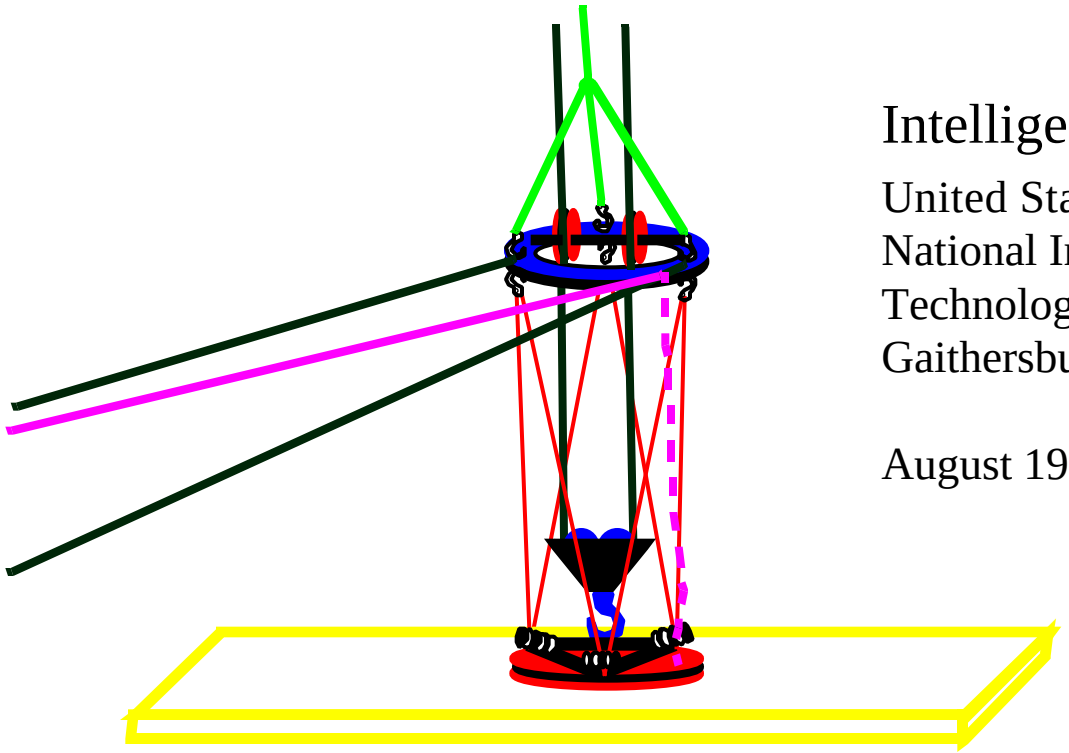
T-ACS/RoboCrane

Suspended Cargo Acquisition and Stabilization



Intelligent Systems Division

United States Department of Commerce
National Institute of Standards and Technology
Gaithersburg, Maryland 20899 USA

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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

(Not included in this presentation. Contact NIST for video info.)

Model of conventional T-ACS boom crane

Model of T-ACS/RoboCrane concept I

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

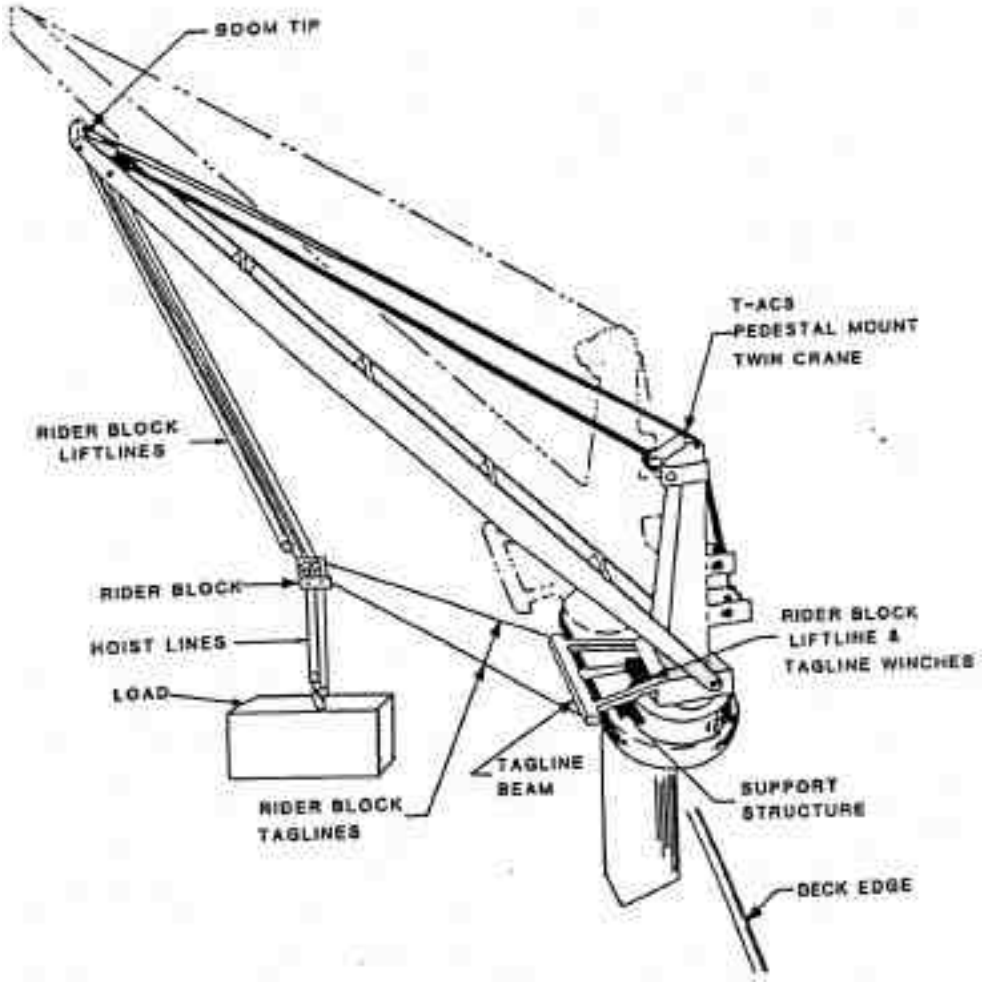
Heave compensators on boom cranes

Anti-sway spacing device on portside cranes

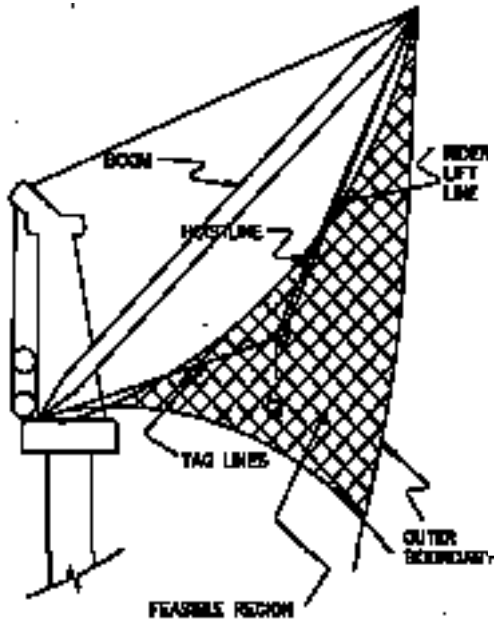
T-ACS (Tactical Auxiliary Crane Ships)

T-ACS 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)

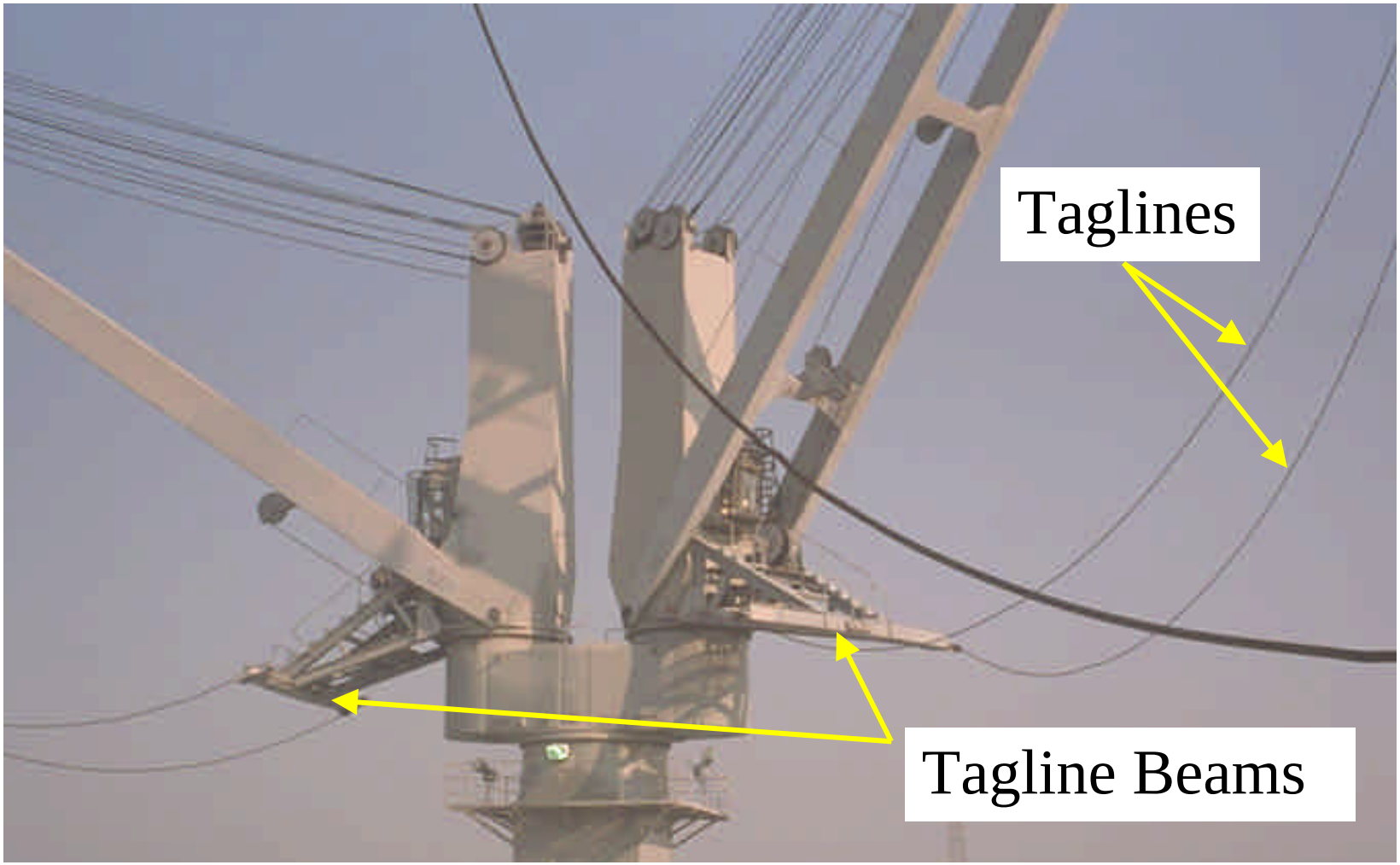


Feasibility Region for the RBTS

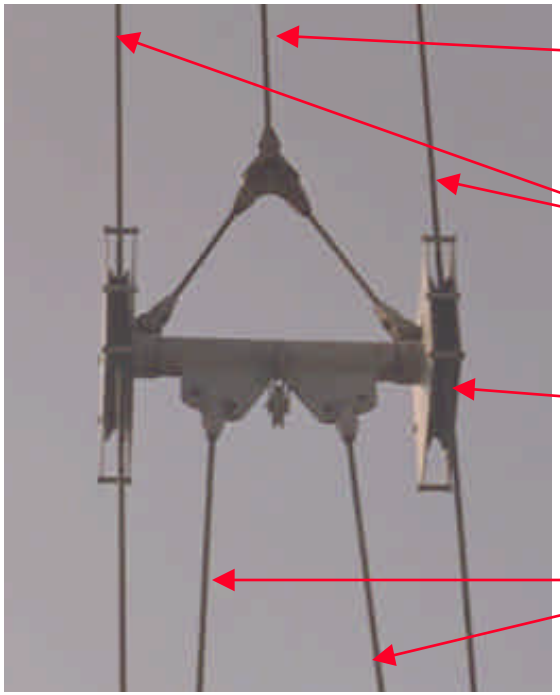


Stowed T-ACS Crane

T-ACS Crane Tagline Beam



Rider Block Suspended from T-ACS Crane



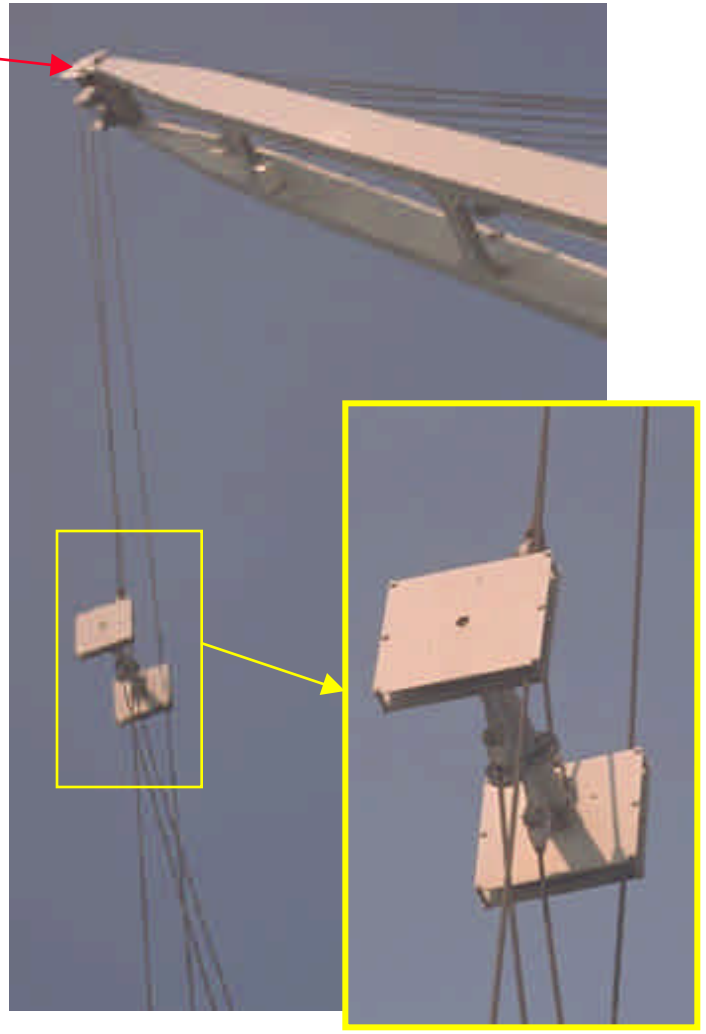
Rider Block lift line
(center line)

Load lift lines
(outer lines)

Rider Block
(rolls along lift lines)

Taglines

Crane boom



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 hinders 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

The T-ACS/RoboCrane Solution

A General Description

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.

The T-ACS/RoboCrane

Model Concept I

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

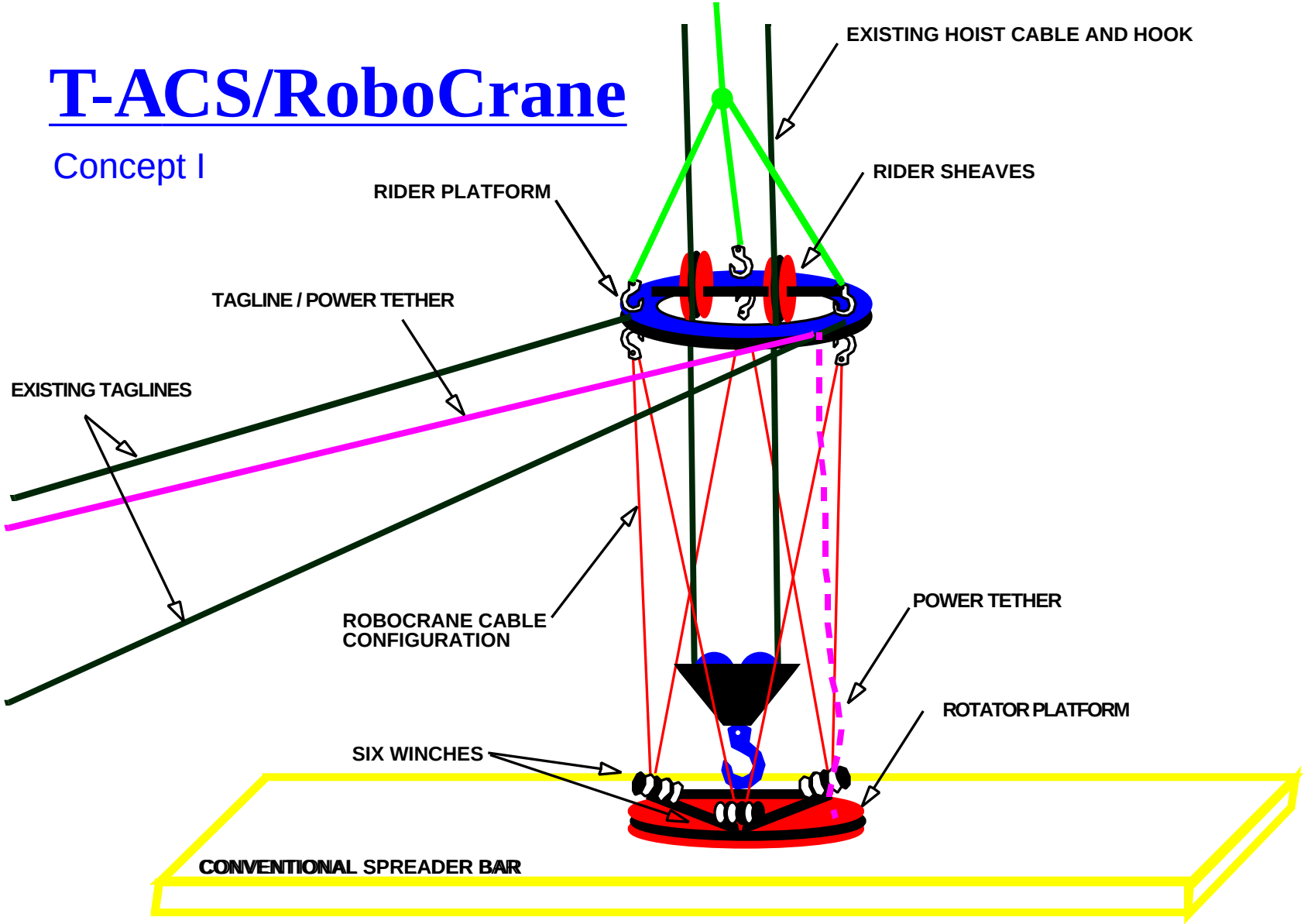
Utilizes existing taglines with additional crossbrace tagline/ power tether

Suspend removable Rotator Platform from Rider Platform via RoboCrane cable configuration

Affix powered, conventional spreader bar to Rotator Platform

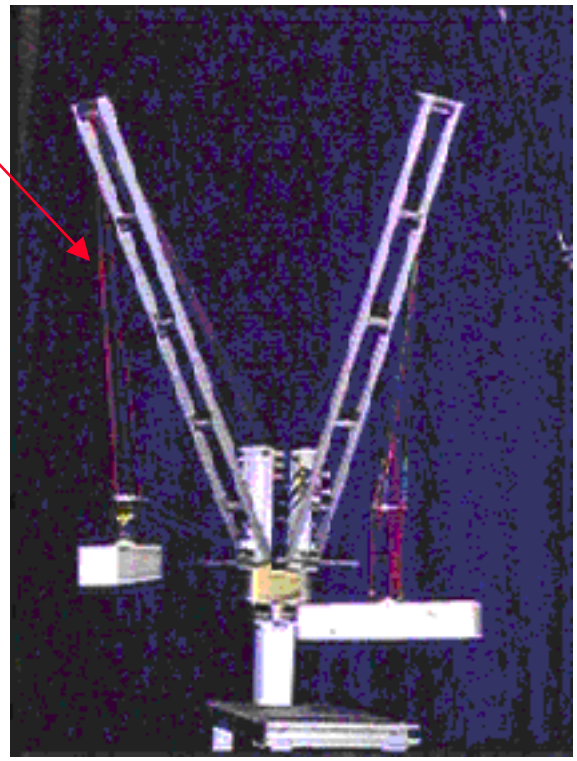
T-ACS/RoboCrane

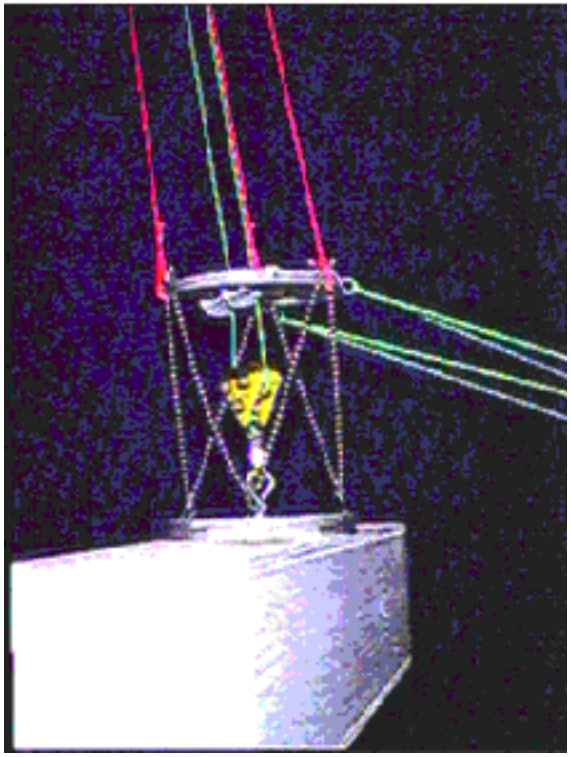
Concept I



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)

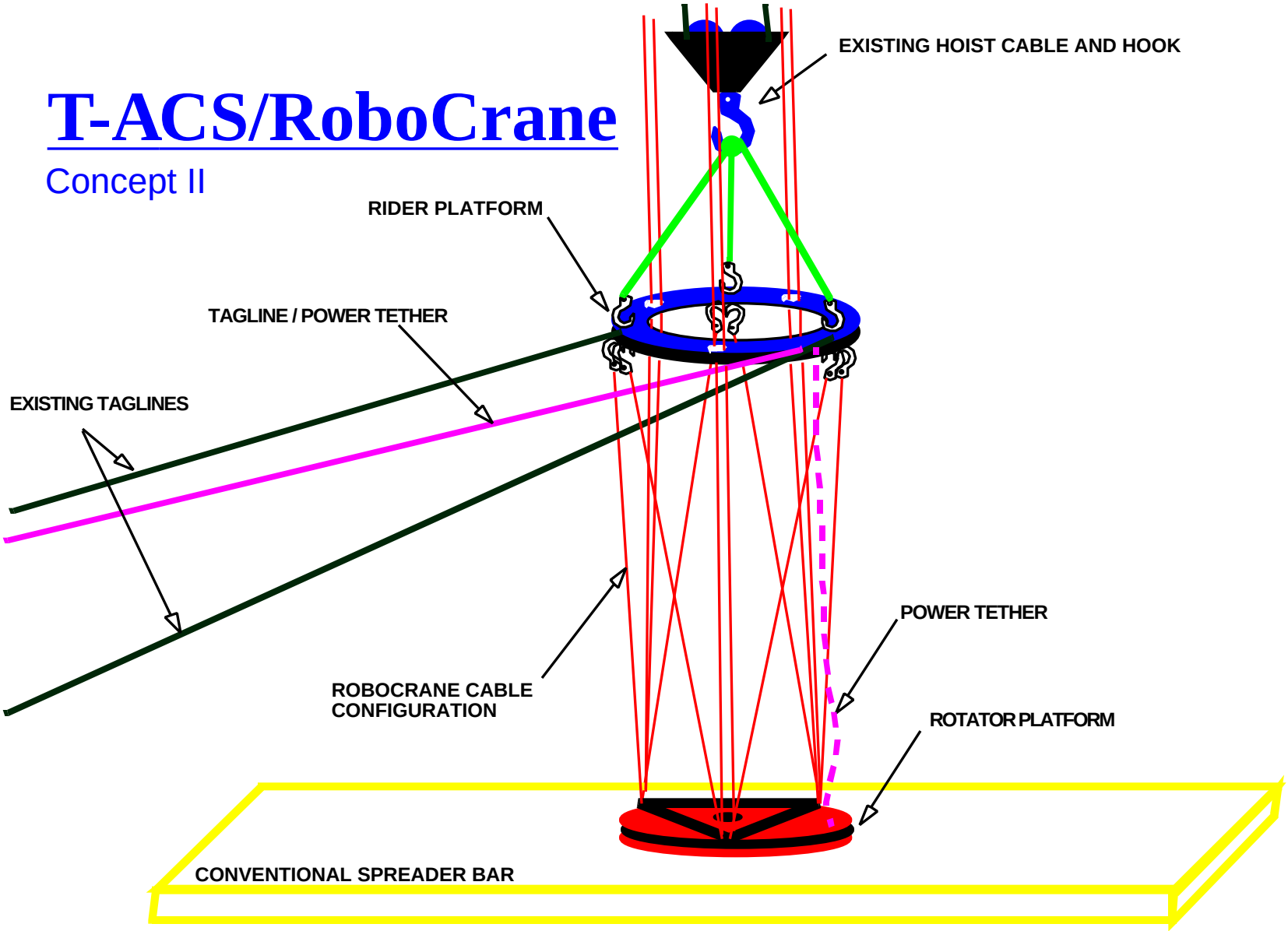
Utilizes existing taglines with additional crossbrace tagline/ power tether

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

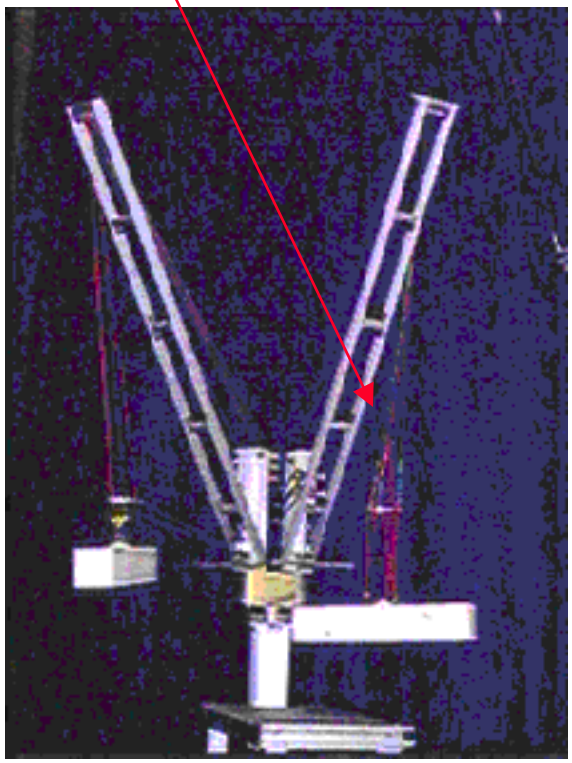
T-ACS/RoboCrane

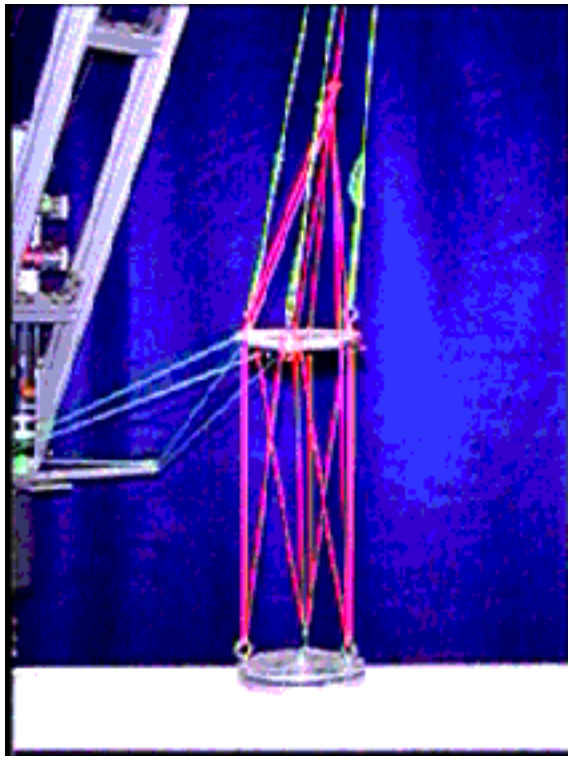
Concept II



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

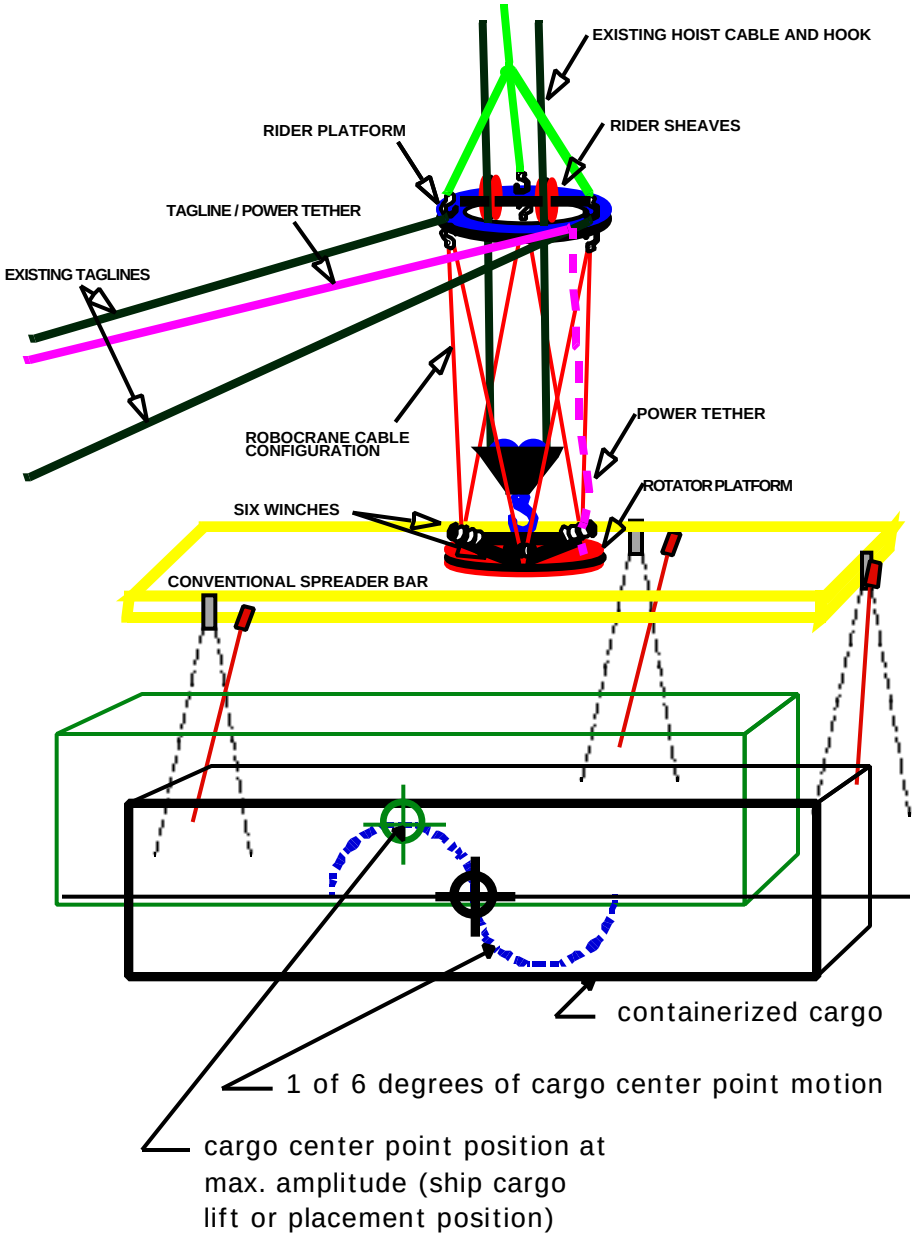
Operator chooses target cargo

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-ACS/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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