T-ACS/RoboCrane
Suspended Cargo Acquisition and Stabilization

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August 1996
Presentation Overview

Emerging cargo handling operational capabilities
Current problems with T-ACS boom cranes
What is a T-ACS/RoboCrane?
The T-ACS/RoboCrane Solution
T-ACS/RoboCrane concept I
T-ACS/RoboCrane concept II
Summary

Video Overview

Model of conventional T-ACS boom crane
Model of T-ACS/RoboCrane concept I

(Not included in this presentation. Contact NIST for video info.)
Emerging Cargo Handling Operational Requirements
This research was conducted during ongoing work to develop Mobile Offshore Base cargo transfer cranes sponsored by DARPA/ONR

Mobile Offshore Base and T-ACS
Reduce load acquisition, transfer, placement times during normal operations
Improve in-transfer load stability
Provide continuous operations in night and adverse weather (to sea state 4)
Enhance safety, especially in confined areas under reduced visibility

Current/Previous efforts
Rider Block Tagline System (RBTS) on T-ACS cranes
Heave compensators on boom cranes
Anti-sway spacing device on portside cranes
T-ACTS (Tactical Auxiliary Crane Ships)

*T-ACTS photo’s and drawing courtesy US Navy and/or August Design, Inc.*
Tactical Auxiliary Crane Ship (T-ACS) Crane including Rider Block Tagline System (RBTS)

Feasibility Region for the RBTS
Stowed T-ACS Crane
T-ACS Crane Tagline Beam
Rider Block Suspended from T-ACS Crane

- Crane boom
- Rider Block lift line (center line)
- Load lift lines (outer lines)
- Rider Block (rolls along lift lines)
- Taglines
Current Challenges with T-ACS Boom Cranes
And Other Single Cable Cranes

Limited control of spreader/cargo sway using Rider Block Tagline System (RBTS)

RBTS introduces complex load motions that are difficult to dampen so operators often disable the system

No rotational control of spreader/cargo

Depth perception and line of sight occlusion hinder performance and safety

Ground personnel needed with taglines in hazardous area to guide cargo

Instability of cargo during transfer can become dangerous

Routine operations require precision boom controls and highly trained operator
What is a T-ACS/RoboCrane?

Cargo Acquisition and Stabilization System

Multi-winch, multi-cable, suspended cargo stabilizer
Augments existing load-bearing winches and cables
Constrains the suspended spreader/cargo from swinging and spinning
Allows controlled motion of spreader/cargo for acquisition and placement
Allows passive and active stabilization of spreader/cargo during transfer
Allows remote teleoperative operations or localized remote control
Vertically position a modified Rider Block, supported from three lift points forming an 8 ft triangle. This is called the Rider Platform.

Laterally stabilize the Rider Platform with three computer controlled taglines, augmenting the existing tagline system.

Constrain a suspended Rotator Platform from the Rider Platform using a RoboCrane cable configuration.

Attach a conventional spreader bar to the rotator.

Intelligently synchronize the winches using a teleoperative computer control system based on intuitive joystick input.
Any modifications allow a return to current T-ACS Crane operational techniques

Utilizes existing Rider Block with modified lift points (Rider Platform)
Utilizes existing main hoist routed through Rider Platform to lift load
Utilizes existing taglines with additional crossbrace tagline/power tether
Suspend removable Rotator Platform from Rider Platform via RoboCrane cable configuration
Affix powered, conventional spreader bar to Rotator Platform
T-ACS/RoboCrane

Concept I

- Six Winches
- Rider Sheaves
- Conventional Spreader Bar
- Rider Platform
- Existing Hoist Cable and Hook
- Tagline / Power Tether
- Existing Taglines
- Robocrane Cable Configuration
- Power Tether
- Rotator Platform
- Conventional Spreader Bar
T-ACS RoboCrane Concept 1 Model

Concept 1 Configuration
The T-ACS/RoboCrane
Model Concept II

Any modifications allow a return to current T-ACS Crane operational techniques

Utilizes existing main hoist to lift Rider Platform (half of the load)

Utilizes existing taglines with additional crossbrace tagline/power tether

Add another main hoist to lift Rotator Platform (other half of the load)

Route cables through Rider Platform to Rotator Platform via RoboCrane cable configuration
T-ACS/RoboCrane

Concept II

RIDER PLATFORM

EXISTING HOIST CABLE AND HOOK

TAGLINE / POWER TETHER

EXISTING TAGLINES

ROBOCRANE CABLE CONFIGURATION

POWER TETHER

ROTATOR PLATFORM

CONVENTIONAL SPREADER BAR
T-ACS RoboCrane Concept 2 Model

Concept 2 Configuration
T-ACS/RoboCrane Implementation

Current Modifications Support Future Enhancements

Support for Remote Teleoperation

6 Degree-of-freedom joystick
Operator visual and audio displays for intuitive cargo positioning
Automatic powered latch mechanism

Future Semi-Autonomous Cargo Acquisition

Operator chooses target cargo
Cargo is equipped with radio beacon or visual queues
Control system drives intersecting course with targets
Operator performs obstacle avoidance
Graphic of the NIST T-ACS RoboCrane Concept 1 with the August Design sensor system, and Intelligent Automation, Inc. feed-forward controlled cargo lift/placement point.
**T-AC S/RoboCrane Summary**

**Capabilities**
- No swinging or spinning of spreader/cargo
- Motion compensation even in heavy seas
- Joystick controlled position/orientation of spreader/cargo
- Supports remote teleoperation of cargo acquisition/placement
- Low visibility cargo acquisition/placement possible

**Mission related benefits**
- Increased cargo acquisition, transfer and placement rates
- Around the clock / adverse weather capability
- Increased mission efficiency
- Safer operations
Proposed Efforts

- Fully investigate initial concepts I and II
- Develop alternative concepts
- Develop additional scale models
- Develop control system
- Articulate scale models
- Design full scale retrofit of best concept to existing T-ACS crane
- Retrofit best concept to existing T-ACS crane
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