ADVANCED ROBOTICS
UNDERWATER

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GRL Underwater Robotics
- ARM System for automated underwater inspection
- ARM adapted for underwater arc welding and grinding
- Polecat® System for automated underwater friction welding
- Polecat adapted for general ROV simulation, visualisation and supervisory control (as ROVolution®)

GRL Background
- 1991-1996 ARM System for Mobil North Sea as part of TSC Limited
- 1996: TSC Control Group moved to GRL
- 1997: ARM underwater welding - Amerada Hess, NHC & TWI
- 1998-2000: ARM adapted to Schilling arms, ACFM inspection of North Rankin platform
- 1997-2002: GRL develop general purpose Polecat software for ROV simulation & control

Requirements
- Oil rigs need to be checked regularly for cracks in all load bearing welds
- Human diver inspection is expensive and dangerous
- Ever deeper oil fields are being found which will need work carried out remotely

ARM System
- A 2.5m hydraulic manipulator with 6 rotary joints for improved reach and dexterity
- Toolskid carried by any work class ROV
- 2m extend/360 degree rotate boom
- 3 ‘sticky feet’ attachment legs
- User friendly man-machine interface
- Robotic control system with 3D Graphics
- Industry standard architecture - IBM PC

The ARM System
Advanced Robotic Manipulator
Key Benefits

- Safety
- Work rate and cost
- Beyond diver depth
- Reliability of inspection
- Repeatability of inspection

ARM Graphical User Interface

System Comparisons

- RovTech
- Sonsub
- DSND Subsea
- SSOL

ARM Robotic Underwater Welding

- Sine Wave
  - Period, amplitude and stand off
- Simple Weave
  - As sine wave + dwell time at edges
- Complex Weave
  - As simple weave + separate edge amplitudes & dwells + centre dwell
- Weave Plane Angle

Test Butt welded by ARM

NICS Simulation Work

NICS Weld Access Simulation for Woodside Energy
Development of core Polecat software began in 1997 with funding from European Union.

- One software system designed to handle ARM, SubSim and EU projects, and be even more flexible.
- ROBHAZ
  - Polecat extended to manipulators
  - ROV friction stitch welding using a marinised electric robot
  - Polecat adapted to factory robots

- First commercial system, SewerCat, sold in 2000 for a tracked ROV (Polecat v2) - robotic
- Second commercial system sold early in 2001 to ROV manufacturer (Polecat v2)
- Third commercial system sold mid-2001: MATIS Simulator for Stolt Offshore (Polecat v3)
- New version has tether modelling & physics (Polecat v4)
ROVolution® Features

- Full vehicle hydrodynamics and modelling of thrusters, etc.
- Manipulator kinematics (optional robotic control)
- Large, detailed graphical models
- Multiple vehicles, manipulators and other systems
- Multiple cameras and lights, each with correct angle of view, light output, etc.
- Surface swell, and current velocity/depth profile
- Full acoustic modelling, including obstacle avoidance sonars and altimeters

SewerCat System

SewerCat Tracked ROV and Manipulator System for Covus Corporation

SewerCat ROVolution® Interface

3D Operator Interface and Robotic Manipulator

SewerCat: Polecat Software

- First ROVolution® system sold, SewerCat tracked ROV, provided visualisation and robotic control
- System works in black water so cameras give poor vision
- ROVolution® software updates ROV position from gyro (heading, roll, pitch), altimeters and cable payout
- ROV is driven by operator using ROVolution® 3D display
- Operator can add in new objects such as obstacles
- Robotic manipulator is under direct computer control by ROVolution® software
- Longest running and best proven underwater robotic system in the world

Operational Use

Rovsim: Pilot Training Software

- First ROVolution® system sold, SewerCat tracked ROV, provided visualisation and robotic control
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- ROVolution® software updates ROV position from gyro (heading, roll, pitch), altimeters and cable payout
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Current Robotic Work

- During 2001 conducted trials on underwater cutting using Polecat to control a Schilling Titan manipulator
  - Petrogen cutting torch
  - Broco rod
  - Kerie cable
- July 2002 further trials to investigate feasibility of cutting with a rotating electrode cutter
- Aim is to produce a robotic solution to decommissioning of offshore platforms