

ADVANCED ROBOTICS UNDERWATER



Trevor Larkum
Managing Director

General Robotics Limited

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

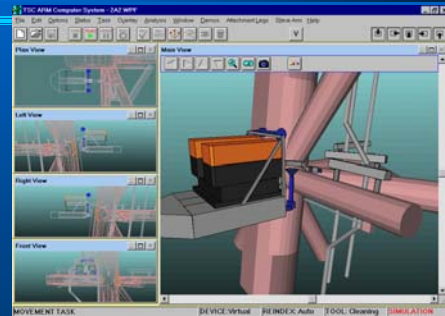
Advanced
Robotic
Manipulator



Key Benefits

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

ARM Graphical User Interface



System Comparisons



RovTech



Sonsub



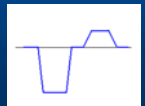
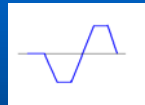
DSND Subsea



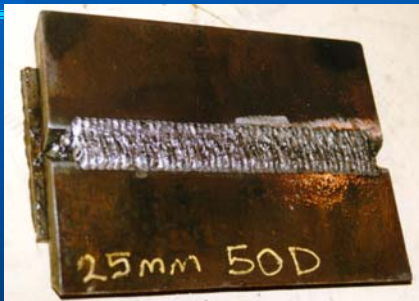
SSOL

ARM Robotic Underwater Welding

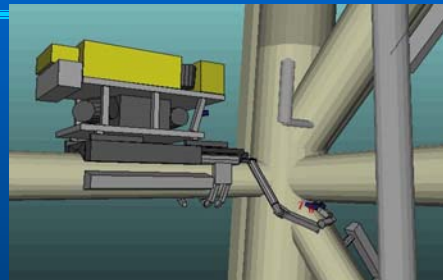
- Sine Wave
 - Period, amplitude and stand off
- Simple Weave
 - As sine wave + dwell time at edges
- Complex Weave
 - As simple weave + separate edge amplitudes & dwells + centre dwell
- Weave Plane Angle



Test Butt welded by ARM



NICS Simulation Work



NICS Weld Access Simulation for Woodside Energy

NICS ARM System Offshore



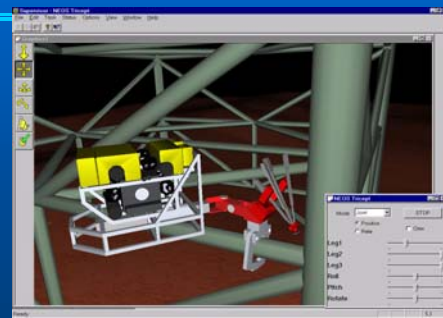
Offshore Inspection



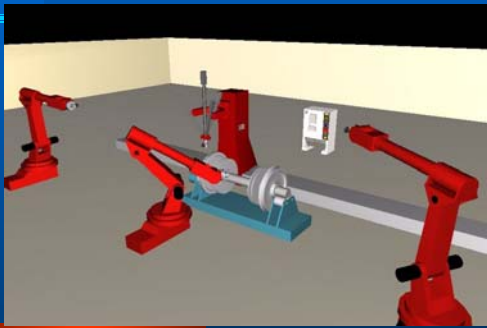
European Projects - Polecat

- 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

ROBHAZ - Polecat Interface



Polecat for Factory Robots



ROVolution®

- 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

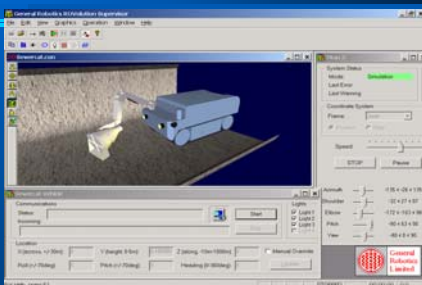
- Full vehicle hydrodynamics and modelling of thrusters, etc.
- Manipulator kinematics (optional robotic control)
- Large, detailed graphical models
- Multiple vehicles, manipulators and other systems
- Multiple cameras and lights, each with correct angle of view, light output, etc.
- Surface swell, 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

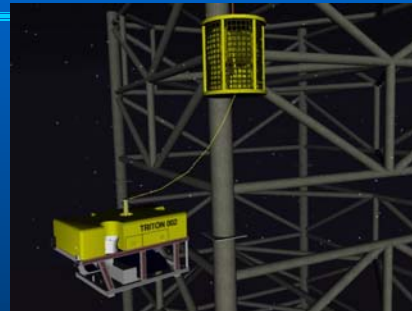
SewerCat: Polecat Software

- 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

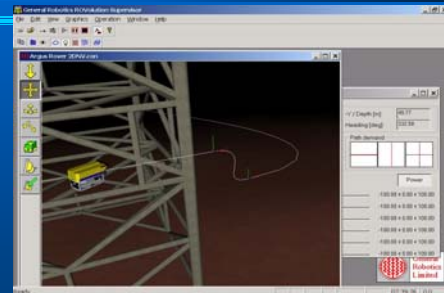


Rovsim: Pilot Training Hardware



Includes: ROV Console, 2 camera views, instrument panel, sonar

ROV Paths: Overview



ROV Offset ('Path Demand') shown at right – vertical, horizontal & hdg

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