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CELEBRATING 150 YEARS IN BROOKLYN

The Ground Sailor

Mechatronics

ME 5643 - 2008

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The Ground Sailor

Outline

- Introduction to sailing
- Sensors & Actuators
- Electronic Hardware & Circuitry
- PBasic Code
- Design
- Conclusions

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Introduction to sailing

Figure 1

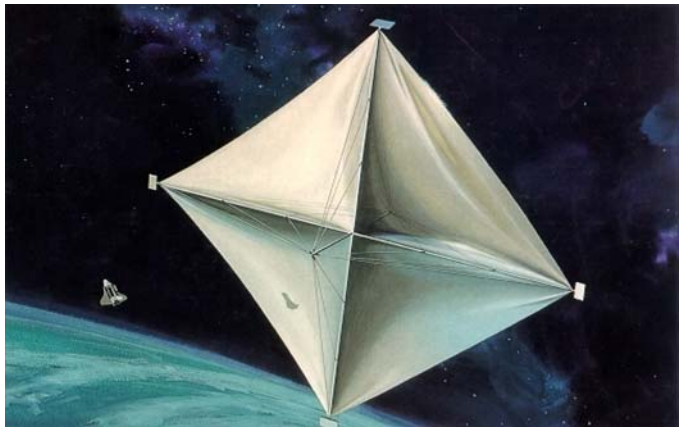

Figure 3

Figure 2

The Ground Sailor

Introduction to sailing

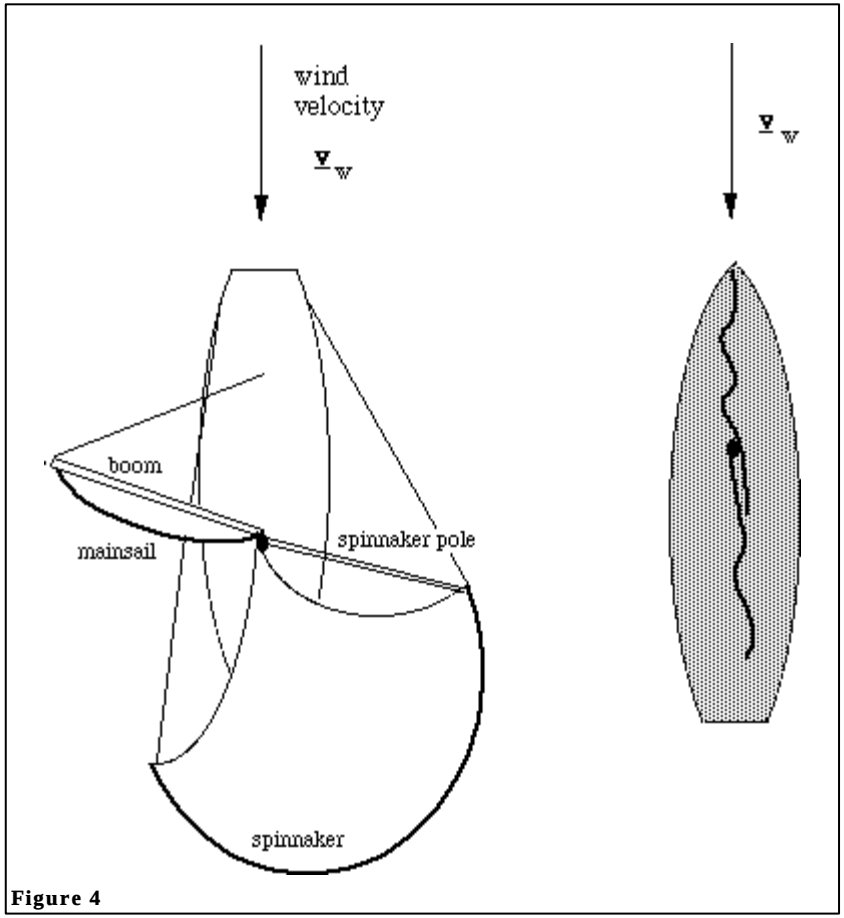

Figure 4

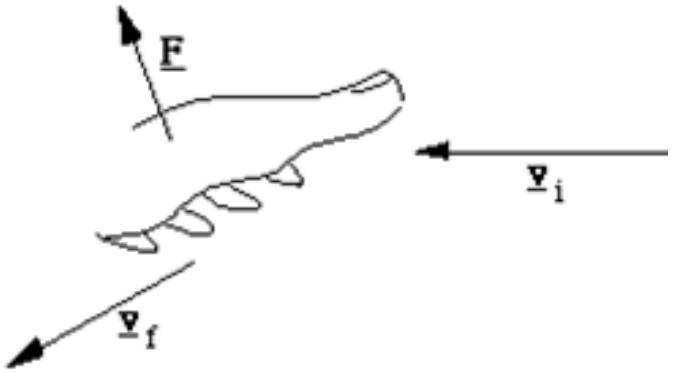

Figure 5

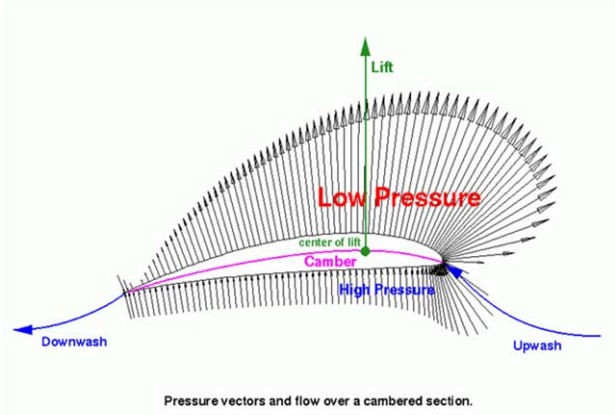

Figure 6

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Introduction to sailing

A. In irons (into the wind)

B. Close haul (27.5° to the apparent wind)

C. Beam reach (90° to the apparent wind)

D. Broad reach (27.5° away from directly downwind sailing)

E. Running (directly downwind)

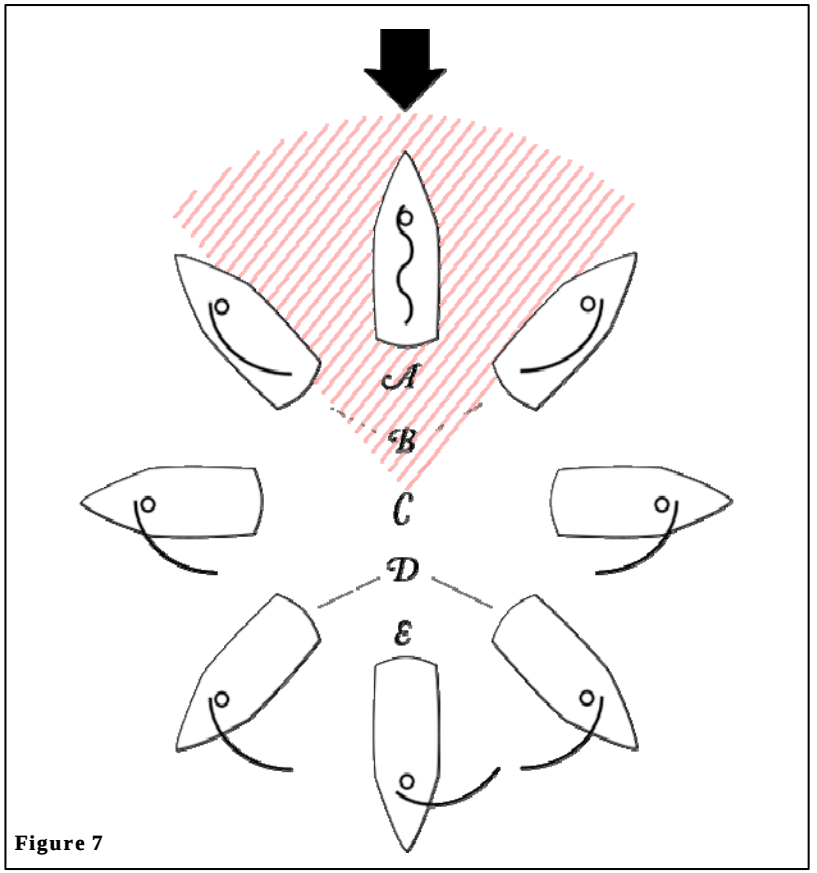

Figure 7

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Sensors

- Analog Hall-Effect Compass
- Non Contacting Hall-Effect Angle Sensor
- Encoder
- Parallax (Futaba) Standard Servo
- ¼ Scale Hobbico Servo CS-72

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The Ground Sailor

Analog Hall-Effect Compass

The Robson Company, Inc.

Model R1655

- Weight 2.25 grams
- Operating Temp. -40°C to +85°
- Current requirement: between 18 and 19 mAmps at 5.00 volts

Figure 9

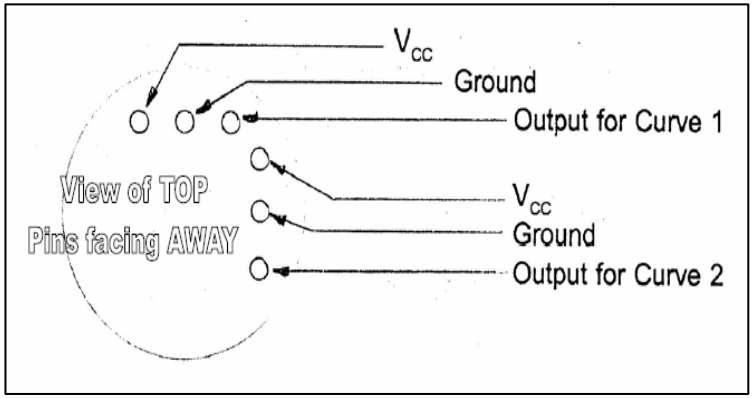

Figure 10

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Analog Hall-Effect Compass

The output closely resembles a sine-cosine set of curves which cross at approximately 2.5 volts and peak at approximately 3.1 volts and floor at about 1.9 volts.

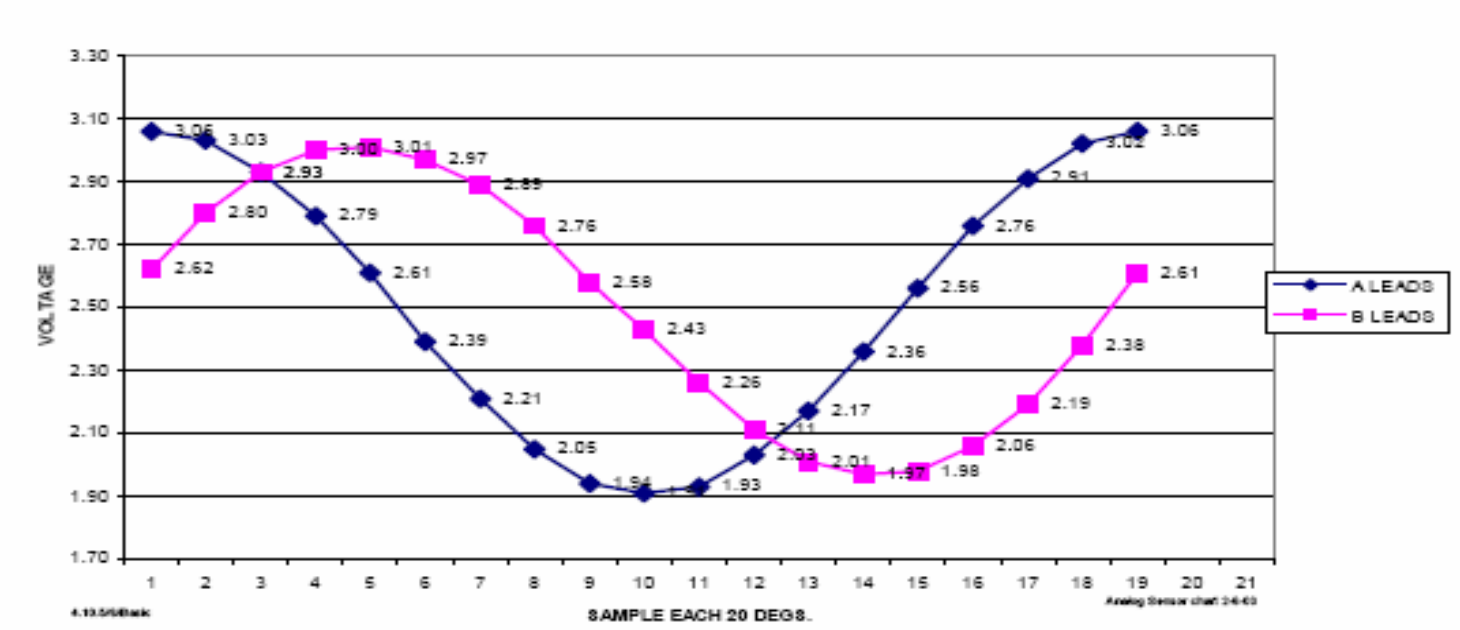

Figure 11

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Non Contacting Hall-Effect Angle Sensor

GMW Associates
Ametes 360ASMF

- Single 5V Power Supply
- Electronic Setting of Zero Angle
- Angle Resolution to 10 bits (0.1%) of Full scale

Figure 12

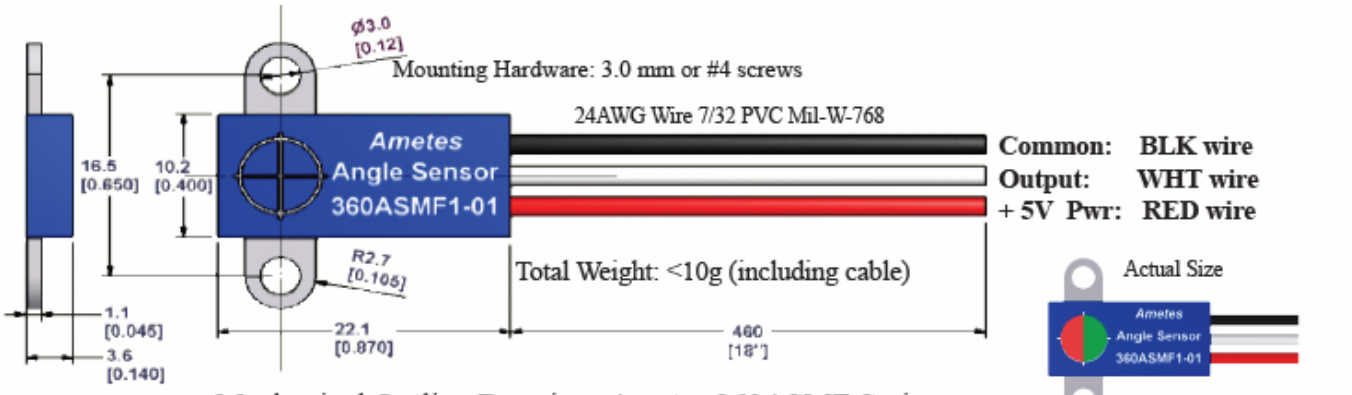

Figure 13

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Encoder

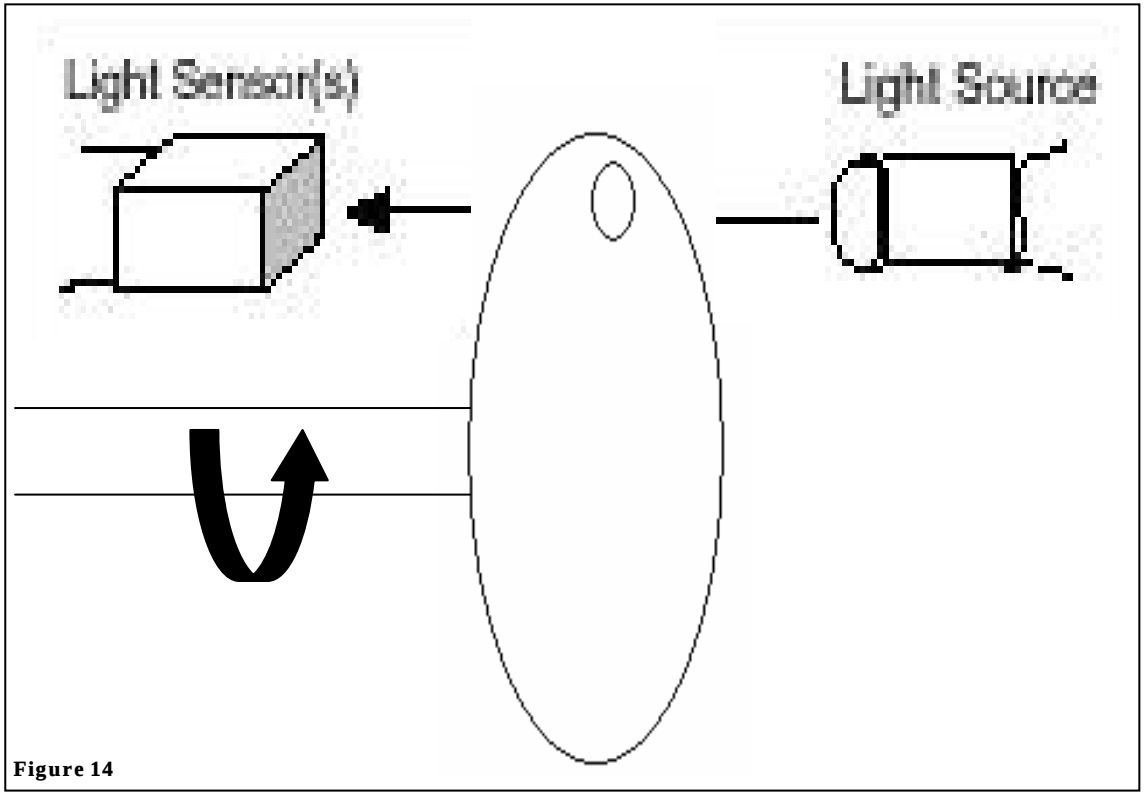

Figure 14

Figure 15

Figure 16

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Parallax (Futaba) Standard Servo

- Power 6vdc max
- Speed 0 deg to 180 deg in 1.5 seconds on average
- Weight 45.0 grams/1.59oz
- Torque 47 oz-in
- Size mm (L x W x H) 40.5x20.0x38.0

Figure 17

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Hobbico Servo CS-72

- Power at 4.8 V or 6 V
- Speed 0.19 sec/60
- Weight 3.60 oz.
- Torque 161.00 oz-in at 6 V
- Size in. 2.3 x 1.1 x 2.0 (L x W x H)

Figure 18

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Electronic Hardware

- 3 Basic Stamps
- 3 ADC
- 23 Resistors
- 1 Potentiometer
- 1 Switch
- 4 1.2 V batteries
- 1 9.0 V battery
- 1 LCD

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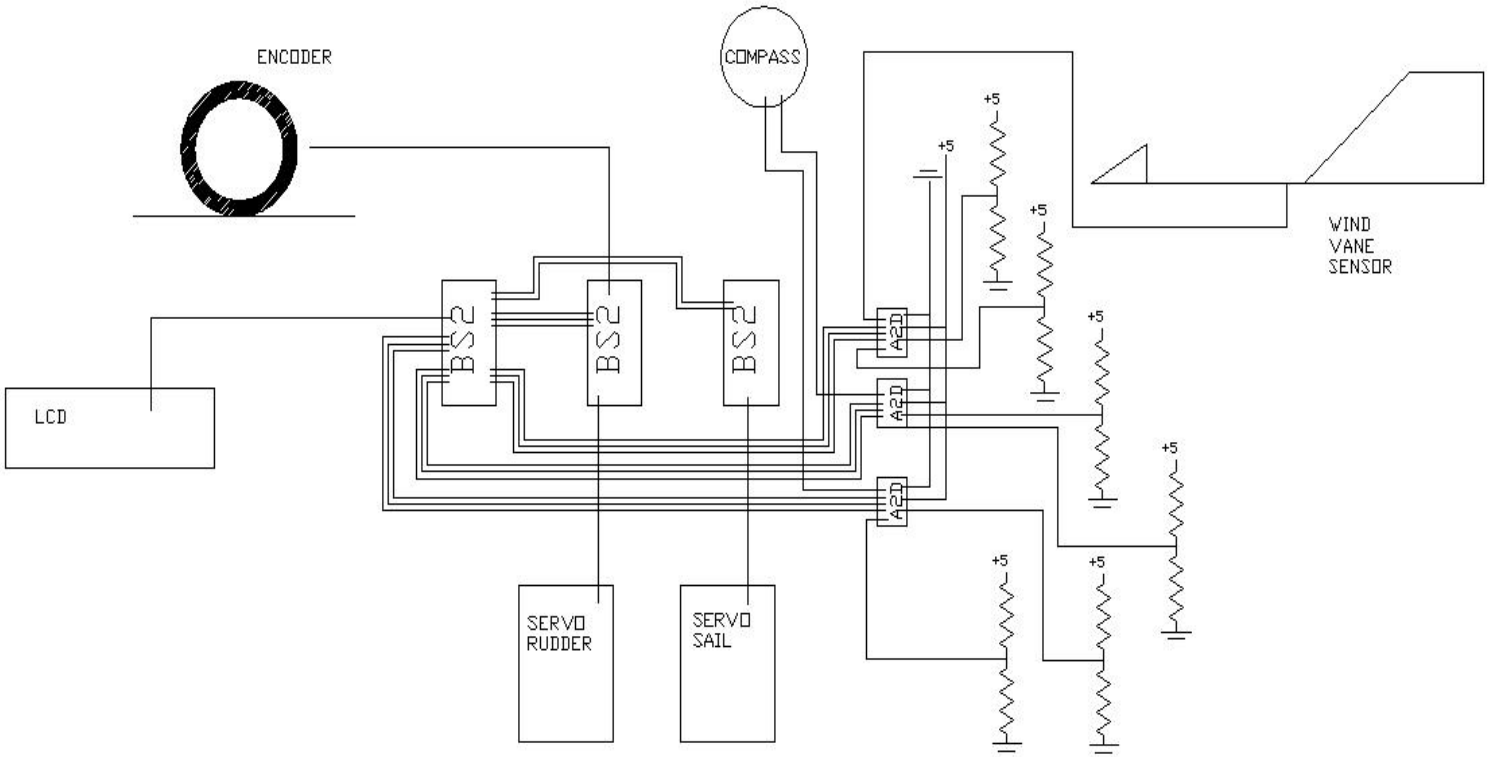
Circuitry scheme



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PBasic Code

```
' {$STAMP BS2}
' {$PBASIC 2.5}
'==================Variable Declaration=========================================
sailpic     VAR Word
windir1     VAR Word
wheelpic    VAR Word
compdir1    VAR Byte
compdir2    VAR Byte
windir      VAR Byte
windcomp    VAR Byte
compdirb    VAR Byte
routeb      VAR Byte
windrel     VAR Byte
rot         VAR Byte
'==================Constant Declaration=========================================
bolconst    CON 55
bolconstb   CON 38
Central     CON 700
Central2    CON 660
'==================Pin assignment===============================================
CSW         PIN  0
CLKW        PIN  1
DatainW     PIN  2
CSC1        PIN 4
CLKC1       PIN 5
DatainC1    PIN 6
CSC2        PIN 3
CLKC2       PIN 11
DatainC2    PIN 12
```

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PBasic Code

```
'==================Main Programm=================================================
GOSUB Compass                                   'Read sailor position relative to magnetic Nord Pole
DEBUGIN DEC3 routeb                             'Gives the route
DEBUG HOME,CR,CR,CR,CR,CR, "route value: ", DEC3 routeb

Main:
GOSUB WindAngle                                 'Reads wind angle respect to sailor
GOSUB Compass                                   'Reads sailor position
windcomp=windir+compdirb                        'Reads wind angle respect to NORD
GOSUB Sail                                      'Controls sail respect to relative wind angle
GOSUB Rudder                                    'Controls Rudder respect to route and sailor position
DEBUG HOME,CR,CR, ? wheelpic
SEROUT 15, 84, [22, 12]                         'Initializes LCD
PAUSE 3
SEROUT 15, 84, [DEC compdirb, 13, DEC routeb]   'Debug route and position on LCD
GOTO Main
```

The Ground Sailor

PBasic Code

```
'==================SubRoutines============================

WindAngle:
HIGH CSW                                                    'Data aquisition from A2D for wind angle
LOW CSW
LOW CLKW
PULSOUT CLKW, 210
SHIFTIN DatainW,CLKW,MSBPOST,[windir\8]
windir=windir-11
windir1=windir*/360
RETURN

Sailmove:                                                   'Comunication to second basic stamp of the sail
SEROUT 13\14, 84, [sailpic.HIGHBYTE, sailpic.LOWBYTE]       'Position through serout command
RETURN
```

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PBasic Code

```
Compass:                                                    'Data aquisition from A2D for wind angle
HIGH CSC1                                                   'from the second and third A2D of the compass
HIGH CSC2
LOW CSC1
LOW CSC2
LOW CLKC1
LOW CLKC2
PULSOUT CLKC1, 210
PULSOUT CLKC2, 210
SHIFTIN DatainC1,CLKC1,MSBPOST,[compdir1\8]
SHIFTIN DatainC2,CLKC2,MSBPOST,[compdir2\8]
IF compdir1>=209 AND compdir2>=88 AND compdir2<209 THEN     'Correlation of compass two signals
compdirb=((209-compdir2)*100/(209-88)*64)/100               'to the sailors position
ELSEIF compdir2<88 AND compdir1>=51 AND compdir1<244 THEN
compdirb=(((244-compdir1)*100/(244-51)*96)/100)+64
ELSEIF compdir1<51 AND compdir2>65 AND compdir2<=198 THEN
compdirb=(((compdir2-65)*100/(198-65)*32)/100)+160
ELSEIF compdir1>22 AND compdir1<209 AND compdir2>198 THEN
compdirb=(((compdir1-22)*100/(209-22)*64)/100)+192
ENDIF
RETURN
```

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PBasic Code

```
Sail:
IF windir > 128 THEN
windrel=255-windir
ELSE
windrel=windir
ENDIF
  IF windir1<bolconst THEN                          'Making decision on the sail position before
    sailpic=Central                                 'comunicating to the second basic stamp
    GOSUB Sailmove
  ELSEIF windir1>=bolconst AND windir1<bolconst+60 THEN
    sailpic=Central+(windrel*2)
    GOSUB Sailmove
  ELSEIF windir1>=bolconst+60 AND windir1<bolconst+125 THEN
    sailpic=1060
    GOSUB Sailmove
  ELSEIF windir1>=bolconst+125 AND windir1<bolconst+190 THEN
    sailpic=345
    GOSUB Sailmove
  ELSEIF windir1>=bolconst+190 AND windir1<360-bolconst THEN
    sailpic=Central-(windrel*2)
    GOSUB Sailmove
  ELSEIF windir1>=360-bolconst AND windir1<360 THEN
    sailpic=Central
    GOSUB Sailmove
  ENDIF
RETURN
```

The Ground Sailor

PBasic Code

```
Rudder:                                                    'Making decision on the rudder position before
SELECT compdirb                                            'comunicating to the third basic stamp
  CASE >routeb
  rot=compdirb-routeb
  SELECT rot
    CASE >=64
    wheelpic=950
    SEROUT 9\10, 84, [wheelpic.HIGHBYTE, wheelpic.LOWBYTE]
    CASE <64
    wheelpic=Central2+((rot/2)*6 )
    SEROUT 9\10, 84, [wheelpic.HIGHBYTE, wheelpic.LOWBYTE]
  ENDSELECT
  CASE <routeb
  rot=routeb-compdirb
  SELECT rot
    CASE >=64
    wheelpic=390
    SEROUT 9\10, 84, [wheelpic.HIGHBYTE, wheelpic.LOWBYTE]
    CASE <64
    wheelpic=Central2-((rot/2)*5)
    SEROUT 9\10, 84, [wheelpic.HIGHBYTE, wheelpic.LOWBYTE]
    ENDSELECT
ENDSELECT
RETURN
```

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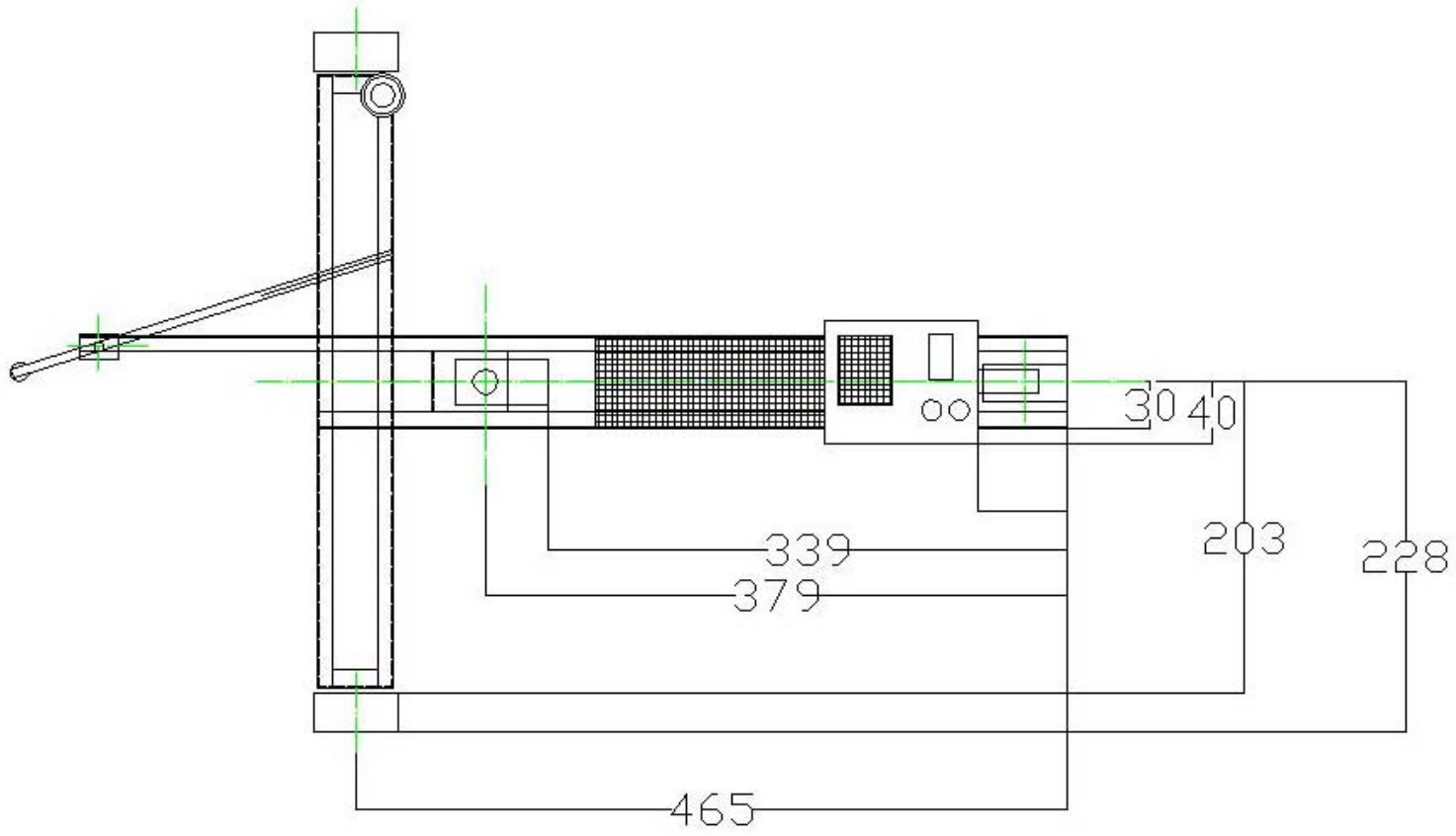
Design



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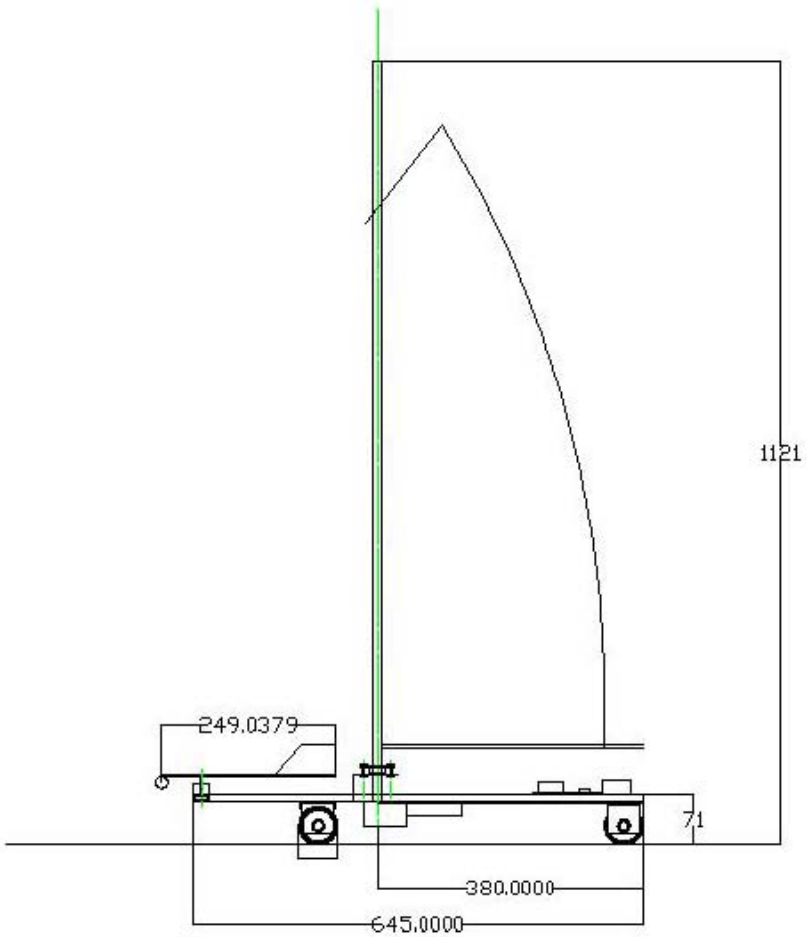
Design



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Conclusions

- Study of dynamical system
- Simultaneous control of various input with BS2
- Construction of sensory systems
- Construction of a land vehicle propelled by wind
- Future implementations

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Figure References

Figure 1
http://images.google.it/imgres?imgurl=http://farm1.static.flickr.com/5/7945634_ea7ad73f17.jpg%3Fv%3D0&imgrefurl=http://www.flickr.com/photos/mikep/7945634/in/set-198645/&h=375&w=500&sz=38&hl=it&start=2&um=1&tbnid=TukHtMvsJoqlKM:&tbnh=98&tbnw=130&prev=/images%3Fq%3Dsailing%2Bgoonies%26um%3D1%26hl%3Dit%26rls%3DDVXA,DVXA:2005-37,DVXA:en%26sa%3DN
Figure 2
http://www.photographytips.com.au/images/sailing-ship1.jpg
Figure 3
http://sail.quarkweb.com/images/Sail_LEO_502x344.jpg
Figure 4 & 5
http://www.physclips.unsw.edu.au/jw/sailing.html
Figure6
http://images.google.it/imgres?imgurl=http://www.northsailsod.com/articles/AIRFOIL.gif&imgrefurl=http://www.northsailsod.com/articles/article6-1.html&h=463&w=600&sz=45&hl=it&start=3&um=1&tbnid=9sDFJWgG3DSG1M:&tbnh=104&tbnw=135&prev=/images%3Fq%3Dlift%2Bairfoil%26um%3D1%26hl%3Dit%26rls%3DDVXA,DVXA:2005-37,DVXA:en%26sa%3DN
Figure 7
http://en.wikipedia.org/wiki/Image:Points_of_sail.svg
Figure 8
http://www.virtualvoyages.net/sailingskills/lesson03/tack-path.gif
Figure 9
http://www.robsonco.com/Dinsmore/Untitled_4.html
Figure 10-11-12
http://www.robsonco.com/Dinsmore/index.html
Figure 13-14
http://www.gmw.com/magnetic_sensors/ametes/360ASMF.html
Figure 15-16-17
http://www.parallax.com/html
Figure 18
http://www3.towerhobbies.com/cgi-bin/wti0005p?&I=HCAM0200&P=PU

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QUESTIONS ?

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THANK YOU

NOW LET US SAIL ! ! !