Wireless Robotic fish as a Sensor Platform

MICHIGAN STATE UNIVERSITY

NEMO Team9 ZIGBEE TECHNOLOGY

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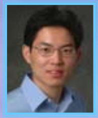

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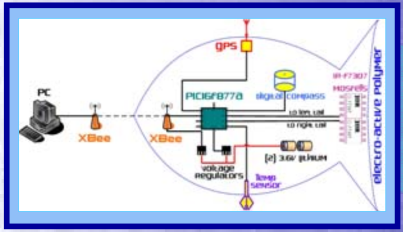
Introduction

We have developed a mobile sensor platform using a bio-mimetic swimming robot propelled by an artificial-muscle actuator. The robot has a hydrodynamic fish body design with waterproof packaging, onboard navigation and control, wireless communication modules, sensing units, and GUI for remote control and monitoring. The goal of this project was to create a wireless robotic fish that has a potential in a wide range of civil and military applications such as environmental monitoring and control, and surveillance in hostile waters. The customer requests that our mobile robotic fish has realistic fish-like body design, can be controlled by a PC, and contain onboard sensors for gathering information.



Design

- Small and fish-like body
- Low power consumption
- Wireless communication
- Sensing capabilities
- Autonomous navigation

Technical Approach:

Body Design

- Justifications for purchasing toy fish
  - Space for electronics and power already available
  - Pre-made solution
- Redesigned compartment to house the electronics
  - Handmade container
  - Waterproof packaging using silicone

ZigBee Wireless Communication

- Two XBee chips
  - Fish body
  - Attached to serial port
- IEEE 802.15.4 Standard
- Low power consumption

Temperature Sensor

- LM335AZ (TO-92 package)
- Capable of monitoring indoor and outdoor temperature
- Less than 1°C error over a 100° range
- Low current
  - Avoids self-heating

www.national.com

GPS

Navigation

- Global Positioning System (GPS)
  - Accurate to 1 meter
  - Capable of receiving signals from 9 different satellites
- 1490 Digital Compass
  - Solid state hall effect device
  - Sensitive enough to pick up 8 basic directions (i.e. N, NE, E, etc.)

Compass

Electro-Active Polymers

- Replaces the need for motor
- F7307 MOSFETs for increased current supply
- Performs large bending motions over low voltage
- Desirable Qualities
  - Light
  - Quiet
  - Robust

Graphical User Interface (GUI)

- Data request functions
- Movement controls
- Advanced features (navigation & signal strength)

Testing Approach

As each component of our project was developed, each one was tested individually with its own microcontroller and C code. Then, after they all worked separately, we put all the components on one board and combined all the code on one PIC. This was true for the tail, digital compass, temperature sensor, wireless ZigBee, GPS, and voltage regulators.

Final Product / Project Results

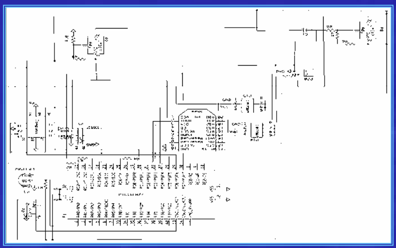
Components include:

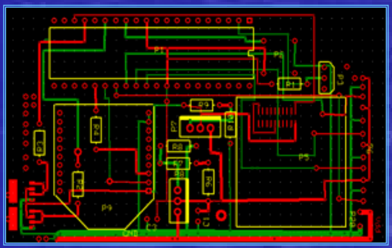
- GPS Module
- XBee Module used for Wireless Communications
- Temperature Sensor
- Digital Compass

- Advantages:
  - GUI is visually appealing
  - Low power consumption
  - Ideal for sensing or surveillance applications

End-Product Description:

Senior design Team Nine has developed a robotic fish which is controlled via wireless communication. We have code-named our fish NEMO, which is an acronym for "Navigating EAP-Controlled Module with Onboard Resources." Our aquatic platform is able to check its environment temperature, display its current orientation (N, S, E, W, NW, NE, SW, SE), and send its coordinates via GPS. It takes 2.5 seconds for digital compass toto respond to a 90 degree displacement. With this information, we are able to decipher exactly where the fish is and tell it exactly where we want it to go. Because we have chosen ZigBee for our communication protocol and electro-active polymer for the movement of our tail, we will save a significant amount of energy, allowing NEMO to navigate the waters for long periods of time.





Budget Effort

Devices	Quantity	Cost
PIC16LF877A PIC	5	$15.00
X-Bee Modules	2	$70.00
Battery Supply	5	$27.58
Temperature Sensors	2	$10.00
Mosfets	20	$14.00
Samtec SMD Mating Header	1	$2.95
Body Material	N/A	$50
Electro-active Polymer	N/A	$500.00
Laipac PG-31 GPS Unit	1	$149.70
GPS 20 pins surface mount header		$12.24
Digital Compass	1	$20.24
PCB	3	$59.00
Total Cost		**$930.71**

Acknowledgments:

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