Control Software Development for Motion Stabilised Gangway (Turbine Access System)
From Concept to Deployed System
The Problem

- Offshore wind increasingly important, but economic challenges:
  - Install + grid connection
  - Through life maintenance costs
- Transferring personnel from boats to wind turbines currently done using “friction lock”
  - Small, light boats – transfers restricted by weather / sea state
  - Risky – even in calm seas, can get occasional big wave
- Even more important for bigger, further offshore wind farms
The Concept

- Houlder developed Turbine Access System (TAS) concept
  - Hydraulic gangway to compensate for vessel heave, pitch and roll
  - Not in contact with tower - important
**Control System Development**

- ISC engaged as subcontractor for control system design
- Initial simulation phase to assess achievable performance
- Implementation in LabVIEW:
  - Emulator built to allow office-based testing – helped greatly
  - Inverse kinematics – used Mathscript nodes
- In factory – core functionality “worked” first time !!
- But took much testing to perfect everything:
  - Control – refining scheme, tuning, validating kinematics and MRU, synchronisation of loops and IO (very important)
  - Operational logic / monitoring – fully tested against faults
The Control System

Motion Reference Unit (MRU) → cRIO + FPGA + IO Modules

- Cylinder lengths
- Cylinder pressures
- Servovalve signals
- Beacons / sounders
- Safety relay
- E-stop buttons
- MCBs / VMRR

(16xDI, 12xDO, 16xAI, 3xAO)

Development Laptop (not normally present) → Hub → Third party TPCs (x2, IP67)
The Control System

- NI CompactRIO Controller runs:
  - Inverse kinematics – LabVIEW Mathscript RT
  - Real time control – cascaded controllers with feedforward and nonlinear compensation
  - Interfacing to MRU and safety system
  - Operational logic – state machine to handle different modes
  - Monitoring / Fault Actions – extensive, changes with operating mode

- FPGA watchdog independent of cRIO – initiates emergency stop

- TPCs – user interface for operating TAS, alarms and configuration
  - Many different screens; via shared variables
Inverse Kinematic Transformations in Mathscript RT Nodes

Everything built in LabVIEW: Real-Time, FPGA, Mathscript RT, TouchPanel Module
Progress

- Fully working – many online videos
  - http://www.youtube.com/watch?v=N21en93lrqg
- Customer acceptance testing / approval by Lloyds Register
- NI user Case Study which won awards UK and internationally*
- Sea Trials – Sept 2012
  - Tested in open water and then on RWE’s Rhyl Flats wind farm
  - Performance good – controllers / MRU retuned for actual motions
- Boat now being fitted with rollers on bow and in operation

* 1) GSDA Awards UK Application of the Year and Advanced Control Systems Winner NI Days 2012
   2) GSDA Awards Worldwide Application of the Year and Advanced Control Systems at NI Week 2013