Automated Testing for AUV Planning Software

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and

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Outline

➢ Overview of T-REX†
➢ Motivation for a Monte-Carlo testing system
➢ Implementation summary
➢ Results and conclusion

† Teleo-Reacto EXecutive
Our Modified AUV Platform

Gulper: water sampling device. Developed by MBARI: needs AUV adaptability

autonomy computer stack

basic AUV control stack

*Courtesy: Alana Sherman & Larry Bird, MBARI
Motivation: To Map Dynamic Events in the Ocean

- Fluid sheets of *suspended particulates*. Originate from the *sea floor* through diverse fluid dynamics [McPhee-Shaw 2004].
- Large Horizontal Scales (Kms)
- Small Vertical Scales (meters)
- Patchy

**Objective**: To map, sample and thus characterize highly dynamic ocean phenomenon

*Intermediate Nepheloid Layer*
Parameters

- Current
- Navigation error

- Sea-surface conditions (GPS fix)
- Summary statistic for backscattering, CTD and chlorophyll fluorescence observations
The Testing Problem

Expensive if things go wrong at sea – but planner produces a wide range of behaviours!

Problems with existing pseudo-simulator

- Parameters need to be set by hand
- Running the system will only test one set of potential conditions

My project: A Monte-Carlo test harness

- Run many missions
- Stochastically change parameters of the system
Integration of the Monte-Carlo System

- New T-REX components
  - Monte-Carlo Sampler
  - Batch Runner

- Existing T-REX components
  - AUV mission control
    - Skipper
    - Navigator
  - VCS Adapter
  - Pseudo-simulator

- Commands
- Observations
Sampling Strategies

Inter-mission

Batch Runner

Mission 1

Mission 2

current=0.7

current=0.4

Intra-mission

Batch Runner

Mission 1

Mission 2

seed=37

seed=3457

Distributions

Fixed value

Uniform Distribution

Normal Distribution

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Results and Future Work

Results

• The tool was able to detect and identify two previously unknown bugs in T-REX
• Experiment – re-inserted 4 bugs in system, which had previously only shown up on sea trials
• Monte-Carlo system was able to detect 3 of the 4 bugs
• Indications that uniform distn works better than Normal

Future work

• Enable the system to alter more simulation parameters
• More intelligent sampling techniques, e.g. random walk, model weakness testing, previous failures analysis
• Automated analysis of failures, grouping of related failures
Conclusions

Monte-Carlo System

• Good testing is vital for complex autonomous systems!
• Monte-Carlo based batch testing looks very promising
• The tool should be valuable for future T-REX development

Relevance to my PhD work

• Especially useful experience for me, as my PhD topic is to develop intelligent software for AUVs
• My work at MBARI means
  – First-hand experience of observations and inputs to vehicle control software
  – Some software I wrote is actually running on an AUV!
  – Much more knowledgeable of the requirements and pitfalls of deploying AI software on an AUV