

# John Leonard: Professional Background



## Education:

- University of Pennsylvania, BSEE (1983-87)
- University of Oxford, DPhil (1987-91) [Mobile Robotics]

## History of MIT Positions:

- MIT Sea Grant AUV Lab 1991-1996
- Dept. of Ocean Engineering 1996-2004
- Dept of Mechanical Engineering in 2005-present
- Computer Science and Artificial Intelligence Laboratory

## Current Responsibilities:

- Area Head for Ocean Science and Engineering
- Director, Ford-MIT Alliance

## Research Interests:

- Mapping, Navigation, and Control of Autonomous Marine Vehicles

## Source Code

- **Source code is a set of computer instructions**
- **Includes comments**
- **Written using a human-readable computer language**

```
#include <stdio.h>
```

```
/* a simple C program to print out "hello, world" */
```

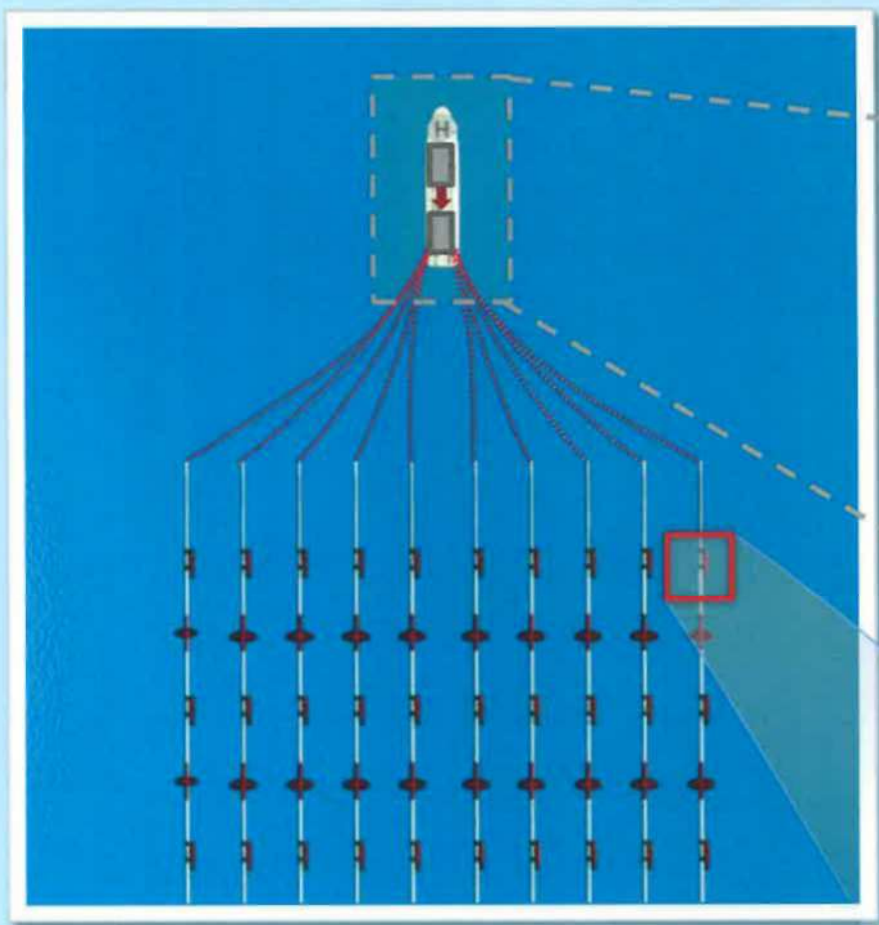
```
main()
```

```
{
```

```
    printf("hello, world\n");
```

```
}
```

# DigiFIN: Lateral Control Software Overview



# DigiFIN Hardware & Software

Motors Ad

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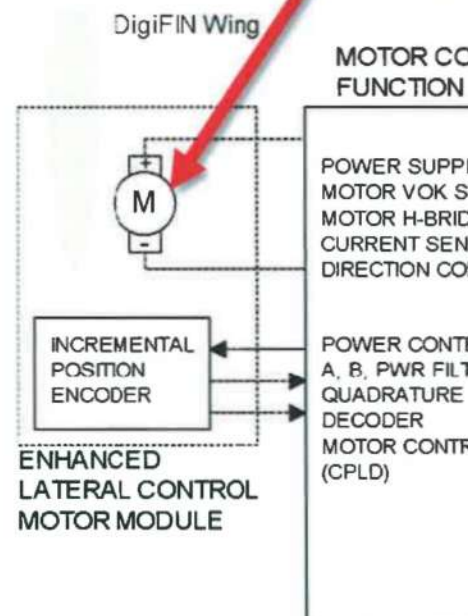
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## Hardware

- Sensors
  - Temperature
  - Depth
  - Wing Angle
  - Pitch
  - Roll
- Motor
- Microcontroller

## Software

- C Language
- Assembler
- Fin Commands
- Backoff Algorithm
- Out Of Bounds Conditions



LATERAL STEERING CONTROL F

# DigiFIN: Back Off Algorithm

```
/* abs(mSine) */  
if(mSine<0.0)  
    mSine= -mSine;  
mult = 1.0;  
mult -> (0.5*mSine);  
  
/* Calculate value of max magnitude */  
mSine=sin_deg(abs_theta+0.01); /* Do not let sine(0)=0 */  
/* abs(mSine) */  
if(mSine<0.0)  
    mSine= -mSine;  
amax = 2.6 /((1.0-abs_angle_deg/80.0)*mSine);  
/* Absolute value of max */  
amax = amax<0.0 ? -amax : amax;  
  
/* Calculate adjusted angle */  
adj_angle = sign*mult*angle_deg;  
  
/* Absolute value of adj_angle */  
abs_adj_angle = adj_angle<0.0 ? -adj_angle : adj_angle;  
  
/* Limit magnitude of adjusted Angle */  
if(abs_adj_angle>amax)  
    adj_angle = adj_angle<0.0 ? -amax : amax;  
}  
else  
    ***** Depth Aware with large Depth Error *****  
    /* Depth Error(ft) = Depth - Depth Target
```

/\*\*\*\*\*\* Depth Aware with large Depth Error \*\*\*\*\*/

/\* Depth Error(ft) = Depth - Depth Target

Depth Error Positive:

- 1) Too deep
- 2) Need upward force

Depth Error Negative:

- 1) Too Shallow
- 2) Need downward force

Upward Force:  $\text{sign}(\text{Roll}) * \text{sign}(\text{Fin}) = -1$

Downward Force:  $\text{sign}(\text{Roll}) * \text{sign}(\text{Fin}) = 1$

If vertical force direction increases depth error,  
we must reduce vertical force.

```
VerticalForce=1;  
else
```

```
/* Zero Force: Roll=Negative, Fin=Zero */  
VerticalForce=0;  
}
```

```
/* No vertical force component because Fin=Zero */  
if(VerticalForce==0)
```

```
{  
    adj_angle = sign*angle_deg;
```

```
/* Reduce Vertical Force if Force increases Depth Error */  
/* (Too Deep and Vertical Force is Downward)  
OR  
/* (Too Shallow and Vertical Force is Upward)  
*/  
else if((DepthErrorFeet<0) && (VerticalForce==1)) ||  
        ((DepthErrorFeet>0) && (VerticalForce==-1))
```

```
    adj_angle = sign*angle_deg/2.0;
```

```
}  
else
```

```
{
```

```
{
```

```
/* Reduce Vertical Force if Force increases Depth Error */  
/* (Too Deep and Vertical Force is Downward)  
OR  
/* (Too Shallow and Vertical Force is Upward)  
*/  
else if(((DepthErrorFeet>=0) && (VerticalForce==1)) ||  
        ((DepthErrorFeet<0) && (VerticalForce==-1)))
```

```
    adj_angle = sign*angle_deg/2.0;
```

```
    }
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```
}  
/* Reduce Vertical Force if Force increases Depth Error */  
/* if(Too Deep and Vertical Force is Downward)  
OR  
/* if(Too Shallow and Vertical Force is Upward)  
*/  
else if(((DepthErrorFeet>=0) && (VerticalForce==1)) ||  
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```

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/* Reduce Vertical Force if Force increases Depth Error */  
/* if(Too Deep and Vertical Force is Downward)  
OR  
/* if(Too Shallow and Vertical Force is Upward)  
*/  
else if(((DepthErrorFeet>=0) && (VerticalForce==1)) ||  
        ((DepthErrorFeet<0) && (VerticalForce==-1)))
```

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