Design Summary

School/Firm: Autonomous Marine Systems

Boat Name: Robotboat “Kristen D”

Team Members: Walter Holemans

Faculty Advisors: NA

Length: 2.03 m (80 in) Beam: 1.27 m (50 in) Displacement: 45.4 kg (100 lb)
Draft: 0.36 m (14 in) Sail Area: 0.56 m^2 (6 ft^2)

Team History: Walter Holemans has been designing robotboats for 15 years as a hobby and now as a company Autonomous Marine Systems (AMS)

Boat Design Summary: Catamaran, fiberglass epoxy foam hulls, printed ABS wing sail. Speed ~ 3 Kts

Navigation System Summary: Use GPS, magnetic heading and wind vector to control rudder.

Sail Control System Summary: Sail is controlled by a weathervane through a cam. There is no electronic actuator for the sail. The sail does not stow

Design Summary

School/Firm: Queen's University

Boat Name: North Star

Team Members: Marc Burnie, Nick Roberts, James Allison, Jon King, Ricky Hogervorst

Faculty Advisors: Dr. Mike Birk

Length: 2 m (78.7 in)   Beam: 0.4 m (15.7 in)   Displacement: 21.5kg (47.4 lb)
Draft: 1.5 m (59 in)   Sail Area: 2.3 m^2 (24.8 ft^2)

Team History: MAST was founded in 2004 as a result of the absence of a naval architecture and mechatronics design team on campus. MAST became a competitive team after UBC approached Queen's about hosting a competition for autonomous sailing vessels. The first competition, Sailbot, took place a year afterwards; hosted by MAST at Queen's University. The first MAST vessel that was entered in the competition was "Black Adder" which used a 2 meter carbon fiber hull and used a PBASIC Stamp for the control system. After the competition, Black Adder was retrofitted and the CPU was swapped with a more capable Motorolla 68HC12 microprocessor and was later renamed "North Star". North Star competed in the 2007 World Robotic Sailing Championship (WRSC) and received 3rd place despite being too unstable for the rough Irish Sea. MAST also competed in the 2008 Sailbot and WRSC competitions and placed 1st and 3rd respectively. Since then MAST has worked on improving North Star's hull and keel for the 2009 Sailbot competition. MAST has also started work on a 4 meter hull designed specifically for the WRSC competition and plans to have it completed by 2010.

Boat Design Summary: North Star is a custom 2 meter hull originally designed for light winds. The light wind sails are made of aluminum reinforced mylar and the heavy air sails are made of reinforced Kevlar. The CPU is a Motorolla 68HC12 low-power microprocessor; PIC chips are used for sail and rudder control. The HC12 uses GPS, digital compass, tilt, wind speed and direction from various on-board sensors to navigate around a pre-set course. North Star has three modes of operation: fully-automatic, semi-automatic and manual. In fully-autonomous mode North Star controls both sail and rudder positions based on sensor data, semi-autonomous mode only the sails are controlled by the onboard computer system and manual mode the sails and rudder are controlled by a human operator via remote control. Power is supplied by three 7.2V 3Ah NiMh marine hobby batteries.

Navigation System Summary: A Motorolla 68HC12 microprocessor receives tilt-compensated compass, GPS, wind speed and direction data from a variety of sensors. Using this information with pre-programmed GPS waypoints North Star determines the appropriate rudder and sail positions which are transmitted to the motor control board. GPS waypoints and tacking boundaries are set using a graphical user interface (GUI) on a remote laptop and are transmitted via a ZigBee radio modem.

Sail Control System Summary: The rudder and sail position is computed by the HC12 and sent to the PIC chips that continuously updates the rudder and sail motors based on this data. Two motors are used to adjust the main and jib sail that are outfitted with 10-turn potentiometers for position feedback. A continuous rope loop is used to keep tension in the main and jib sheets.

Design Summary

School/Firm: U.S. Naval Academy

Boat Name: “First Time”

Team Members: Tim Keily, Chris Riedel, Brian Rigez, Matt Hays, Matt Hamlet, Peter VanVliet, Owen Brooks, Brian Ocampo

Faculty Advisors: Brad Bishop, Paul Miller

Length: 2 m (78.7 in) Beam: 0.36 m (14 in) Displacement: 26.7 kg (58.9 lb)
Draft: 1.5 m (59 in) Sail Area: 3.1 m^2 (32.8 ft^2)

Team History:
The first USNA team was formed in 2007 and resulted in the construction of “First Time” which entered the 2008 SailBot competition and finished second. The 2009 team came together in September and set to work optimizing “First Time” and designing a new boat.

Boat Design Summary:
“First Time” was a sailboat veteran when work began in September of 2008. She received an upgraded keel, taller mast, greater sweep in her spreader bars and new sails. It was determined that “First Time” had a deficiency in sail area so a taller mast was made to handle sails that increase the sail area by 25%. The newly installed keel also provides greater stability while reducing the total weight of the keel/bulb assembly. “First Time” is a beamier version of the newer “Give Me Liberty” and offers a more stable platform for longer distance travel testing.

Navigation System Summary:
“First Time” is equipped with a Rabbit 3000 microprocessor. Information including heading, wind direction, GPS location, speed and heel are fed into the microprocessor, along with wanted waypoints, using a C programming language. “First Time” has the capabilities to be wirelessly monitored and programmed. With this data “First Time” will calculate what point of sail it will be on, and if sailing upwind, it will determine proper up wind courses to sail, when to tack, and will react to wind shifts.

Sail Control System Summary:
The Rabbit 3000 microprocessor has the ability to output PWM signals which control both the rudder servo and sail winch. A separate PIC microprocessor controls relays which switch between autonomous and manual sail control. Manual sail control is achieved using a standard Futuba radio PWM transmitter and receiver.

Design Summary

School/Firm: U.S. Naval Academy

Boat Name: “Luce Canon”

Team Members: Tim Keily, Chris Riedel, Brian Rigez, Matt Hays, Matt Hamlet, Peter VanVliet, Owen Brooks, Brian Ocampo

Faculty Advisors: Brad Bishop, Paul Miller

Length: 2 m (78.5 in) Beam: 0.28 m (11 in) Displacement: 24 kg (52.9 lb)
Draft: 1.5 m (59 in) Sail Area: 3.1 m^2 (32.8 ft^2)

Team History:
The first USNA team was formed in 2007 and resulted in the construction of “First Time” which entered the 2008 SailBot competition. The 2009 team came together in September and set to work optimizing “First Time.” After a new keel and rig, the team set into velocity prediction programs to determine the most efficient vessel dimensions for the second boat. The result is “Luce Canon” which promises to be a strong competitor.

Boat Design Summary:
The primary dimensions for “Luce Canon” were determined using a VPP that trended to a smaller beam and larger sail area. Every aspect of the design keeps the best sail performance in mind. The keel design balances structural weight with performance along with a redesigned bulb that is much longer and thinner. The redesigned rudder will give better performance and have less frictional drag. This vessel has both a traditional double-spreader and unstayed rigs.

Navigation System Summary:
“Luce Canon” is equipped with a Rabbit 3000 microprocessor. Information including heading, wind direction, GPS location, speed and heel are feed into the microprocessor, along with wanted waypoints, using a C programming language. “Luce Canon” has the capabilities to be wirelessly monitored and programmed. With this data “Luce Canon” will calculate what point of sail it will be on, and if sailing upwind, it will determine proper up wind courses to sail, when to tack, and will react to wind shifts.

Sail Control System Summary:
The Rabbit 3000 microprocessor has the ability to output PWM signals which control both the rudder servo and sail winch. A separate PIC microprocessor controls relays which switch between autonomous and manual sail control. Manual sail control is achieved using a standard Futuba radio PWM transmitter and receiver.

Design Summary

School/Firm: Aberystwyth University, Computer Science

Boat Name: MOOP1

Team Members: Barry Thomas (and Mark Neal)

Faculty Advisors: Mark Neal

Length: 0.72 m (28.4 in) Beam: 0.21 m (8.3 in) Displacement: 4 kg (8.8 lb)
Draft: 0.125 m (4.9 in) Sail Area: 0.08 m^2 (0.8 ft^2)

Team History:

We have been building sailing robots since around 2004 and have a much longer history of mobile and manipulator robotics. Mark Neal has been the focus of this activity, but is surrounded by a small, growing team. Colin Sauze, has carried out much of the software development, and Mark Neal has produced the overall design concepts and many of the prototype components and boats. Recently Barry Thomas has been working on properly engineering the experimental designs we have been working with and this has resulted in the latest series of boats (Mini Ocean Observation Platforms). Barry is a part-time second year undergraduate student who also works part-time on boat development.

Boat Design Summary:

The MOOP is heavily influenced by our earlier wingsail powered boats, but uses a custom built hull equipped with interchangeable wingsails of varying areas. The actuators used are off-the-shelf radio control servos which are controlled by a high end PIC microcontroller (18LF4550). A satellite tracking system (based on a SPOT tracker) is also an optional fitting used for longer missions. All electronic hardware is designed for minimal power consumption and most can be powered down from software. This is to ensure that the boats are completely power-autonomous: power is provided from 26Ah of NiMH batteries and a 400mA (peak) photovoltaic array. The boat uses a magnetic linkage for the rudder movement, but conventional direct drive for the wingsail. The wingsails are fitted with “zero moving parts” ultrasonic wind sensors which are custom built in order to improve reliability for long term operations. The hull is epoxy-glassibre composite, the deck is polycarbonate sheet, the wingsail is foam cored epoxy-glassfibre with a carbon fibre main spar mounted on a stainless steel tubular “mast”.

Navigation System Summary:

A standard GPS and tilt-compensated electronic compass are monitored by the PIC microcontroller and used to derive a great-circle course to steer. A list of pre-loaded waypoints are then visited in turn until the final waypoint is reached where the boat attempts to hold station until recovery. Waypints can also be given a “linger time” if intermediate station holding is required.

Sail Control System Summary:

The wingsail only uses 10 preset positions which allows reasonable but not optimal performance. A highly damped wind direction reading is used to perform sail adjustments. This is mainly to reduce power consumption and “dithering” between sail positions.

Design Summary

School/Firm: Aberystwyth University, Computer Science

Boat Name: MOOP2

Team Members: Barry Thomas (and Mark Neal)

Faculty Advisors: Mark Neal

Length: 0.72 m (28.4 in) Beam: 0.21 m (8.3 in) Displacement: 4 kg (8.8 lb)
Draft: 0.125 m (4.9 in) Sail Area: 0.08 m^2 (0.8 ft^2)

Team History:

We have been building sailing robots since around 2004 and have a much longer history of mobile and manipulator robotics. Mark Neal has been the focus of this activity, but is surrounded by a small, growing team. Colin Sauze, has carried out much of the software development, and Mark Neal has produced the overall design concepts and many of the prototype components and boats. Recently Barry Thomas has been working on properly engineering the experimental designs we have been working with and this has resulted in the latest series of boats (Mini Ocean Observation Platforms). Barry is a part-time second year undergraduate student who also works part-time on boat development.

Boat Design Summary:

The MOOP is heavily influenced by our earlier wingsail powered boats, but uses a custom built hull equipped with interchangeable wingsails of varying areas. The actuators used are off-the-shelf radio control servos which are controlled by a high end PIC microcontroller (18LF4550). A satellite tracking system (based on a SPOT tracker) is also an optional fitting used for longer missions. All electronic hardware is designed for minimal power consumption and most can be powered down from software. This is to ensure that the boats are completely power-autonomous: power is provided from 26Ah of NiMH batteries and a 400mA (peak) photovoltaic array. The boat uses a magnetic linkage for the rudder movement, but conventional direct drive for the wingsail. The wingsails are fitted with “zero moving parts” ultrasonic wind sensors which are custom built in order to improve reliability for long term operations. The hull is epoxy-glassibre composite, the deck is polycarbonate sheet, the wingsail is foam cored epoxy-glassfibre with a carbon fibre main spar mounted on a stainless steel tubular “mast”.

Navigation System Summary:

A standard GPS and tilt-compensated electronic compass are monitored by the PIC microcontroller and used to derive a great-circle course to steer. A list of pre-loaded waypoints are then visited in turn until the final waypoint is reached where the boat attempts to hold station until recovery. Waypints can also be given a “linger time” if intermediate station holding is required.

Sail Control System Summary:

The wingsail only uses 10 preset positions which allows reasonable but not optimal performance. A highly damped wind direction reading is used to perform sail adjustments. This is mainly to reduce power consumption and “dithering” between sail positions.