Abstract : Interceptor 1.4 is a boat that's designed by roboboat team from Universitas Diponegoro, Indonesia. It uses SWATH (Small Waterplan Area of Twin Hull) for its hull to reduce resistance that's generated by hull form. It has propulsor for each cylinder body that can improve manuveribility so that this boat can reach all the mission that's challanged by comitte. System of this boat uses two modes, they are autonomous system and manual system which is completed by sensor, controller, and electrical component to compate in the annual competition in Virginia Beach by association Unmanned Vehicle Systems International (AUVSI) 2014.

I. Introduction

Autonomous vehicle have purpose to help human. The Autonomous Surface Vehicle (ASV) have main purpose to build a autonomous watercraft robot . This ASV project is for international competition in Virginia Beach. This ASV project or Interceptor 1.4 uses. Controller, various sensor and programs of DiBoat 1.1 to make this boat can navigate in autonomous. Additionaly, it possesses a radio control backup system in case the vehicle become lost, allowing it to be manually controlled back to base port.

2. Detailed Design Description

2.1 Background Design

Autonomous is a system that has ability to do a complex task without human interaction. Interceptor 1.4 is the boat using SWATH (Small Waterplan Area of Twin Hull) for it't hull. It's completed by censor, program, and electrical control to make this boat can navigate autonomously to pass the mission. User only manage this boat with remote control when this boat is loss control and drive it into jetty. Generaly, interceptor 1,4 consist of three division, they are design, mechanical, and electrical division.

This boat uses swath system for its hull so that this boat can sail faster and has good stability. From this design, this boat has a large deck opening used to manage electrical component. This boat has various censor such as camera,pinger detected,gps and compass

DESIGN HARDWARE

2.2 Linesplan

Determination for design and dimension based on ship comparation methode. We find out the boat that has similar form and dimension then we scale it into real dimension as we need. Linesplan of this vessel are as follows :

1	Displacement	3344,5	kg	14	LCB from aft perp. (+	35,427	mm
2	Volume	3344,5	mm^3	15	LCF from aft perp. (+	35,209	mm
3	Draft to Baseline	4	mm	16	LCB from aft perp. (+	49,183	%
4	Immersed depth	5,2	mm	17	LCF from aft perp. (+	48,88	%
5	Lwl	72	mm	18	KB	2,3	mm
6	Beam wl	62,2	mm	19	KG	10	mm
7	WSA	2323,7	mm^2	20	BMt	237,6	mm
8	Max cross sect area	56,4	mm^2	21	BMl	122,4	mm
9	Waterplane area	1075,3	mm^2	22	GMt	229,9	mm
10	Cp	0,823		23	GMl	114,7	mm
11	Cb	0,557		24	KMt	239,9	mm
12	Cm	0,677		25	KMl	124,7	mm
13	Cwp	0,933		26	Immersion (TPc)	10,753	tonne/c
				27	MTc	0,053	tonne.
				28	RM at 1deg = GMt.Di	13419,1	kg.mm
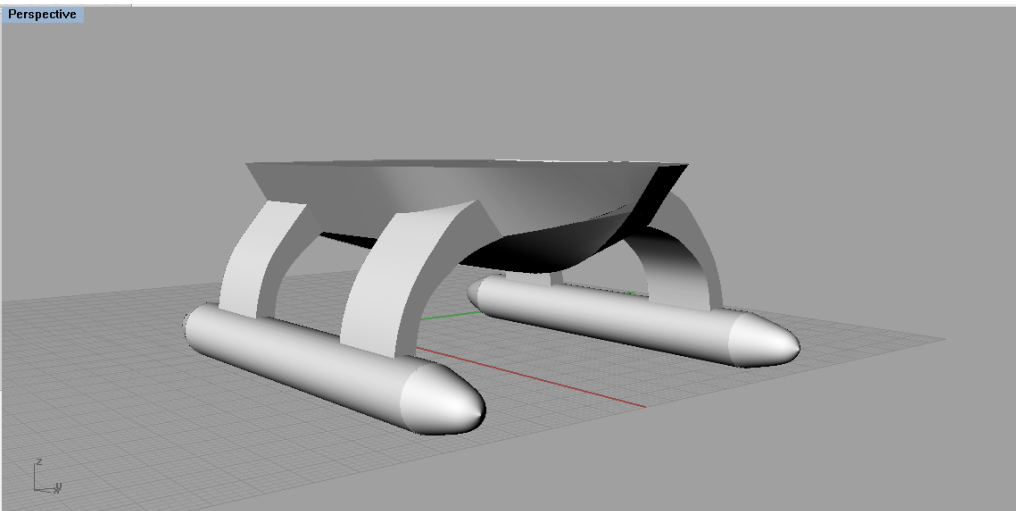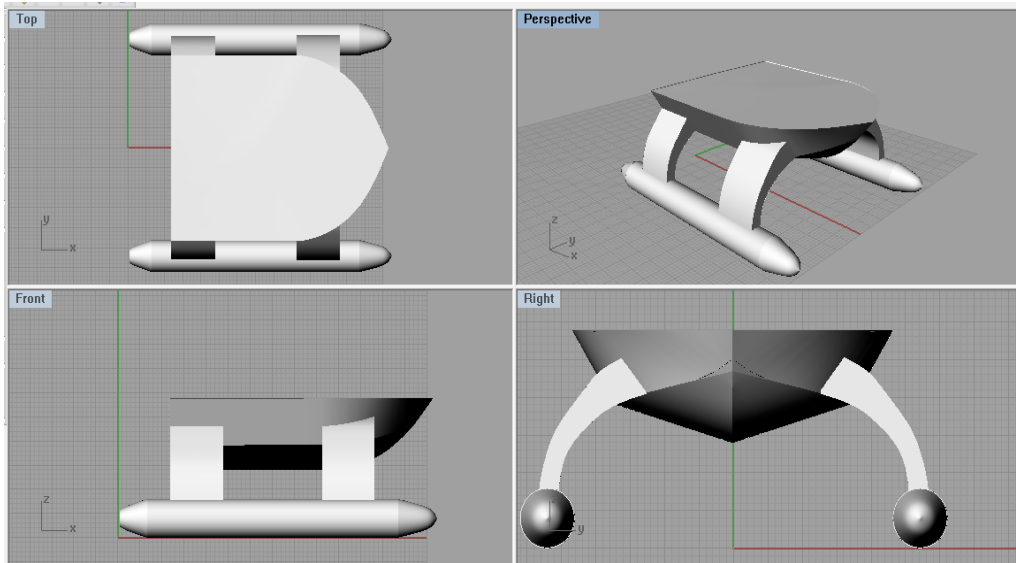
Perspective View

2.1.2. Hydrostatic curve

Hydrostatic curves are curves that show the characteristics of a submerged bilge water. Including the following :
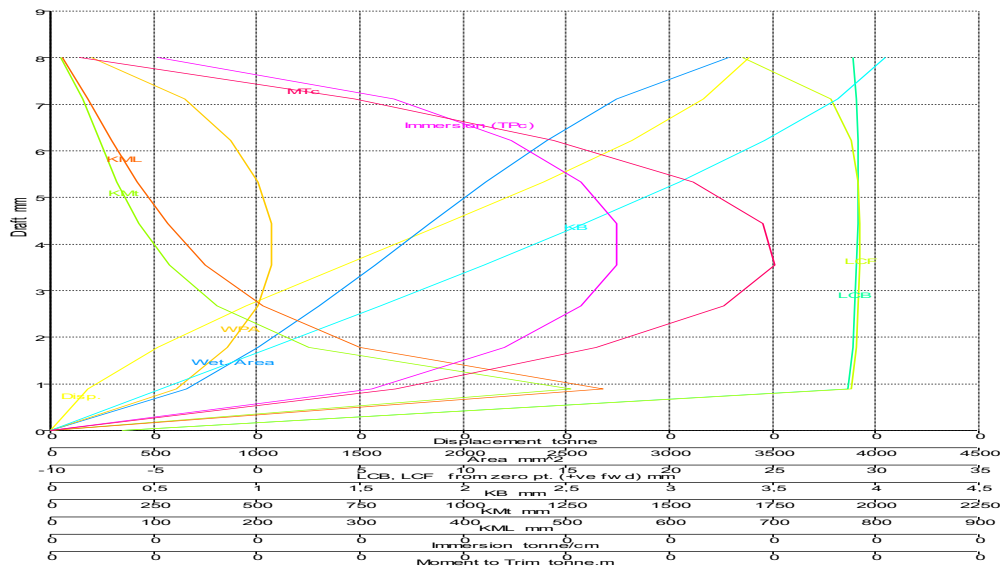

Fixed Trim = 0 mm (+ve by stern)
Relative Density (specific gravity) = 1,025; (Density = 0 tonne/mm^3)

| Draft Amidsh. mm	0,0	0,9	1,8	2,7	3,6	4,4	5,3	6,2	7,1	8,0
Displacement tonne	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Heel to Starboard degrees	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Draft at FP mm	0,0	0,9	1,8	2,7	3,6	4,4	5,3	6,2	7,1	8,0
Draft at AP mm	0,0	0,9	1,8	2,7	3,6	4,4	5,3	6,2	7,1	8,0
Draft at LCF mm	0,0	0,9	1,8	2,7	3,6	4,4	5,3	6,2	7,1	8,0
Trim (+ve by stern) mm	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
WL Length mm	12,0	63,6	68,9	71,1	71,7	71,7	71,1	68,9	63,6	57,0
WL Beam mm	0,0	59,1	60,8	61,7	62,1	62,1	61,7	60,8	59,1	56,5
Wetted Area mm^2	0,0	656,3	1008,8	1304,7	1574,7	1838,2	2107,7	2402,7	2748,5	3290,2
Waterpl. Area mm^2	0,0	606,8	859,7	1004,4	1069,6	1069,6	1004,7	872,2	648,2	201,3
Prismatic Coeff.	0,000	0,935	0,897	0,895	0,903	0,913	0,926	0,953	1,011	1,082
Block Coeff.	0,000	0,633	0,624	0,649	0,687	0,739	0,817	0,896	1,019	1,272
Midship Area Coeff.	0,000	0,677	0,696	0,725	0,761	0,810	0,883	0,940	1,008	1,176
Waterpl. Area Coeff.	0,000	0,962	0,939	0,940	0,941	0,941	0,940	0,885	0,760	0,310
LCB from zero pt. (+ve fwd) mm	-6,6	28,7	28,9	29,0	29,1	29,1	29,1	29,1	29,0	28,9
LCF from zero pt. (+ve fwd) mm	-6,6	28,8	29,1	29,1	29,3	29,3	29,2	28,8	27,8	23,6
KB mm	0,0	0,5	1,1	1,6	2,1	2,6	3,0	3,5	3,8	4,0
KG mm	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0
BMt mm	0,0	1258,7	624,5	401,0	284,6	211,7	159,2	116,6	76,1	20,4
BML mm	0,0	535,1	298,6	204,5	148,4	110,4	81,3	55,9	32,7	8,3
GMt mm	-10,0	1249,3	615,5	392,6	276,7	204,3	152,2	110,1	69,9	14,5
GML mm	-10,0	525,7	289,7	196,1	140,5	103,0	74,3	49,4	26,5	2,4
KMt mm	0,0	1259,3	625,5	402,6	286,7	214,3	162,2	120,1	79,9	24,5
KML mm	0,0	535,7	299,7	206,1	150,5	113,0	84,3	59,4	36,5	12,4
Immersion (TPc) tonne/cm	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
MTc tonne.m	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
RM at 1deg = GMt.Disp.sin(1) tonne.mm	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Max deck inclination deg	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trim angle (+ve by stern) deg	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

2.1.3 Stability

Stability is the ability of an object to float or float back to its original position after a force from outside influences. This ship stability calculations using the standard IMO A. 749
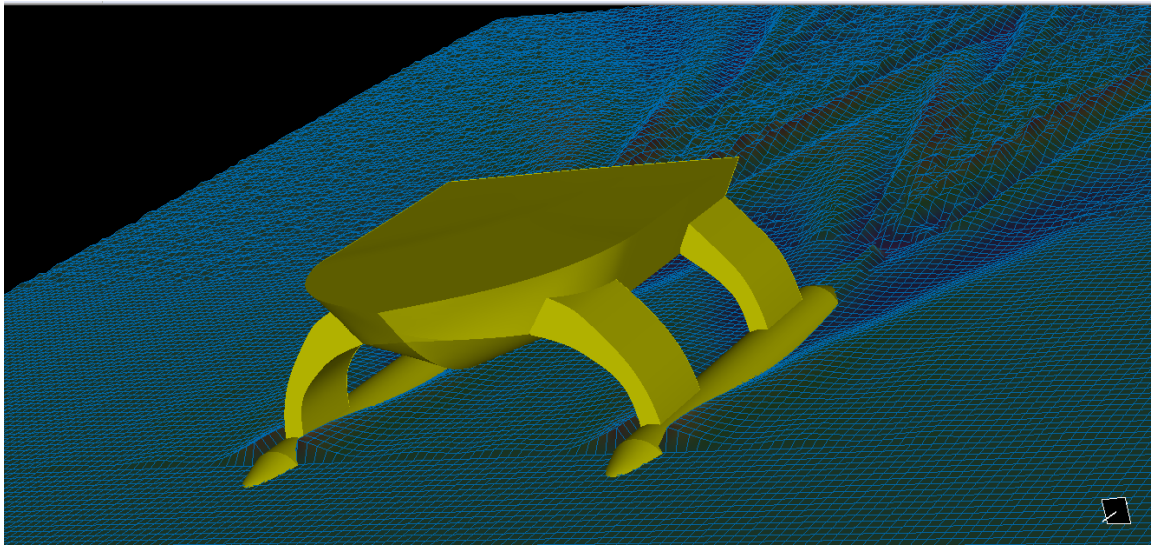
(18) ch 3, with the maximum stability Arm (GZ max) is 1.126 meters, the maximum stability occurs at arm tilt angle of 20
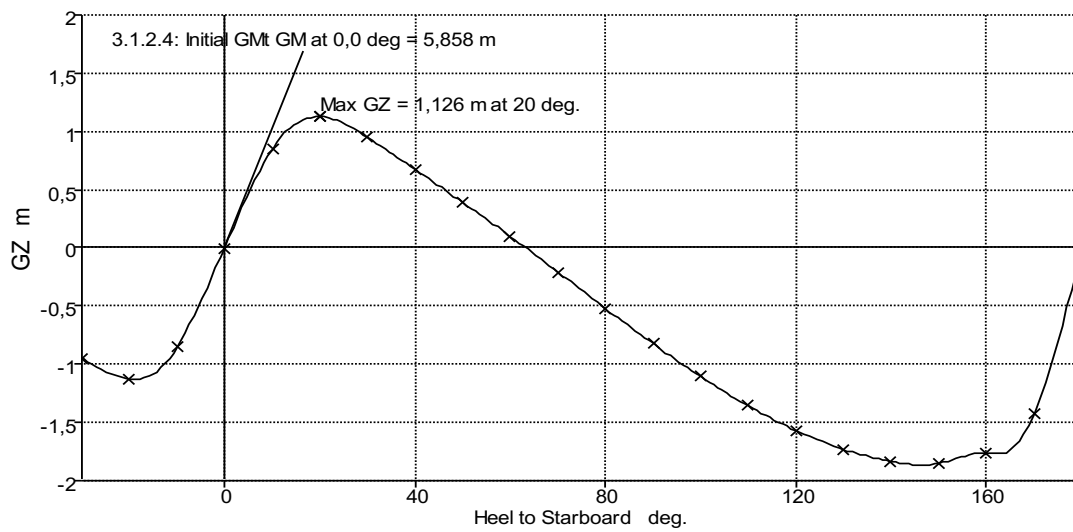
2.1.4 Resistance

The method used for this analysis is a slender body, by knowing the resistance vessels, we can know the power that is used in order to meet the desired speed:
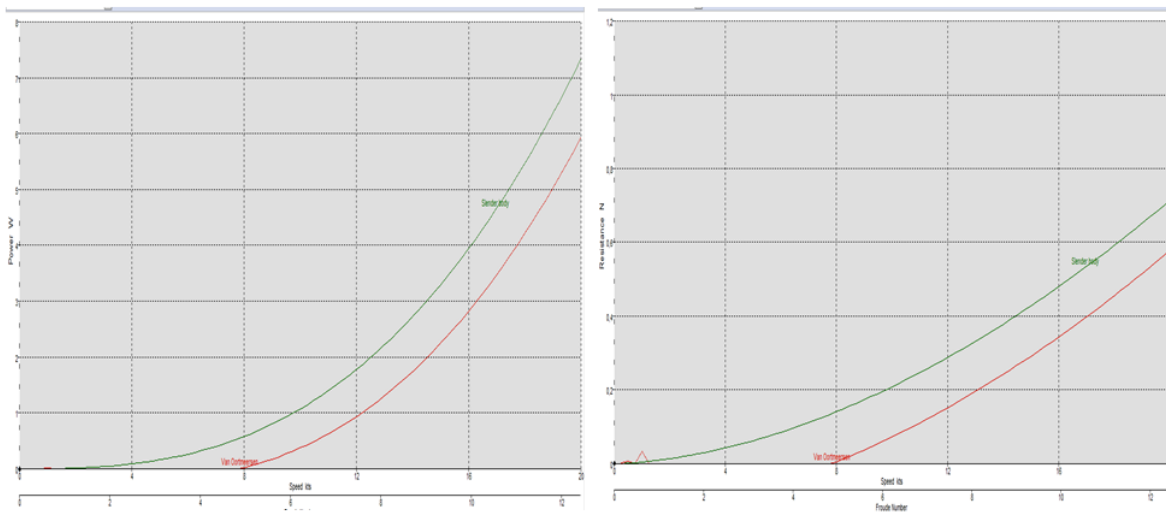
Software Design

The software used as the boat artificial intelligence is built on top of C# .NET Framework. The Platform itself is a desktop application so it can easily deployed on PC. A scenario editor provided in the program's interface, was designed to help the end-user configure the boat behavior for any circumstances based on the constrain of each mission.

1. Vision

   The software implement AFORGE.NET libraries to help the boat recognize the environment. These library use the Euclidean Color Filtering to distinguish the color of the buoy which is used as the reference of navigation heading in the speed gates and the first mission. To keep the track of red and green buoy, the system uses one camera (hereinafter referred to as gate viewer) for each of those buoys. Each camera is attached with a servo to mobilize the camera heading and the algorithm will maintain camera view to focus on a buoy. The action of algorithm maintaining the camera heading, result in the angle production of servo's rotation, which will be gathered as boat's heading data relative to the gates. As the route of first mission is filled by colored obstacles, a camera located at the prow (hereinafter referred to as obstacle viewer) is utilized by the software provide a color array to save the value of every color used as the obstacle buoy color. The algorithm will produce a warning if there is obstacle on safe area, and execute the appropriate action of the corresponding detection. The gate viewer will also recognize polygon in docking mission.

2. Navigation

   The software calculate the GPS data from Arduino (which is defined as current location data) and the one that saved on program's memory (which is defined as desired location data), to create the boat's desired heading using Haversine formula. An error of heading will be calculated by finding the difference between current heading and desired heading. As mentioned before, the angle of servo's rotation will be calculated to produce desired heading which is only used in first mission, the obstacle avoidance.

A. Electrical system

According to the last year design we make an improvement, in software and hardware. But the improvement still make the system simple and powerfull. Because with simple system we avoid the error caused by complexity algorithm. Just make a effective and efficient design.

The laptop Lenovo thinkpad yoga with processor Intel Core i5-4200U and RAM 4GB DDR3 has been chosen as the main processor. The main processor will calculate the data of 3 camera (webcam Logitech C270 with servo, 2 camera moves and 1 camera static) to get buoys position and convert it to the control signal throttle and rudder. The control signal will be transferred to the control board (Arduino Mega) microcontroller board based on the ATmega1280 It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The main processor also have to finished the TCP/IP task by using the internal wireless module, acquired GPS data and get the heat data.

A.1 Cooling System
The new ship's body has a new cooling system that is much more efficient than the system that was used in previous years. This new cooling system consists of two fans, similar to last years, except the fans are located on the end of the box instead of the top. Another major difference is,
both fans are facing the same direction, to double the airflow. The airflow now goes in the forward facing side of the box and out the rear facing side. This box has slits along the rear facing side to allow the hot air escape from the box. We also oriented the internal components of the box so that they would not block any airflow through the box.

A.2 Power
Two Lipoly Battery use for our robot. Turnigy Nanotech 3S use as the supply voltage of the brushed and Turnigy Nanotech 2S use as the supply voltage of the others. We use separate supply voltage to avoid the error caused by lack of voltage. The brushed motor itself can

drain the battery rapidly. So, if we joint the voltage source, it will be used up rapidly and will be lack of energy in controller series which is cause controller series become error.

**A.3 Sensory and Servo**

A.3.1 Camera (Webcam Logitech)

We used 3 webcam Logitech C270 as our main vision sensor, which uses the RGB color space for data output. The Logitech C270 is capable of 3 mega-pixel resolutions for video output. The camera resolution is scaled down to 640x480 pixels to enhance processing speed and reduce computational power requirements. The resolution of the camera controls the amount of video frames per second that can be processed. Since pixels are processed in a matrix form, the more pixels, the longer processing time required for each frame.

A.3.2 DS04-NFC 360°

This is a continuous rotation DC servo gear motor. Comes with a package of mounting hardware and cranks/pivot arms.

Specifications:

- Weight: 38g (grams)
- Size: 40.8mm x 20mm x 39.5mm
- Torque: @4.8vDC 5.5kg/cm
- Speed: @4.8vDC 0.22sec/60°
- Current draw:under 1 amp
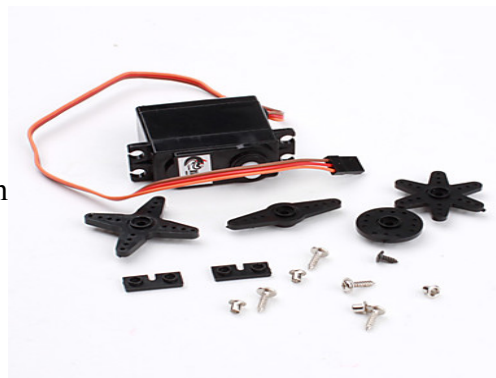
A.3.3 GPS Module APM2.5 NEO-6M

Cost effective, high-performance u-blox 6 based NEO-6 series of GPS modules, that brings the high performance of the u-blox 6 positioning engine to the miniature NEO form factor. The module will automatically fix its gps position and output positioning information via its serial port with no configuration.

These receivers combine a high level of integration capability with flexible connectivity options in a small package. This makes them perfectly suited for mass-market end products with strict size and cost requirements.

Specification:

- GPS module, 3 v - 5 v power supply general
- Ublox NEO - 6 m module cabin with ceramic is predestined friends the antenna, the signal is strong
- Take the data backup battery
- Take data off electric storage EEPROM
- Antenna size and * 22 mm

A.3.4 CMPS03

The magnetic compass needed to aid the navigation of the robot. In this case we used CMPS03 because it's easy to purchase and easy to use. The specification of CMPS03 is shown below:

- Supply voltage : 5 VDC
- Current consumption : 15 mA
- Interface : I2C or PWM
- Accuracy : 3-4 degree
- Resolution : 0,1 degree
- Time conversion : 40 ms or 33,3 ms can be choosen by changing the register.
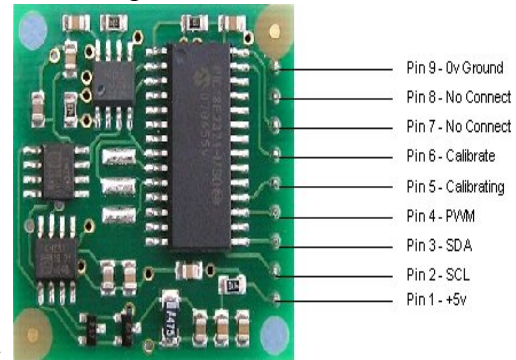
A.4 Main Processor

Different than the robot 2 years ago, in this year we use the Arduino Mega as main processor in our robot. The Arduino Mega is a microcontroller board based on the ATmega1280 It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.
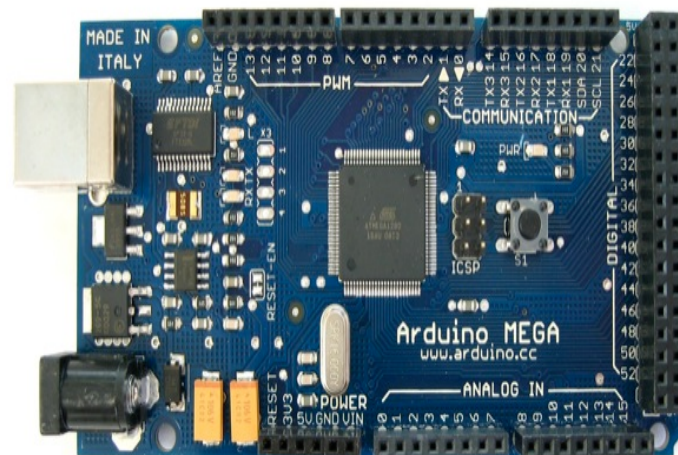
A.5 Motor Driver

In this year our robot use 2 motor brused DC and then for the motor driver we use EMS (Embedded Module Series) 30 A H-Bridge H-Bridge driver is designed to generate two-way drive with a continuous current to 30 A at a voltage of 5.5 Volts to 16 Volts. Equipped with a load current sensor circuit that can be used as feedback to the controller. This module is able to drive inductive loads such as DC motors, stepper motors, relay coils, selenoida, and other expenses. Dimensions: 7.4 cm (p) x 6.1 cm (l) x 1.9 cm (t).

specifications:
- Consisting of a full H-Bridge driver. (IC VNH2SP30 features the current sense).
- Drivers capable of passing continuous current 30 A and support the load voltage from 5.5 V to 36 V (IC VNH2SP30 only up to 16V).
- Input compatible with TTL and CMOS voltage levels.
- Output tri-state.
- The output MOSFET with low drain-source resistance (typ. 0.034 ohm).
- Supports PWM control with a frequency of up to 20 Khz.
- Fault detection.
- Short-circuit protection and overtemperature protection.
- Undervoltage and overvoltage shutdown.
- Reverse battery protection.
- Line power supply input (logic) separate from the power supply line to the load.