT” method to determine the optimal time to launch the tasks and thus loose as little time as possible on the realization of the model and thus start the code quicker.

3.3 To conclude

In conclusion, the construction of the catamaran will be used in the next year for boat stability tests and to determine which of the different boats will be the most stable for measurements at sea. In addition, the AIS communication system will probably be used for a future project in South Africa to determine and avoid drag marks from oil made by large boats passing through this area.

This internship allowed me to improve my coding skills and to learn a new language such as C++. Lastly, I was also able to use what I saw during the school year and thus understand and/or improve those notions.

Figure 3.1: Mecanical marine laboratory team

List of Figures

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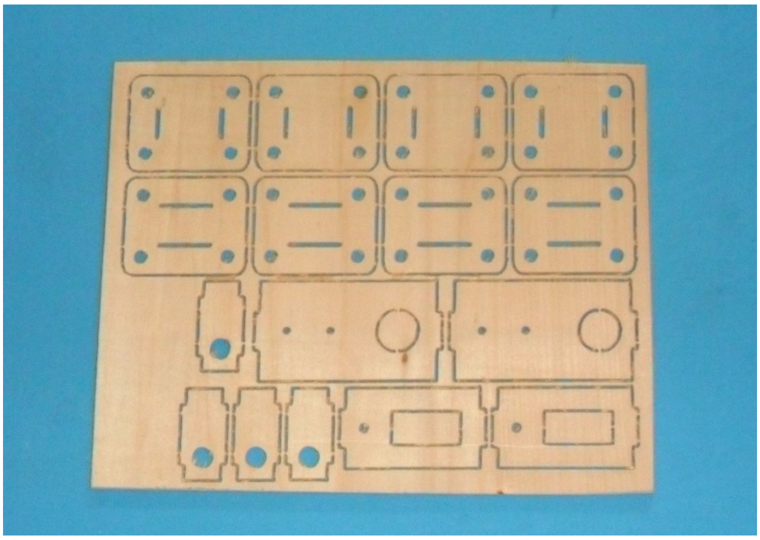
Annexes

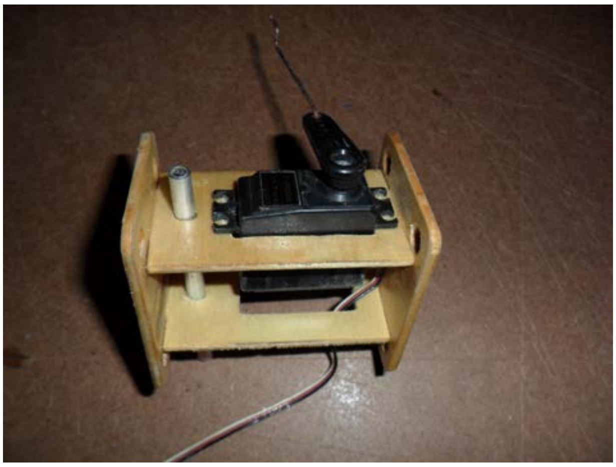
Annexe 1: Ninja and Ninja1000 - Building instructions Rev1.0
Annexe 2: Mini40 - Fat Top Swingrig Kit - Assembly Instructions Rev2.0
Annexe 3: Assessment Report

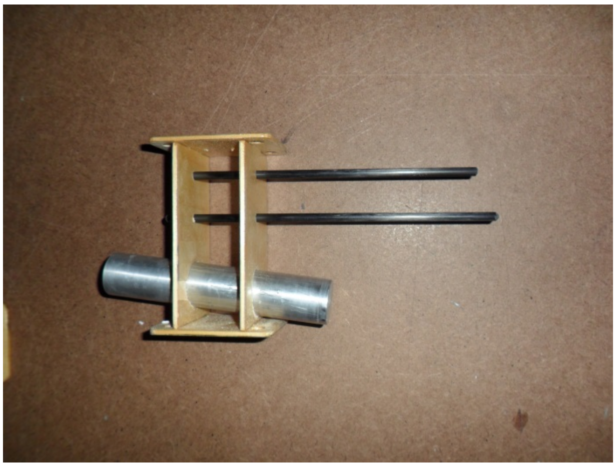
1. Remove the pre cut plywood parts from the plywood sheet and sand them smooth. Match the parts and glue them together to groups as shown in the two pictures below.



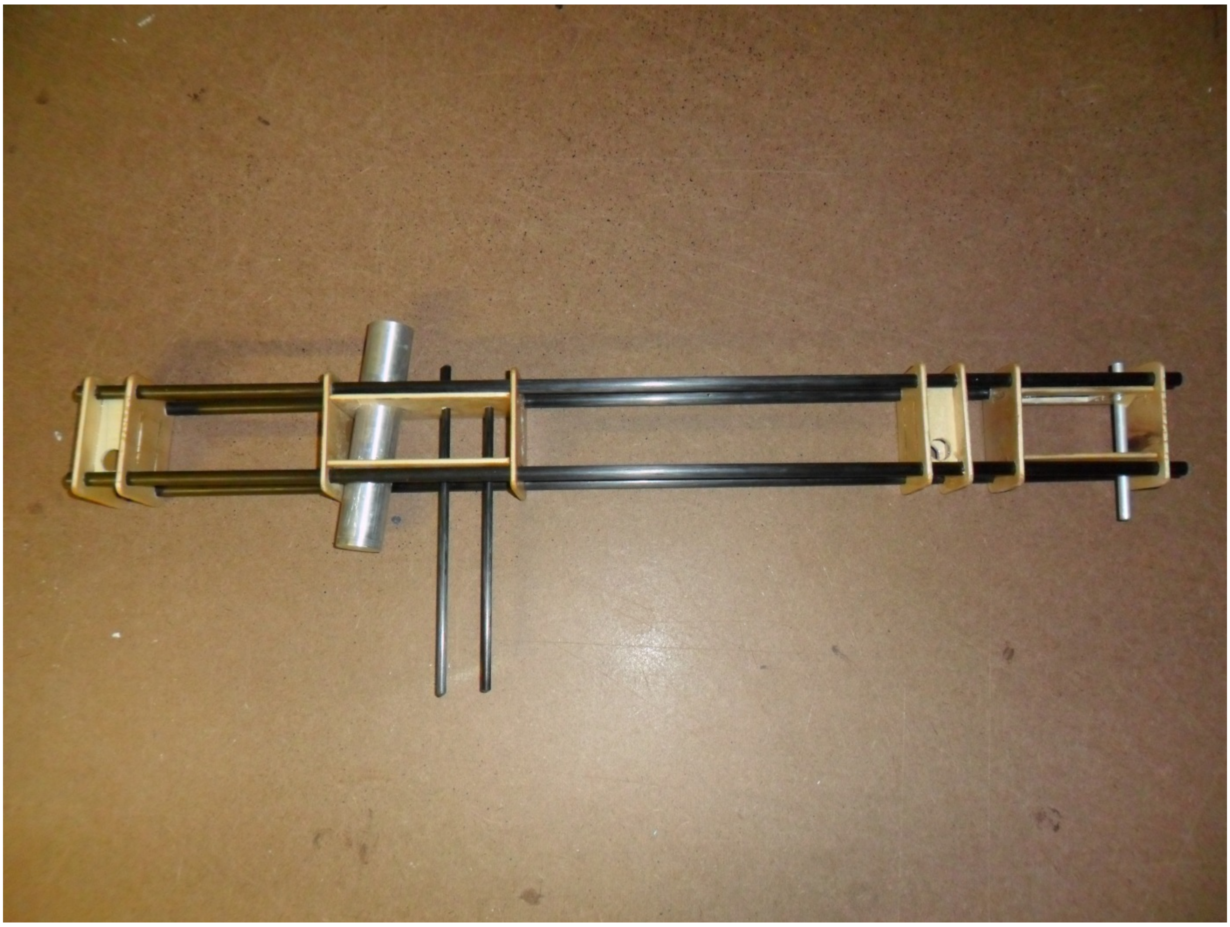
It is a good idea to paint the groups with some of epoxy to make them waterproof.

2. When the paint has cured match your servo to the servo tray and the mast-tube and the fin bolts to the mast tray. You will have to widen the holes a bit for a perfect fit. Glue the rudder tube into the servo tray, the lower end protruding about 30mm from the bottom of the tray. Glue the mast tube into the mast tray, the lower end protruding 45mm from the bottom of the mast tray.

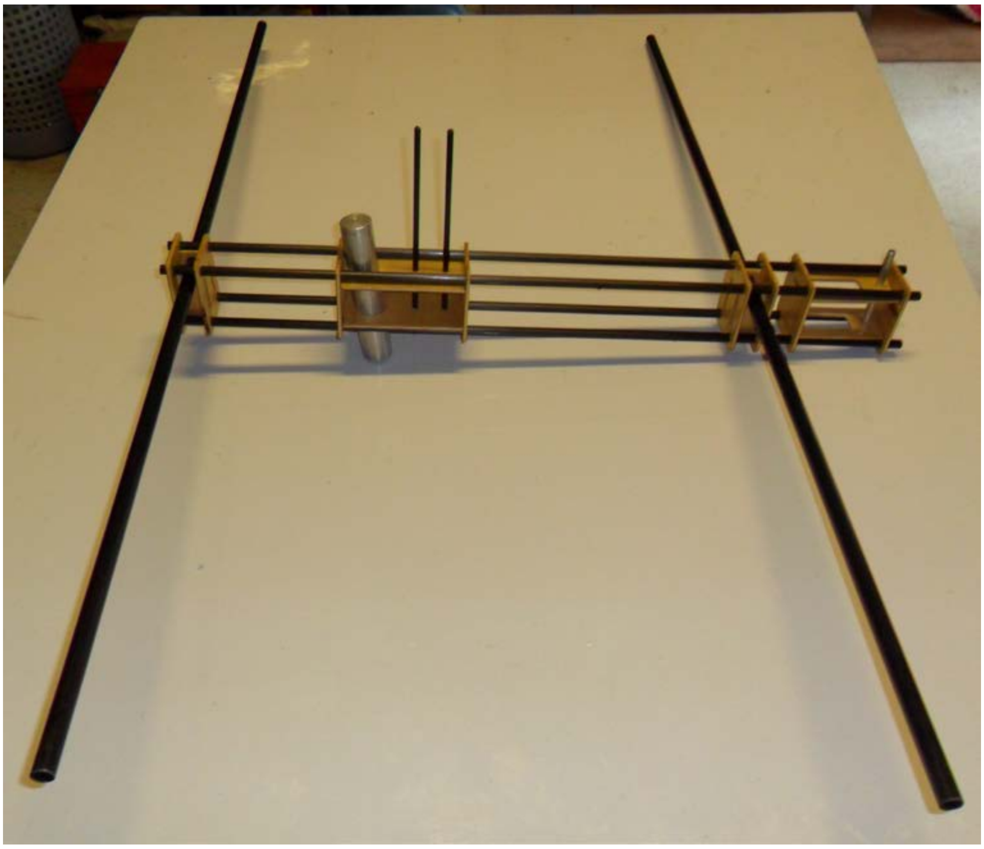




3. Take the four 600mm long carbon tubes with an OD of 8 mm and line up the groups you have built in the steps before to the tubes as shown in the picture below. You will not need to glue them into position for now.



4. Take the two 1000mm long carbon tubes with 12mm OD and slide them into the corresponding holes in the center pod. Align the tubes so that they protrude the same length on both sides of the center pod. Glue them into position.



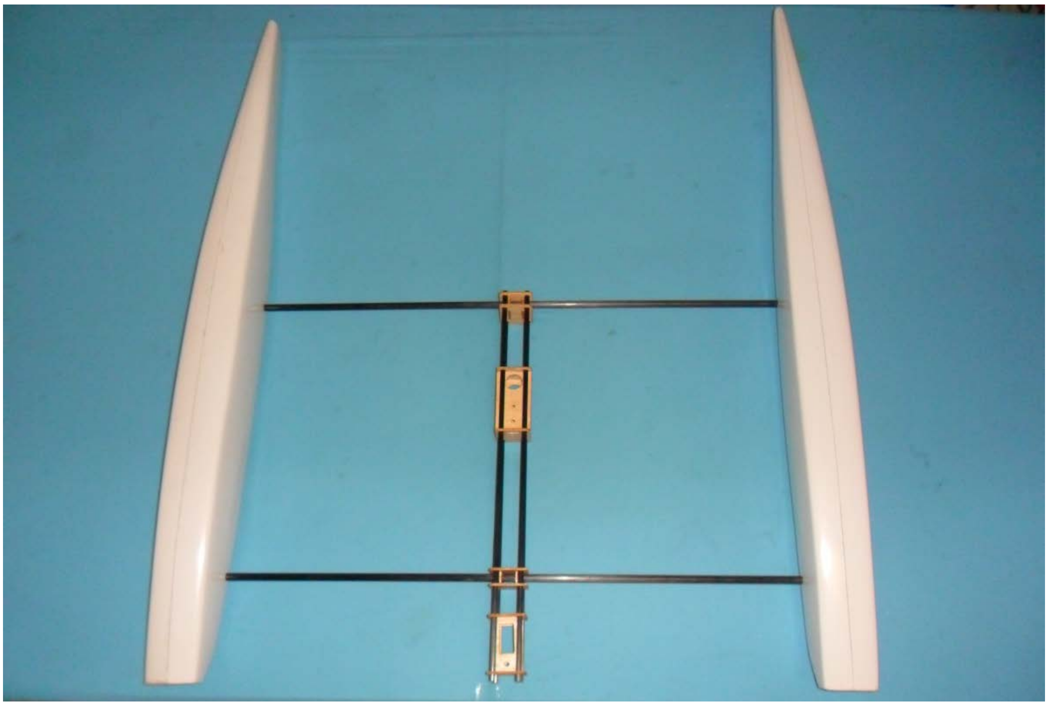
5. Next step will be to glue the two 150mm long 5mm stainless steel bolts into the keel fin. To align the fin insert the bolts into the corresponding holes in the mast tray and then glue the fin to the bolts while carefully aligning the fin vertically and in line to the center pod according to the drawings.


6. Glue the T-Foil to the rudder and secure with two small screws (not included). Glue the rudder shaft into the rudder and cut the shaft to the desired length if required.

7. Sand the jointing surfaces of the hull halves thoroughly and match the halves. Now test slip the halves on the 12mm tubes on the center pod assembly to align them. The halves should slide on easily. Now cover the tubes with mold release where the hull parts are to be fitted.
   To avoid spills you should cover the outer surfaces less the joining surface with masking tape.



8. Apply epoxy thickened with microfiber to the hull halves joining surfaces and join the halves together. Slip the hulls onto the beams on the center pod assembly align them and secure the joints with strips of masking tape until the resin has cured.



9. Cut the bow and transom bulkheads from some leftover plywood according to the plans and match them to your hulls, sand the joining surfaces of your hulls and glue the bulkheads into position with some thickened epoxy. Secure the joints with masking tape until the resin has cured.

10. Cut the hatches for battery and RC equipment into the two hulls according to the plans and insert your trays. (We have included some sample drawings for the trays in the plans).

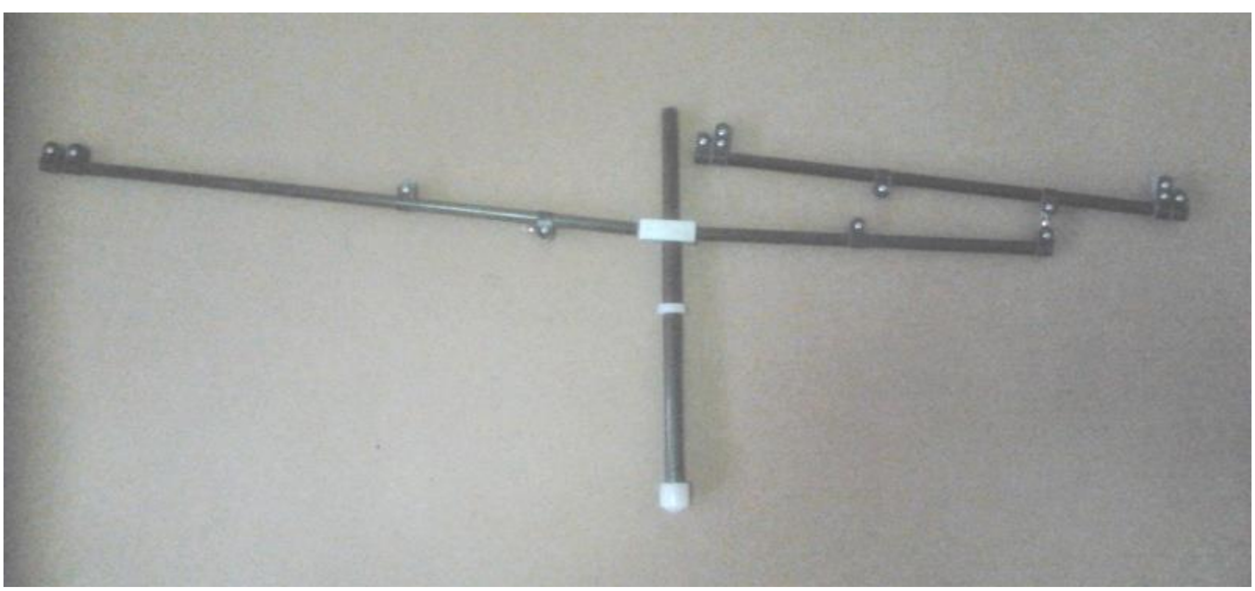
(On our boat we use a 5 cell AA sized battery in the battery tray and a SM8030 winch servo in the RC tray. Battery is connected over a long wire from the left hull to the right hull, the rudder servo is connected from the center pod to the right hull with a servo extension cable.)

11. Remove the hulls and do the paint job. After the paint job glue the two 12mm beams into the hulls carefully aligning the hulls parallel, assemble keel fin, rudder and RC components and your platform is ready.

1. Unpack the rig parts and assemble the mast foot(not included - 12mm OD carbon tube 250mm long) as shown in the pictures below. The two short lengths of carbon tube (not included) will be cut to size according to your mast tube length and the height of the combined boom over deck of your boat.

You will need some epoxy to join the mast foot and the mast.

2. Next join the mast foot with the swing rig main boom.



Now you can epoxy the mast foot into the mast.

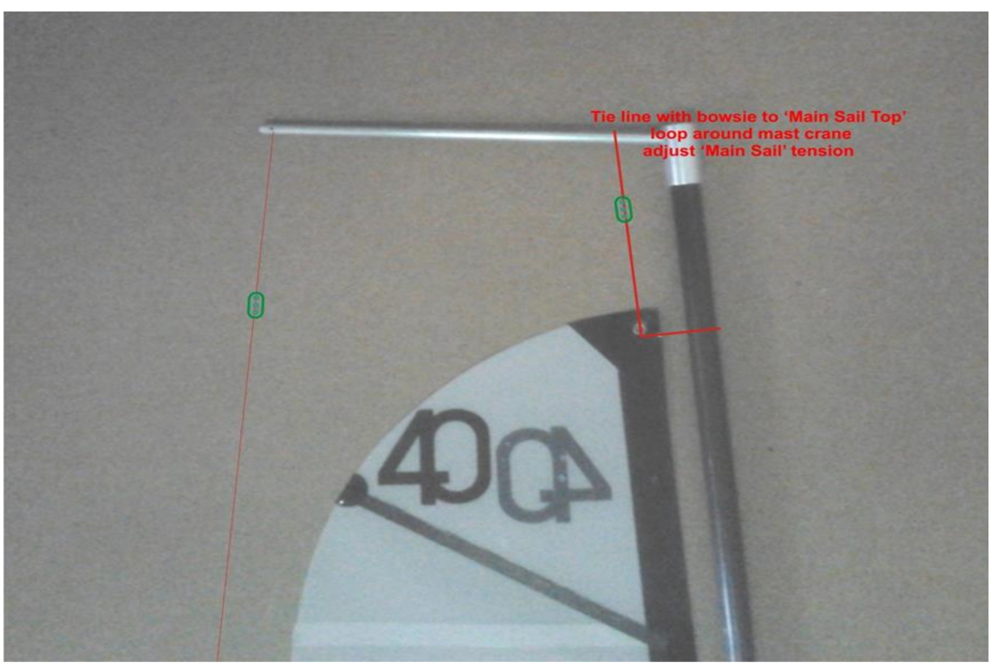
3. Sails:

   Unroll the sails and glue the included precut carbon battens to the seams of main sail and jib leach using double sided tissue tape. Glue a sticker button on each end of the batten.

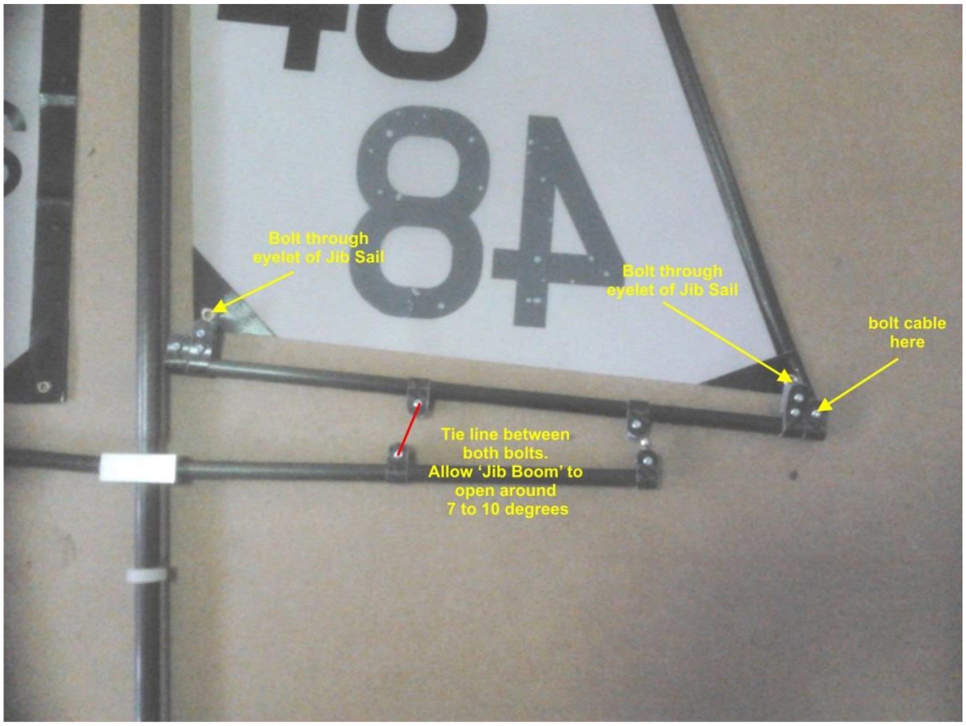
   Batten lengths from sail foot upwards at the leach of each panel joint:

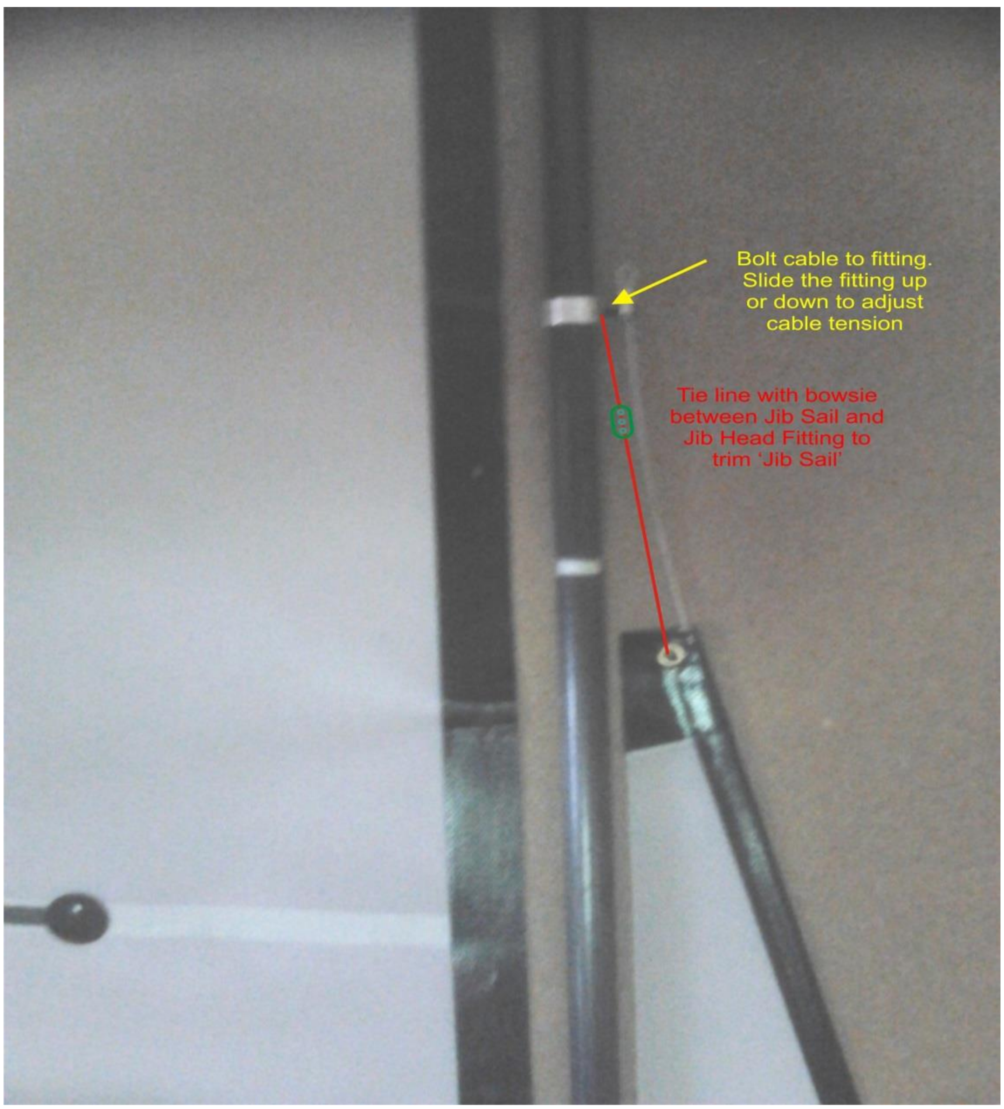
Mainsail		A	B	C
		210mm	210mm	200mm
		165mm	165mm	135mm
		135mm	135mm	
		100mm		
	Gaff	280mm	280mm	280mm
Jib Sail		A	B	C
		125mm	125mm	120mm
		85mm	55mm	

At the sail head glue the gaff battens in 45 degree angle from the upmost panel joint to the leach of the sail on both sides. Drill a hole through the gaff battens near luff to tie the sail to the mast through the batten.

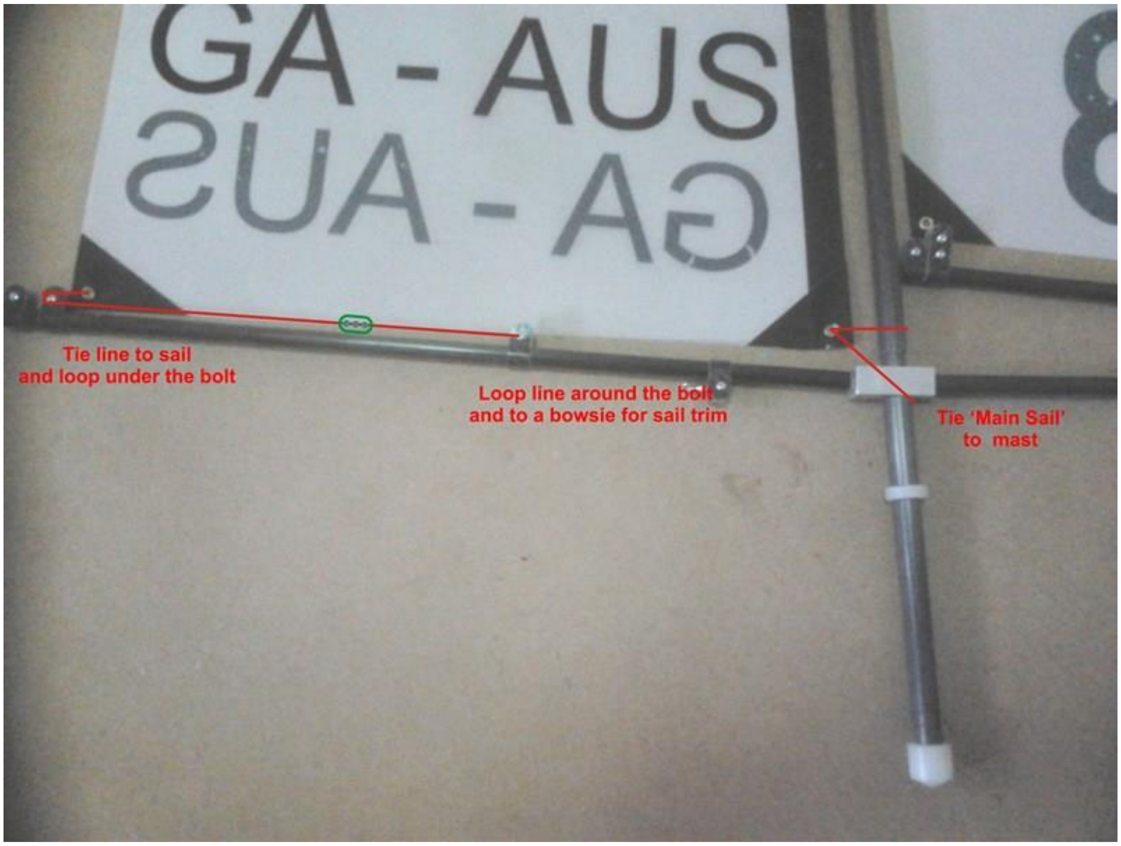


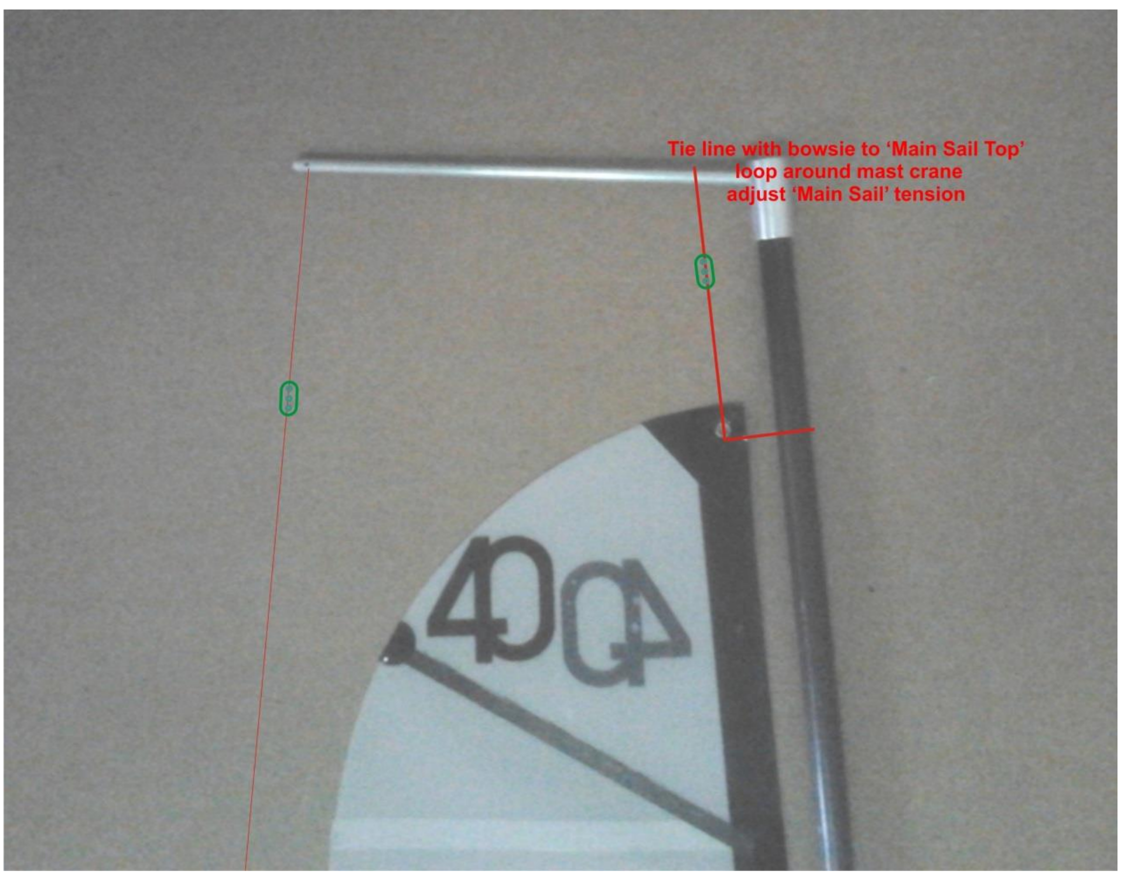
4. Fit the Jib Sail to the Jib Boom according the pictures below:



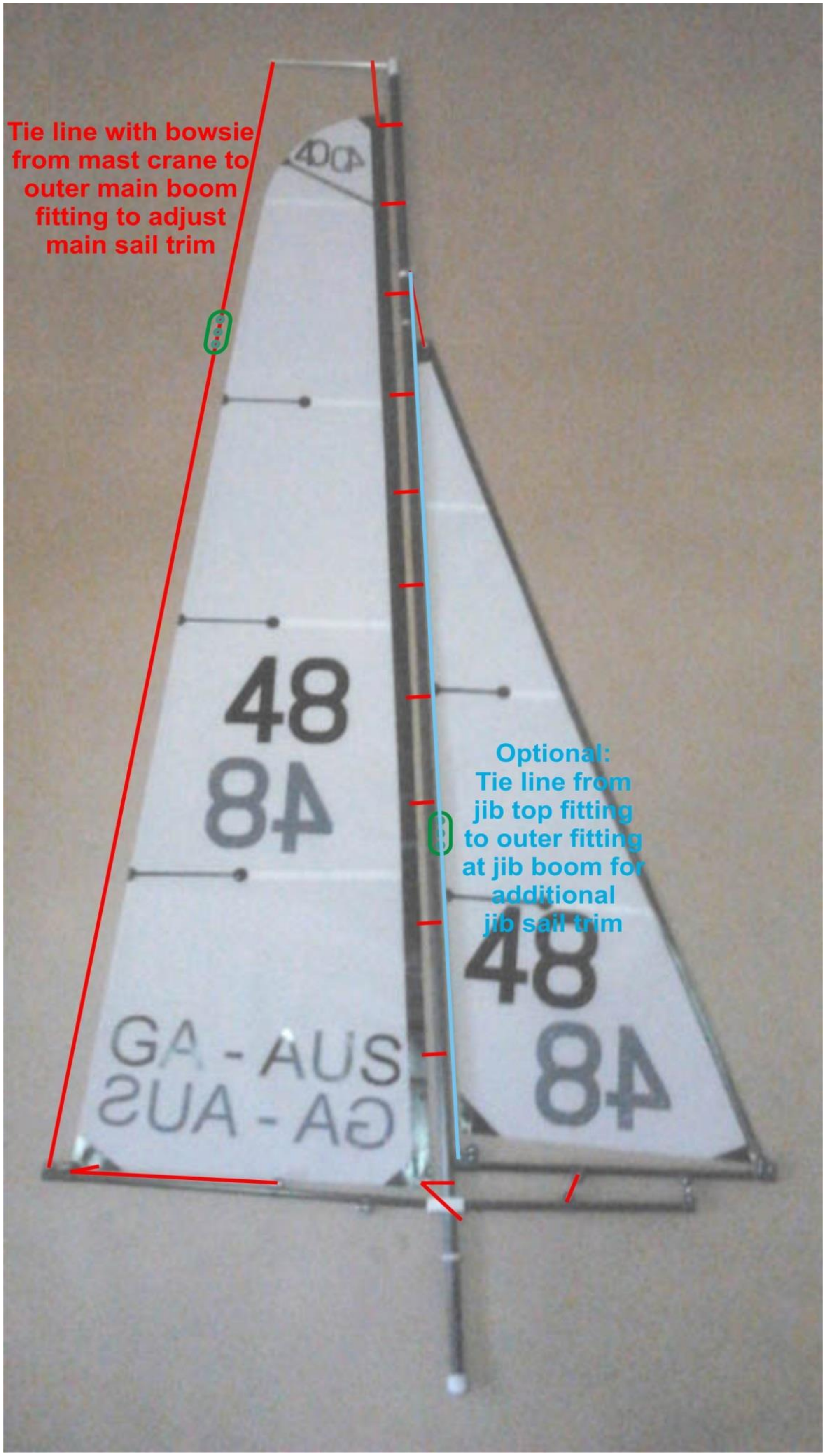


5. Fit the Main Sail to the main boom according the pictures below:





6. Fit the additional lines shown in the picture below:



7. Tie the main sail to the mast using short loops of the enclosed line through the holes in the main sail. You can add a pencil between mast and sail while tying the knots, to get the same distance between mast and sail.

   Don’t forget to secure the knots with a drop of cyano glue.

   Your rig assembly should be done by now and you are ready for the last adjustments between sheeting and rig.

RAPPORT D'EVALUATION
ASSESSMENT REPORT

ENSTA Bretagne

Merci de retourner ce rapport en fin du stage à :
Please return this report at the end of the internship to :

ENSTA Bretagne – *Bureau des stages - 2 rue François Verny - 29806 BREST cedex 9 – FRANCE*
☎ 00.33 (0) 2.98.34.87.70 - Fax 00.33 (0) 2.98.38.87.90 - stages@ensta-bretagne.fr

I - ORGANISME / *HOST ORGANISATION*

NOM / *Name* University of Plymouthe

Adresse / *Address* Drake Circus,Plymouth, Devon PL4 8AA, United Kingdom

Tél / *Phone (including country and area code)* +44 1752 600600

Fax / *Fax (including country and area code)* ____

Nom du superviseur / *Name of placement supervisor*
Jian WAN

Fonction / *Function* Lecturer in Control Systems Engineering, Member of Autonomous Marine Systems (AMS) Research Group

Adresse e-mail / *E-mail address* jian.wan@plymouth.ac.uk

Nom du stagiaire accueilli / *Name of trainee* CLAVIER Evann

II - EVALUATION / *ASSESSMENT*

Veuillez attribuer une note, en encerclant la lettre appropriée, pour chacune des caractéristiques suivantes. Cette note devra se situer entre **A (très bien)** et **F (très faible)**
*Please attribute a mark from **A (very good)** to **F (very weak).***

MISSION / *TASK*

- La mission de départ a-t-elle été remplie ? A B C D E F
  Was the initial contract carried out to your satisfaction?

- Manquait-il au stagiaire des connaissances ? ☐ oui/*yes* ☑ non/*no*
  Was the trainee lacking skills?

  Si oui, lesquelles ? / *If so, which skills?* ____

ESPRIT D'EQUIPE / *TEAM SPIRIT*

- Le stagiaire s'est-il bien intégré dans l'organisme d'accueil (disponible, sérieux, s'est adapté au travail en groupe) / *Did the trainee easily integrate the host organisation? (flexible, conscientious, adapted to team work)*

  A B C D E F

Souhaitez-vous nous faire part d'observations ou suggestions ? / *If you wish to comment or make a suggestion, please do so here* ____

COMPORTEMENT AU TRAVAIL / *BEHAVIOUR TOWARDS WORK*

Le comportement du stagiaire était-il conforme à vos attentes (Ponctuel, ordonné, respectueux, soucieux de participer et d'acquérir de nouvelles connaissances) ?
Did the trainee live up to expectations? (Punctual, methodical, responsive to management instructions, attentive to quality, concerned with acquiring new skills)?

A B C D E F

Souhaitez-vous nous faire part d'observations ou suggestions ? / *If you wish to comment or make a suggestion, please do so here* Can be more focused and better time management as well as organization

INITIATIVE – AUTONOMIE / *INITIATIVE – AUTONOMY*

Le stagiaire s'est –il rapidement adapté à de nouvelles situations ? A B C D E F
(Proposition de solutions aux problèmes rencontrés, autonomie dans le travail, etc.)

Did the trainee adapt well to new situations? A B C D E F
(eg. suggested solutions to problems encountered, demonstrated autonomy in his/her job, etc.)

Souhaitez-vous nous faire part d'observations ou suggestions ? / *If you wish to comment or make a suggestion, please do so here* __________

CULTUREL – COMMUNICATION / *CULTURAL – COMMUNICATION*

Le stagiaire était-il ouvert, d'une manière générale, à la communication ? A B C D E F
Was the trainee open to listening and expressing himself /herself?

Souhaitez-vous nous faire part d'observations ou suggestions ? / *If you wish to comment or make a suggestion, please do so here* __________

OPINION GLOBALE / *OVERALL ASSESSMENT*

- La valeur technique du stagiaire était : A B C D E F
  Evaluate the technical skills of the trainee:

III - PARTENARIAT FUTUR / *FUTURE PARTNERSHIP*

- Etes-vous prêt à accueillir un autre stagiaire l'an prochain ?
  Would you be willing to host another trainee next year? ☑ oui/*yes* ☐ non/*no*

Fait à Plymouth, le 23/08/2018
In Plymouth, *on* 23/08/2018

Signature Entreprise
Company stamp

School of Engineering
University of Plymouth
Drake Circus
Plymouth
Devon
PL4 8AA

Signature stagiaire
Trainee's signature

Merci pour votre coopération
We thank you very much for your cooperation