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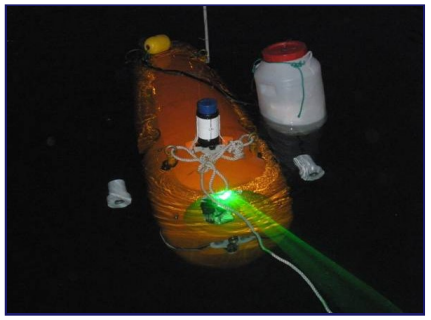
Lab-STICC

Underwater Activities in Ocean University of China

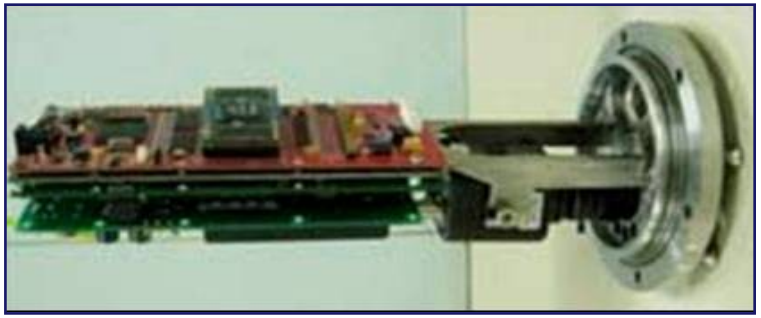
YANG Rui – Benoît CLEMENT

Summary

- Underwater Research in OUC

- FPGA Instruments



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Introduction

Ocean University of China

College of Information Science and Engineering(CISE)

Underwater Vehicle Laboratory

College of Engineering(CE)

Department of Ocean Engineering

Department of Automation and Measurement

Department of Mechanical Engineering

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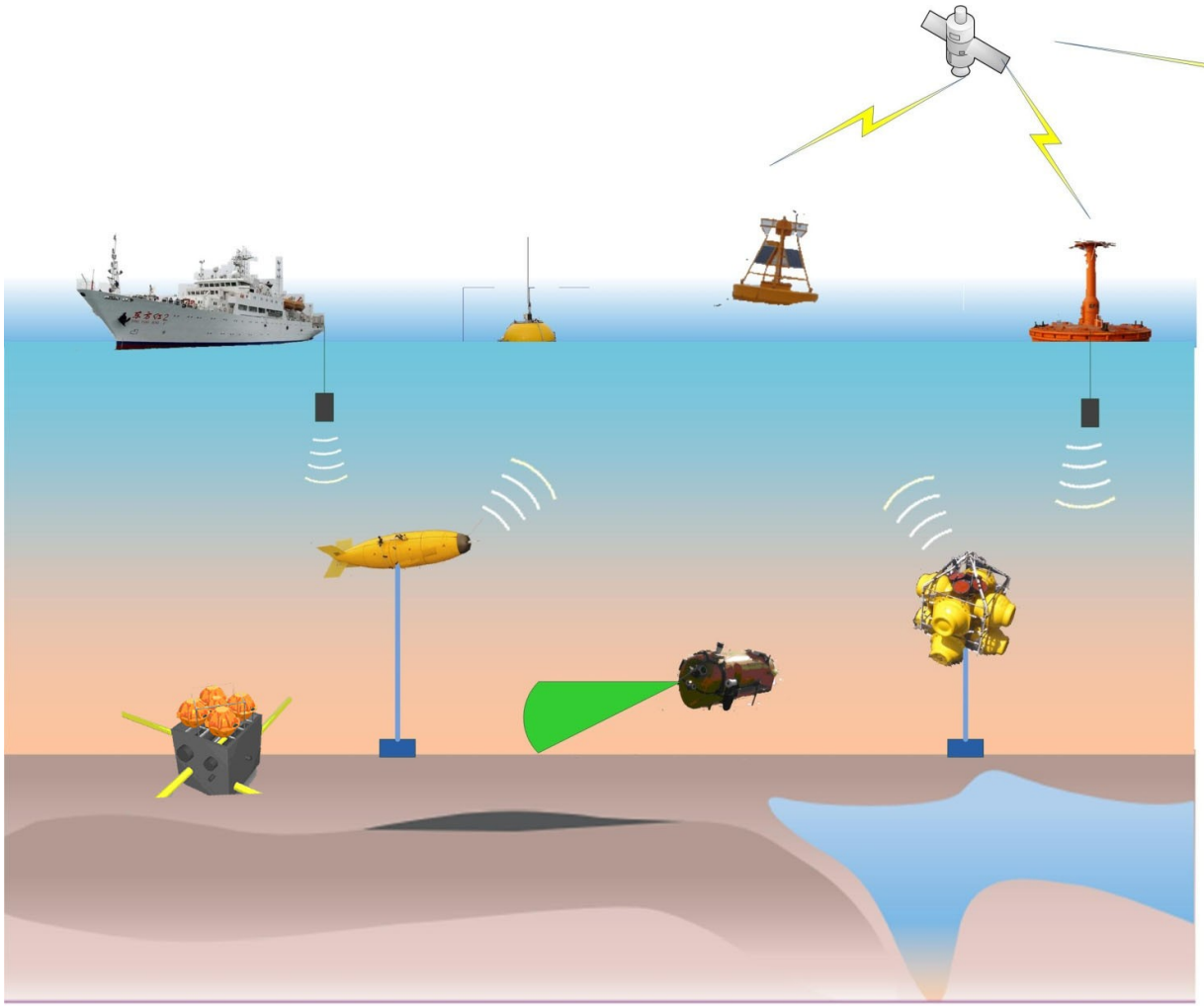
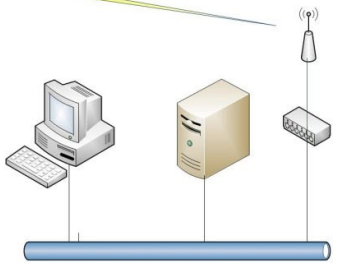
Underwater Projects (Ocean Observing & Monitoring)





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Research Areas

Three main research areas：

1.Autonomous Underwater Vehicle

2.Machine Vision and Digital Image Processing

3.Measurement Devices

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Underwater Vehicles in OUC

Underwater Vehicle Laboratory

- **Underwater Vehicle Laboratory (UVL)**

  Founded in 2004, is a research group under College of Information Science and Engineering

- **Objectives:**

  AUV/ROV platforms, Sensors System, Navigation Technology, SLAM,etc.

- **Team:**

  Leader: Prof. Bo HE

  Academic Staffs: Nian Rui, Yue Shen, Yong Sun, Liang Dong, Xinmin Ren, Bo Yin, Guijie Liu

  PhD/MEng students: 27

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AUVs

C-Ranger-01

Dimensions： 150cm*120cm*110cm

Weight in air： 180kg

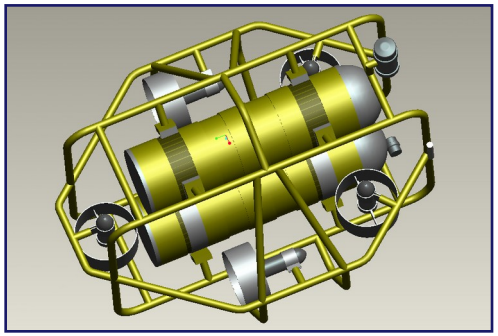
Thrusters： 5 （800W*2， 300W*3）

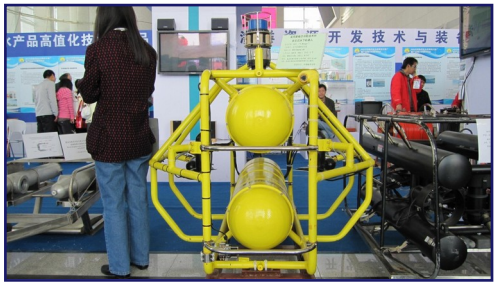
Power： 5KWh lithium ion batteries rechargeable

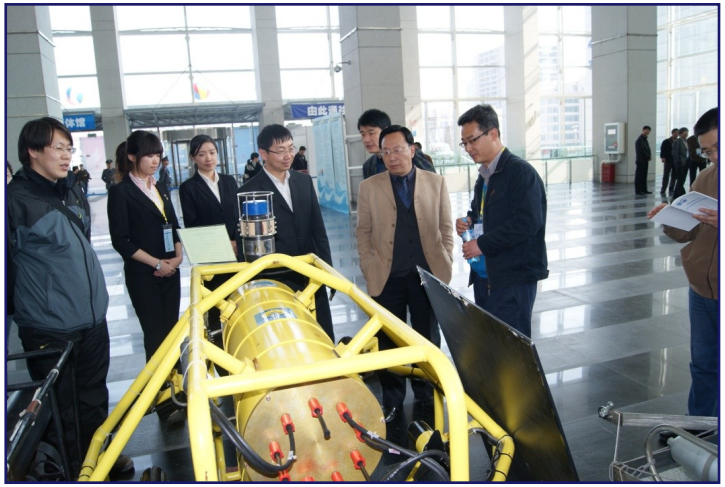
Depth rating： 300 m

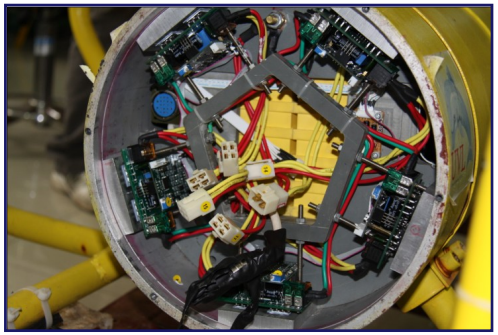
Max speed： 4 knots

Endurance： Typical: 8 hours at 2 knots









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Sea Trials

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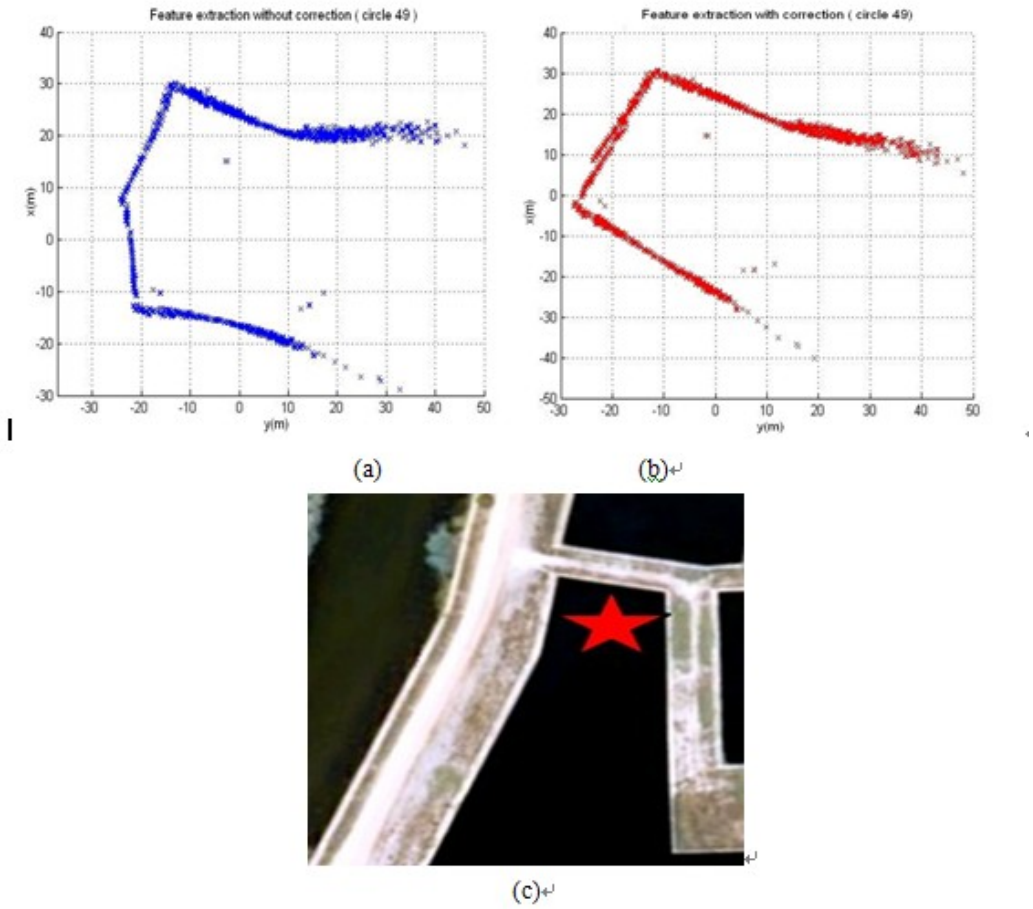
Motion-induced distortion and correction for acoustic images



(a) Raw Sonar Image

(b) Corrected Sonar Image.

(c) Zenithal View of the Abandoned Marina.

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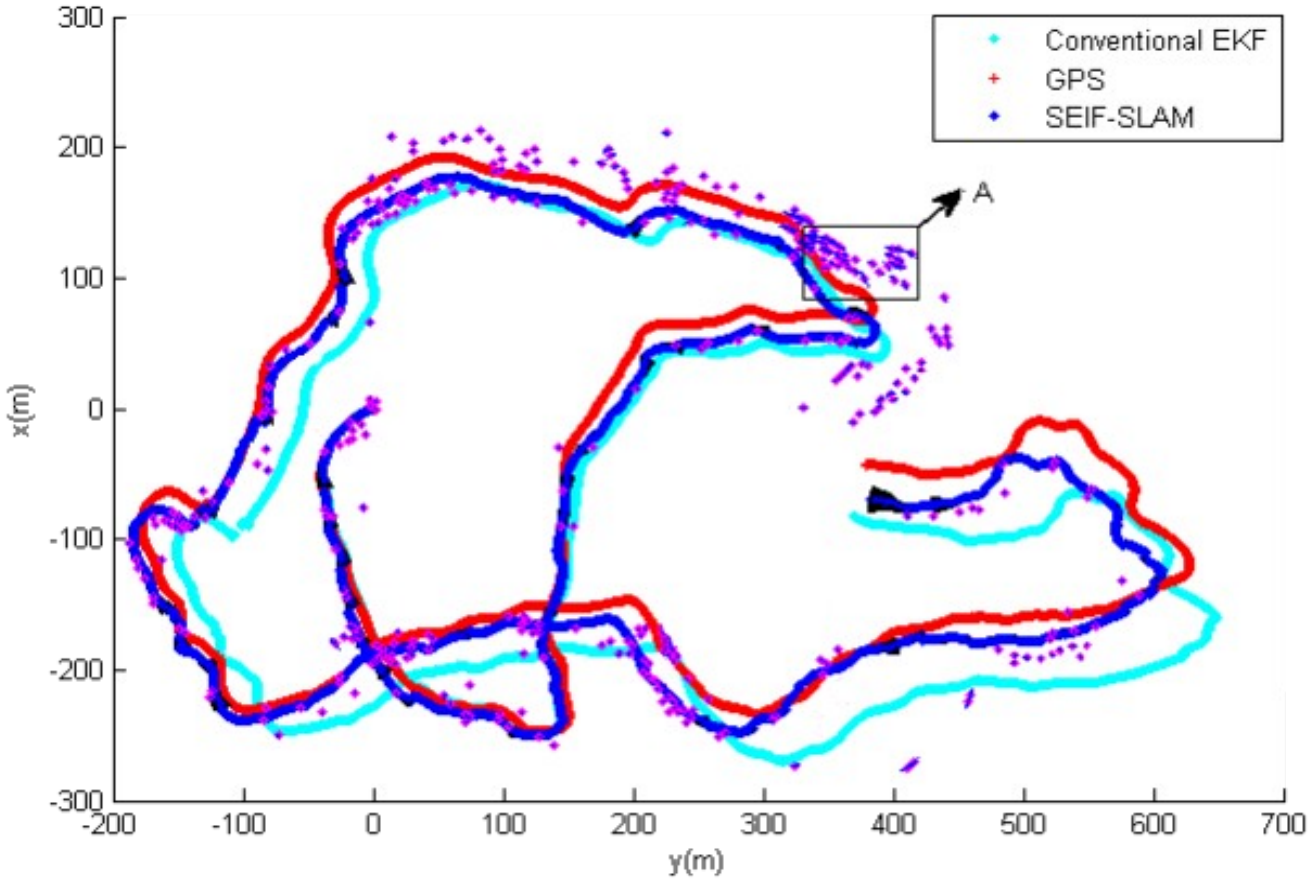
Sea Trials using SLAM-based Navigation Technology for AUV



Comparison of the trajectories for GPS (red line), EKF (light blue line) and the SEIF-SLAM algorithm.

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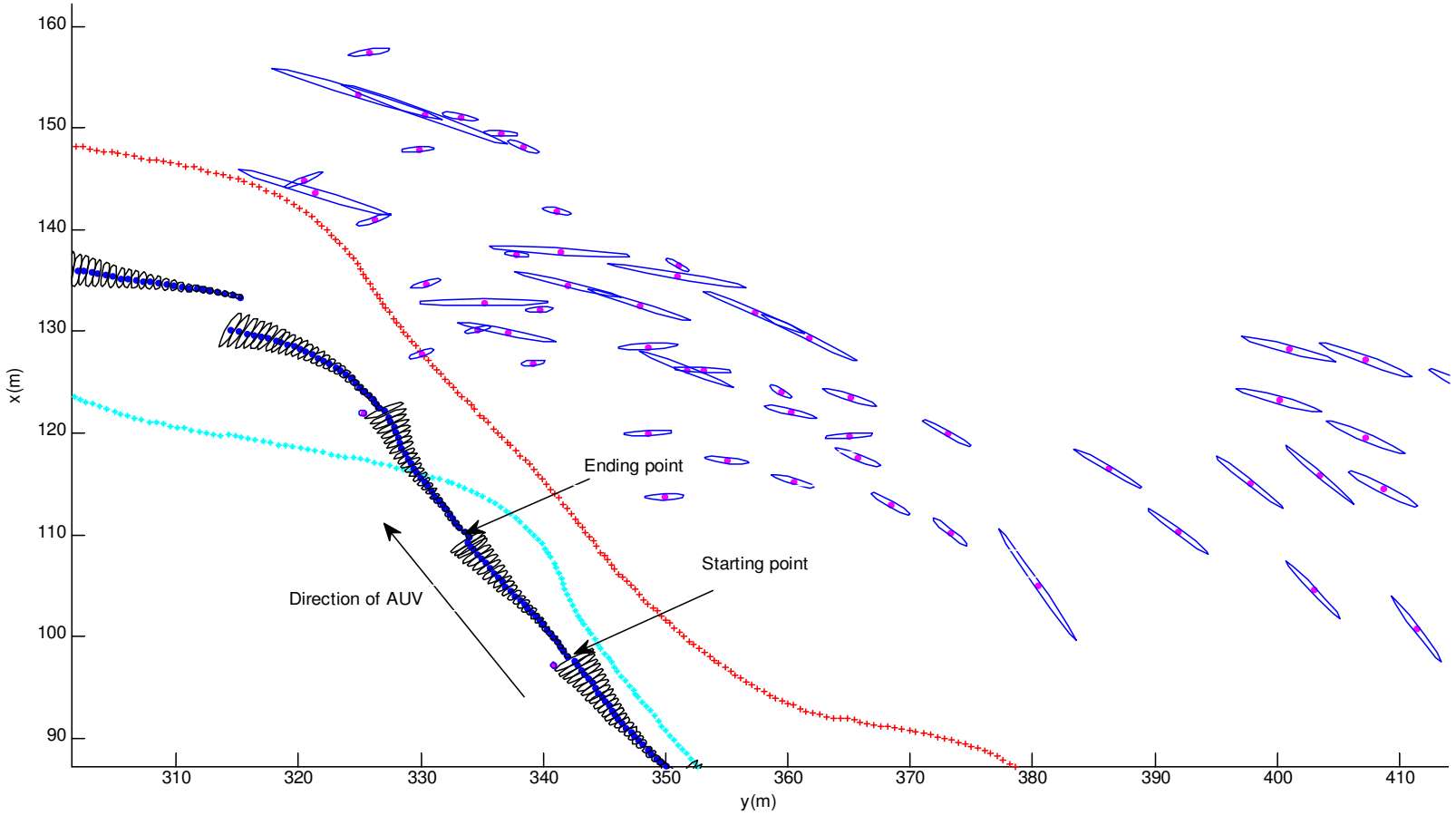
The uncertainty of vehicle pose and environment features(area A)



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Machine Vision&Digital Image Processing

Underwater 3D Detection

Sonar Detection

High reliability

Mesoscale & large-scale detection
Detection precision is comparatively low.

Optical Detection

Easily influenced by water quality

Small-scale detection

Detection precision is comparatively high.

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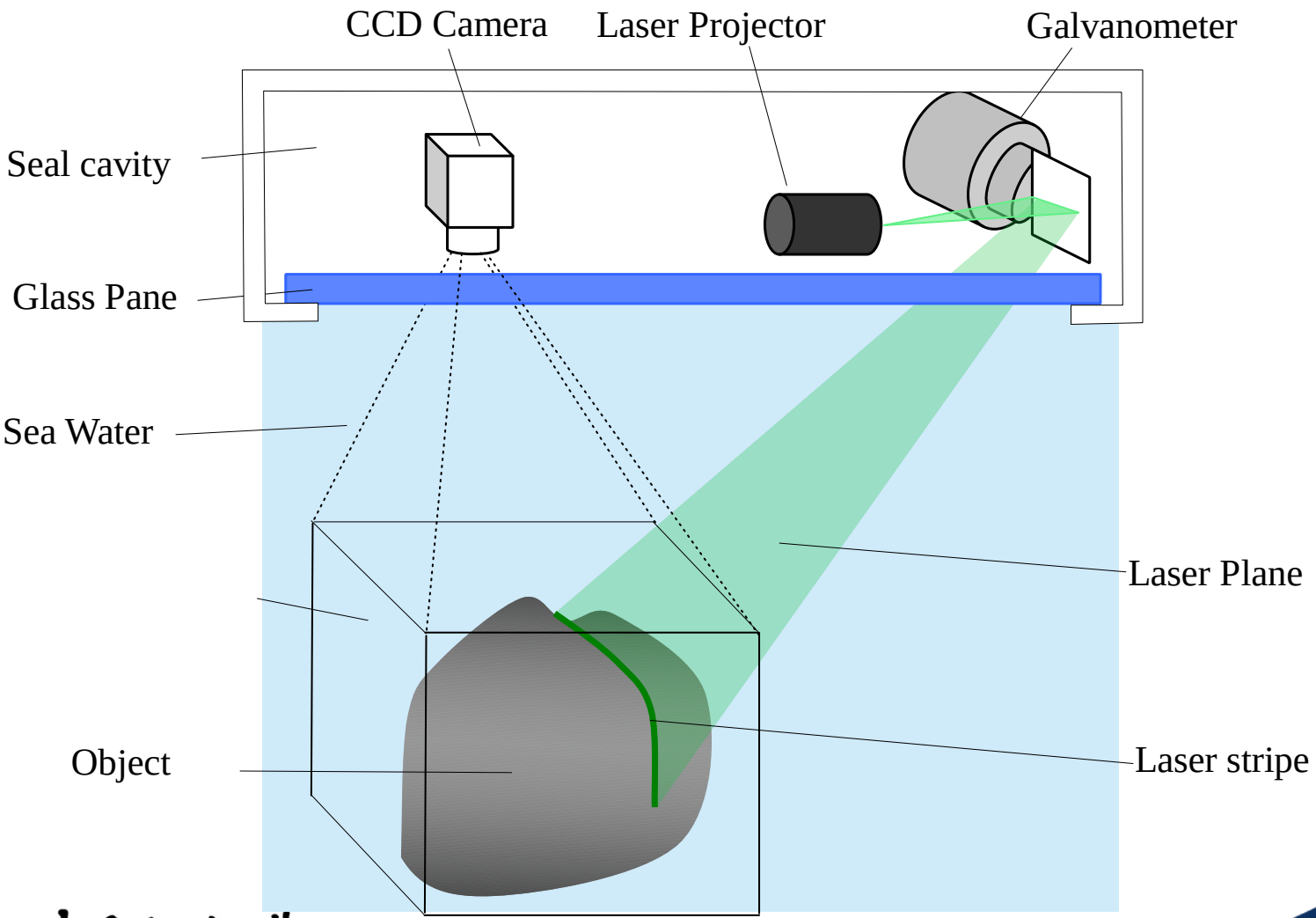
3D Detecion Method



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Application fields

- Underwater Topography and Landform Detection
- Navigation of AUV
- 3D Detection of Underwater Structures

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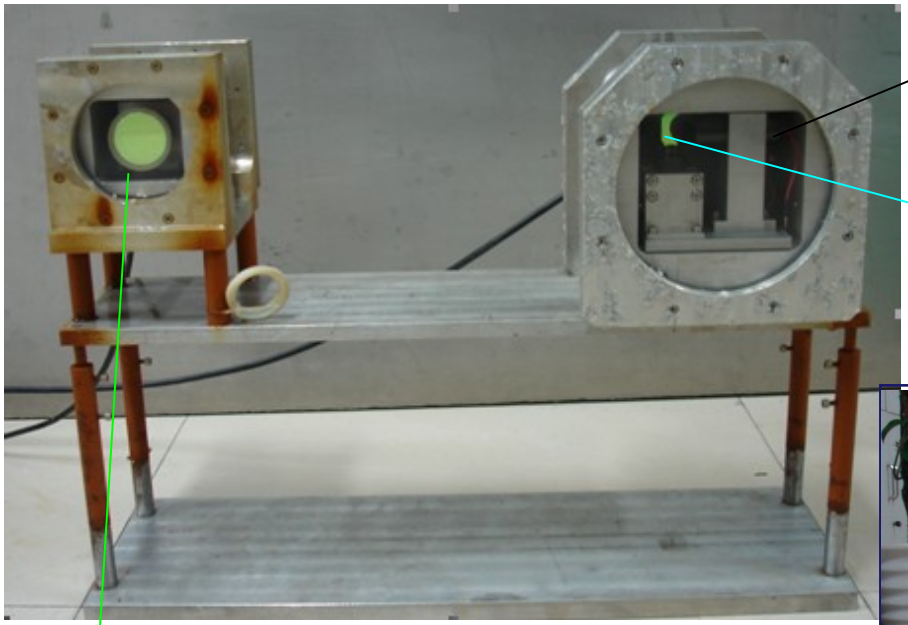
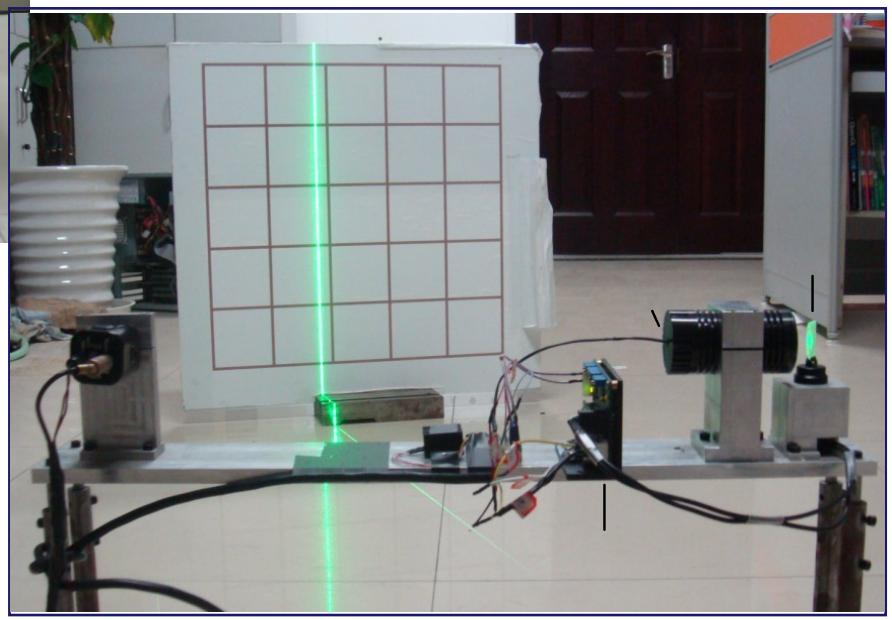
Measuring system and Calibrating Process





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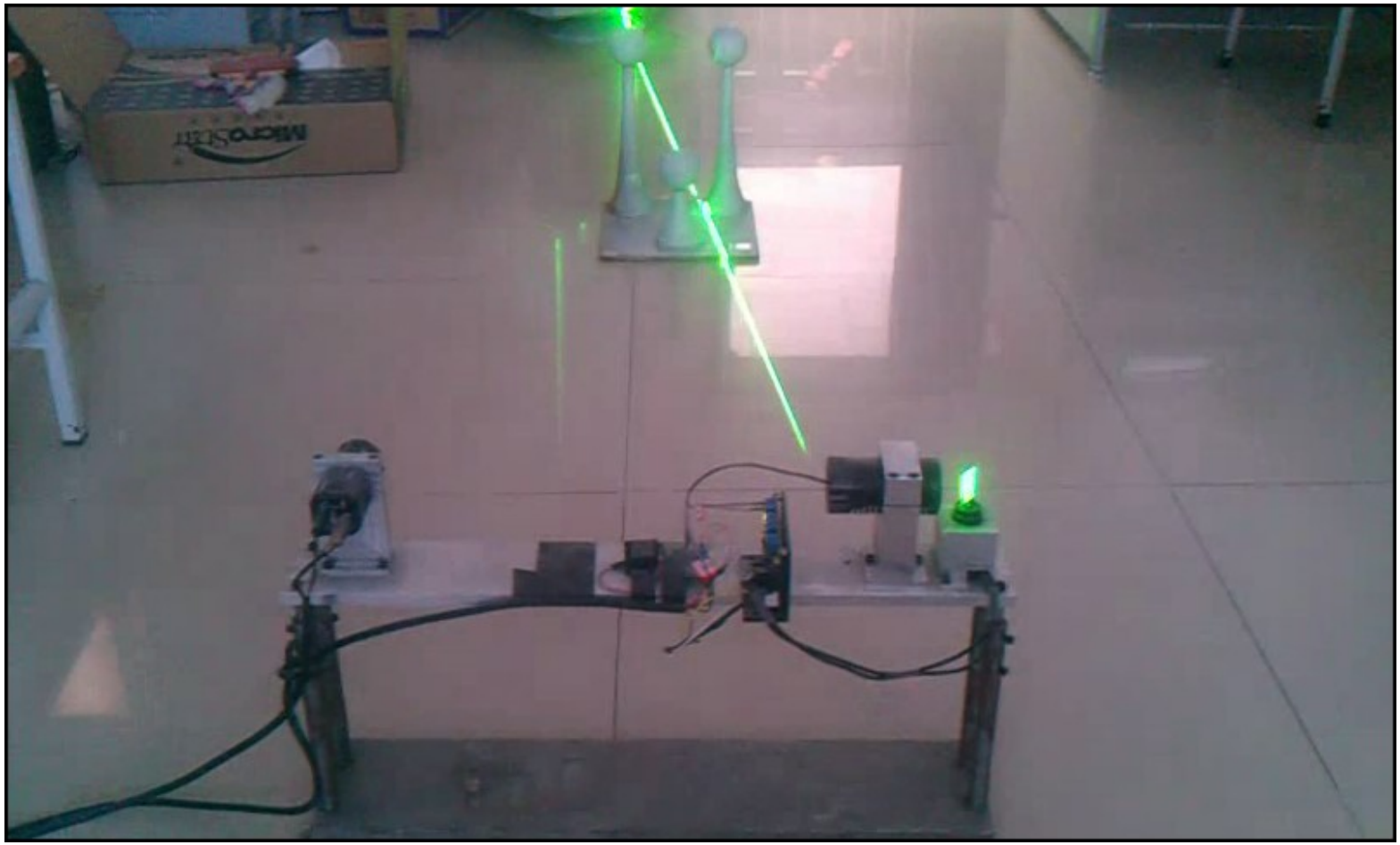
Working Vedio



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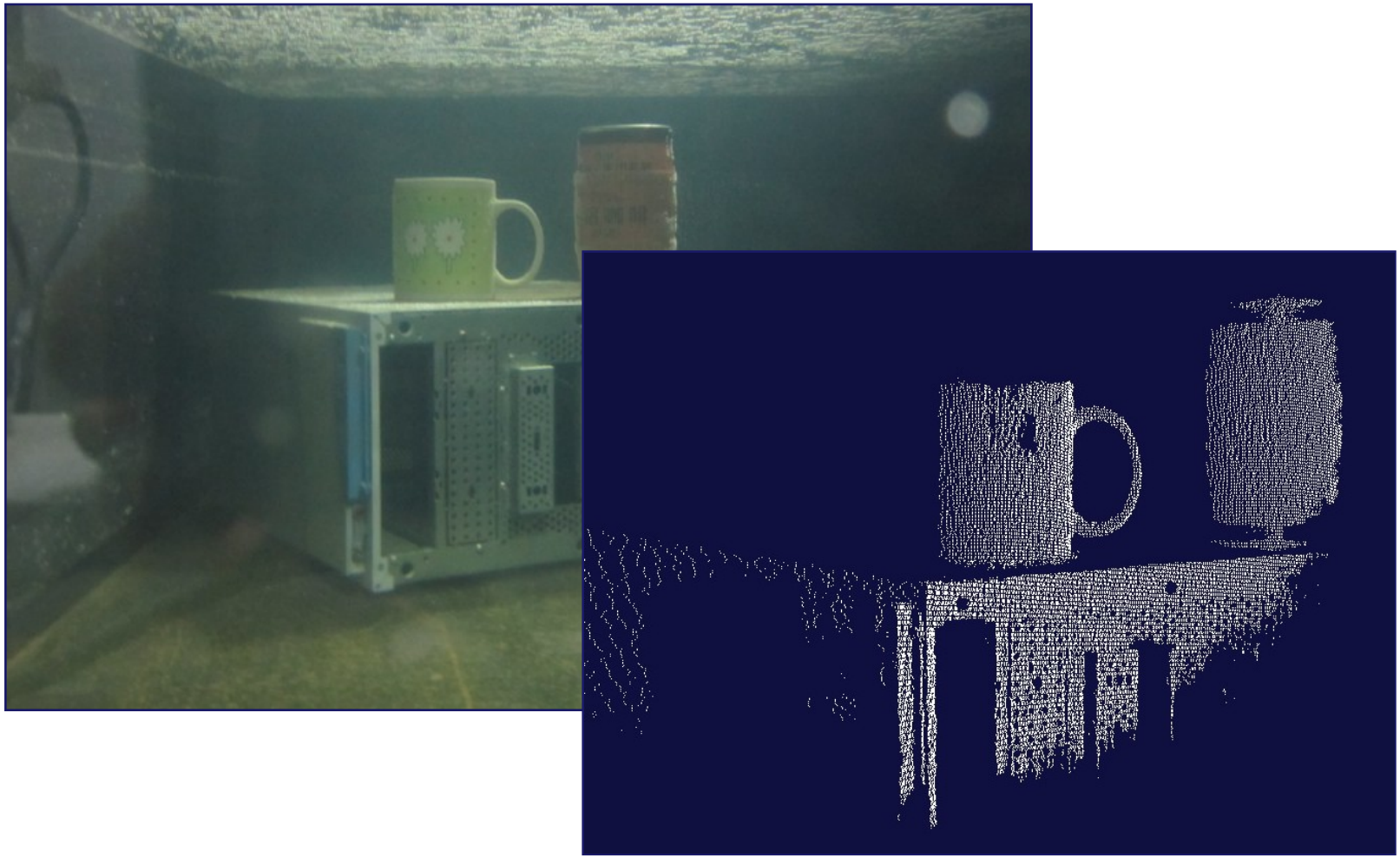
An Object Underwater and Reconstruction



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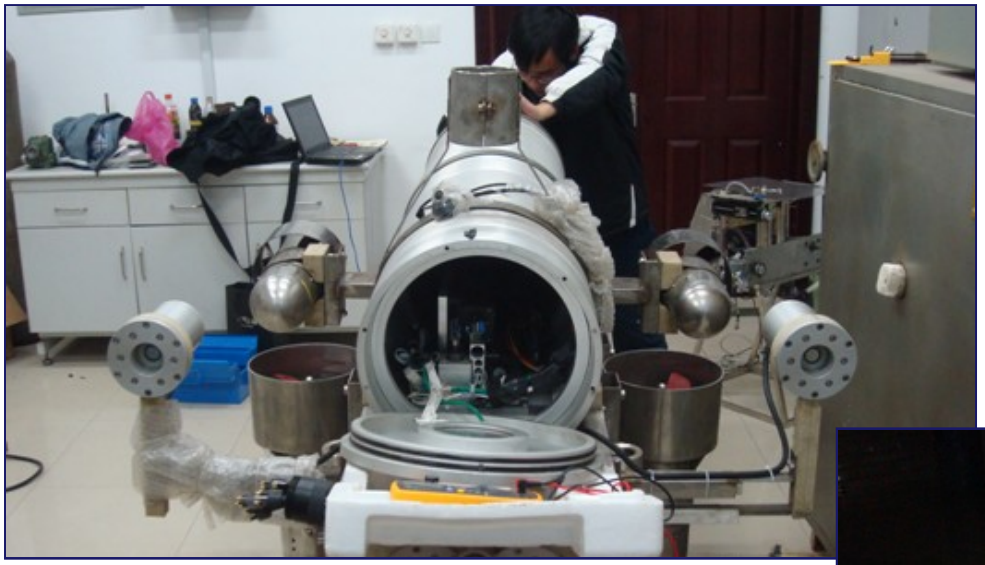
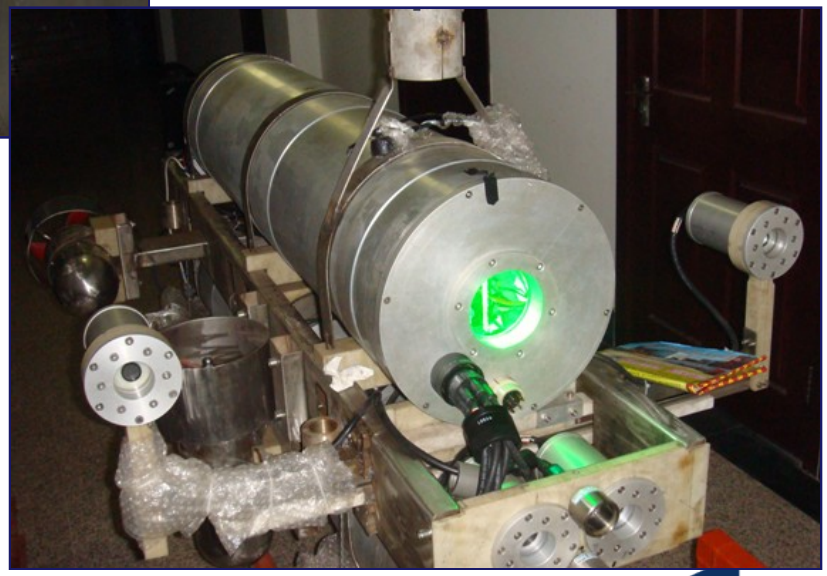
A typical application: Navigation of AUV

Laser system can obtain the information of barrier in front of the AUV,including:

- The 3D shape of the barrier
- The position of the AUV relative to the barrier

A Typical application: Navigation of AUV





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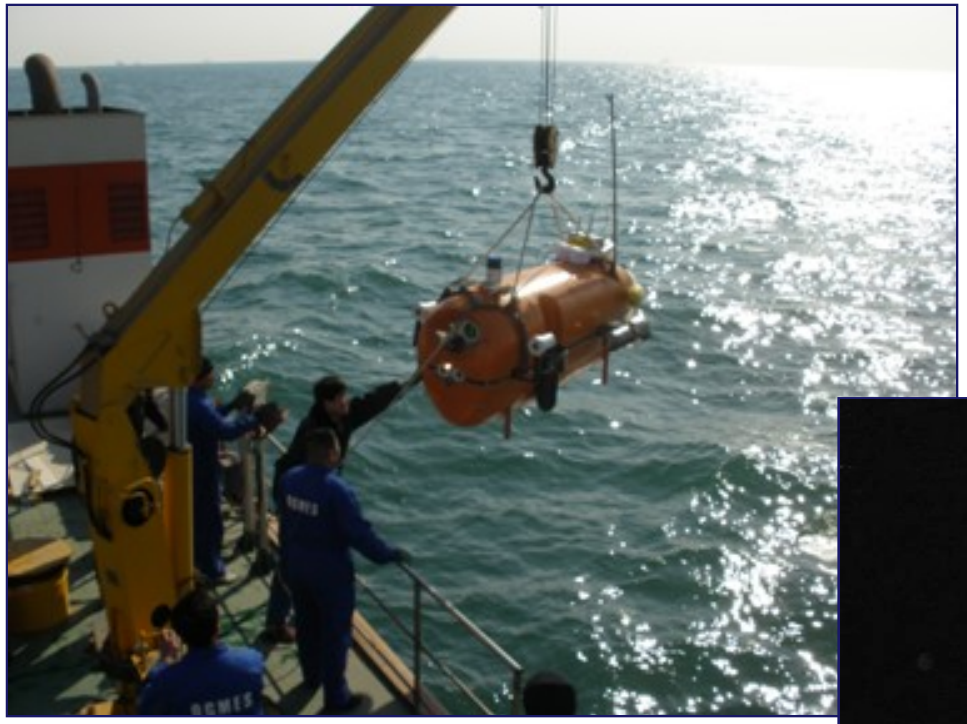
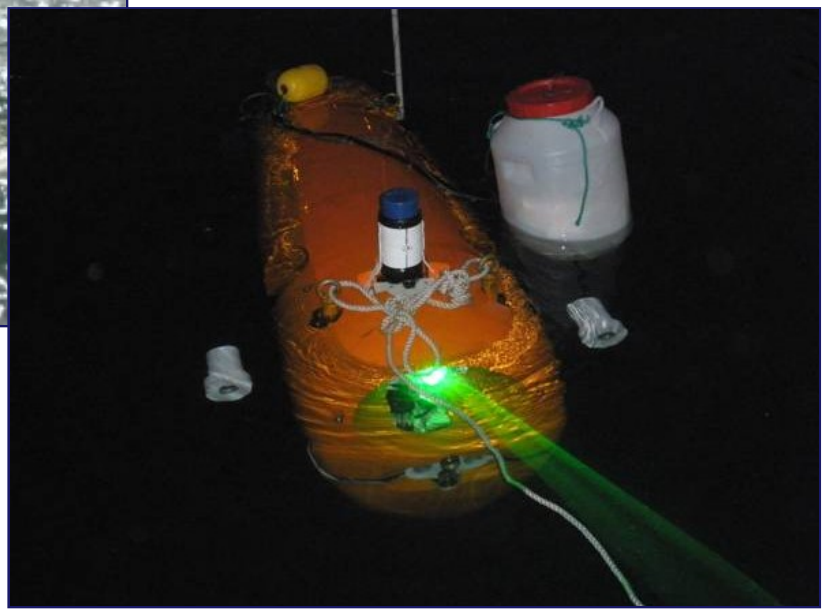
A Typical application: Navigation of AUV





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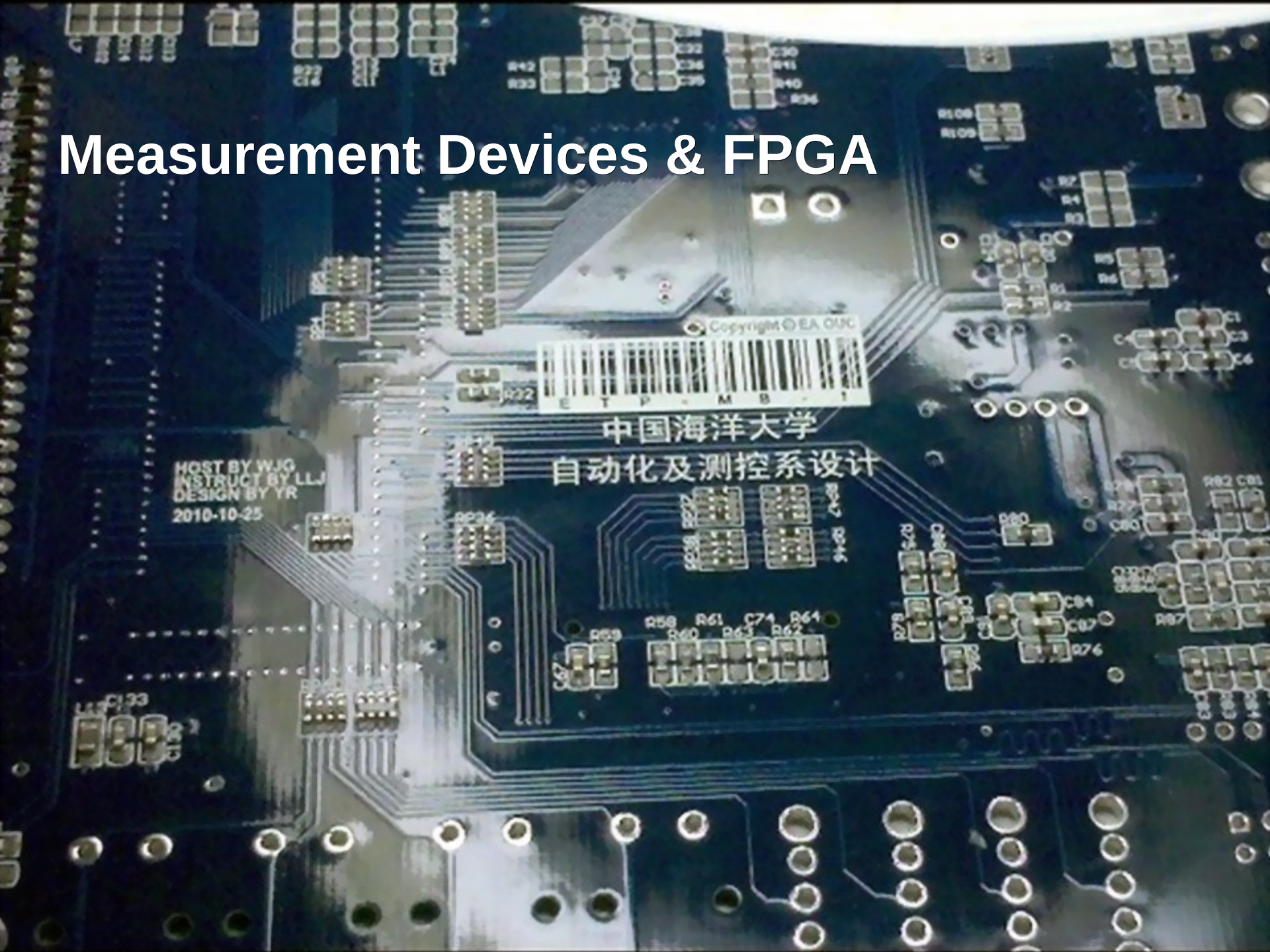
Measurement Devices & FPGA



Underwater Video Compression Algorithm

Compression ratio: 200:1—540:1

(a) Original Image

(b) Compressed Image

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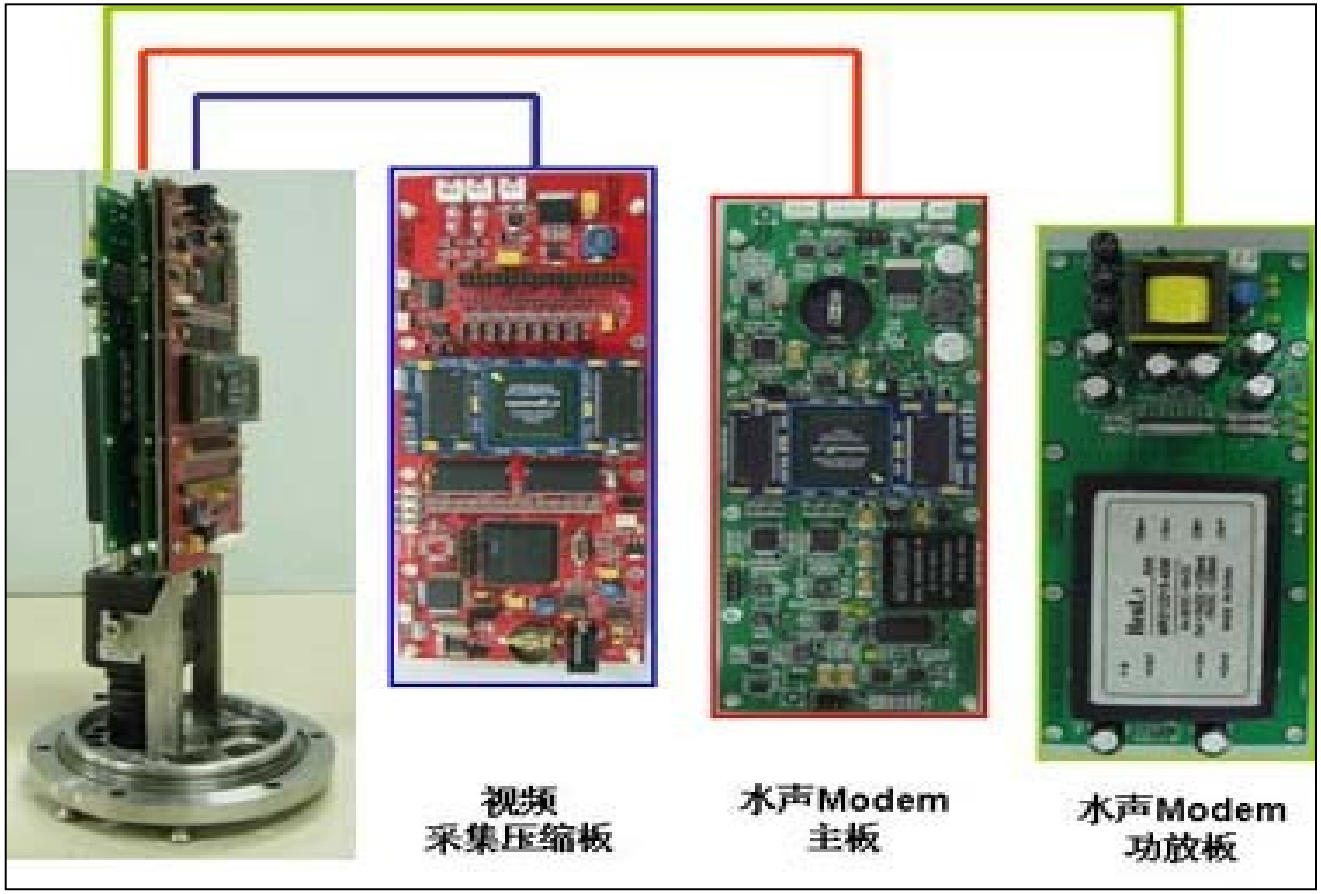
FPGA Based Acoustic and Video Processing Device



Video Compression Device and Acoustic Modem

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Underwater Image Enhancement Algorithm

(a) original images

(b) enhanced images

Reasons Come For FPGA

- Features:
  - Parallel Caculation
  - System On Programmable Chip(SOPC)
  - Compatible I/O
  - Digital Processing
  - Low Power comsumption
  - Flexible & Reconfigurable via VHDL

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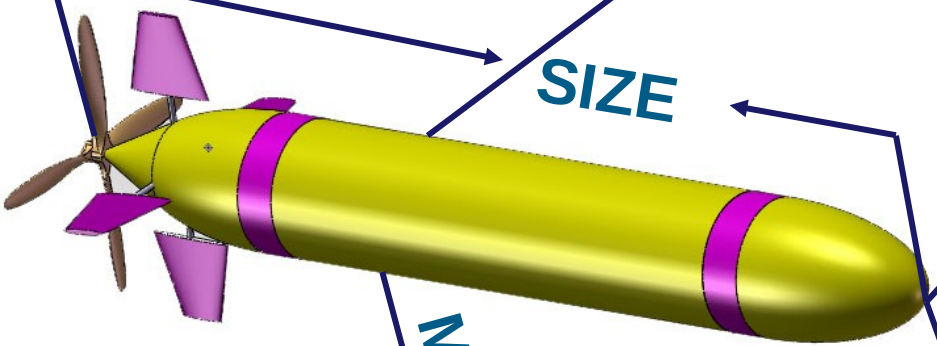
Chanllenges for AUV applications & FPGA



BETTER ALGORITHMS
MORE BATTERY
REALTIME CACULATION
LOW POWER CONSUMPTION
LOW TIME CONSUMED
SIZE
LONG RANGE
HIGH SPEED
MORE DEPTH
MORE SENSORS

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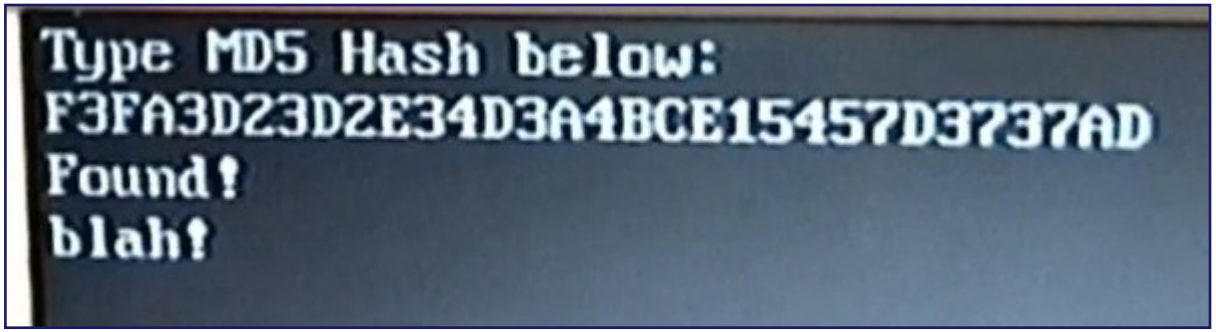
Crack MD5 Using FPGA

- **16** Parallel MD5 Cracking Units
- One MD5 Hash in **68 Clock Cycles** Each Unites.
- **50 MHz** FPGA Working Frequency.

50MHz*16*60/68 = 706 Million Hashes a Minute

Find the Passwords within 20 seconds Go to Video



Digital Systems Laboratory (ECE 385) at the University of Illinois

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1Gbit/s Bandwidth Video Processing(CMOS Sensor)

20 bits/pixel x (1280 x 720) pixels/frame x 60 frames/s = >1 Gbit/s

Changing lens

Go to video

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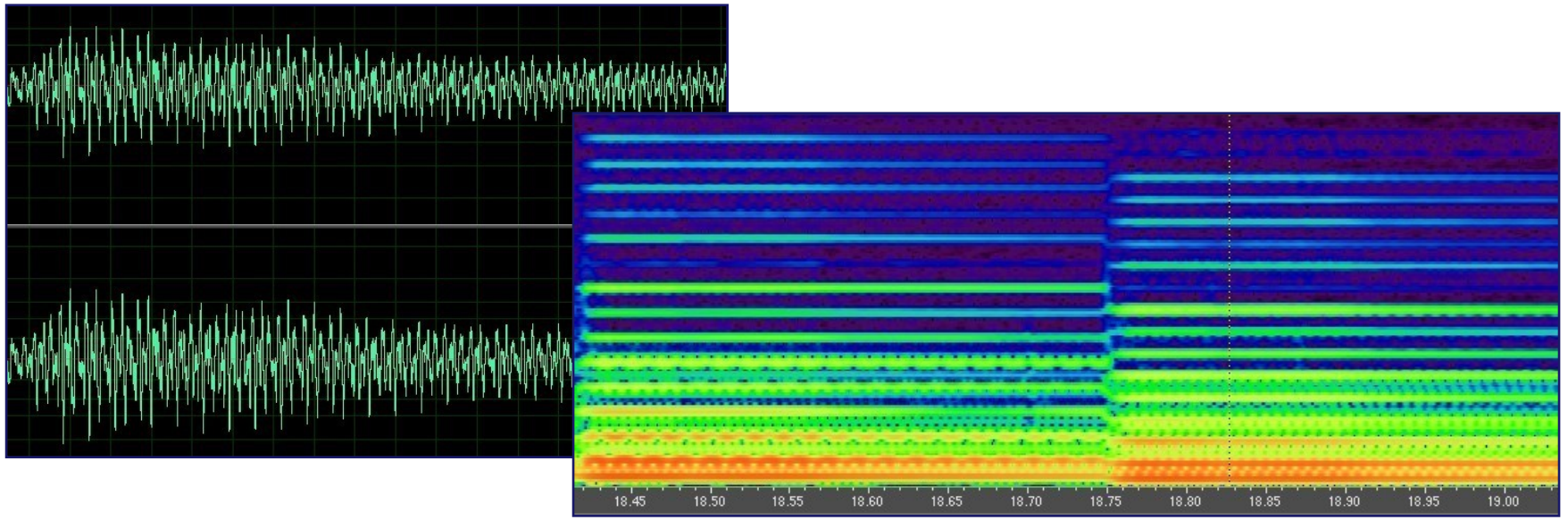
Synthesize High Definition Audio in Realtime

$$F(wt) = A_0 + A_1 \sin(wt + \psi_1) + A_2 \sin(2wt + \psi_2) + \ldots + A_k \sin(kwt + \psi_k) + \ldots$$

16 sine wave generator & 4 channel of Chords & 48bits 96khz



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Questions?

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