Thermal Imagine Applications Toward Design Optimization and Operational Troubleshooting of Lightweight Robotic Vehicles

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GVSS, Redondo Beach, California

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TARDEC
U.S. ARMY TANK-AUTOMOTIVE RESEARCH DEVELOPMENT AND ENGINEERING CENTER

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

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Introduction

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

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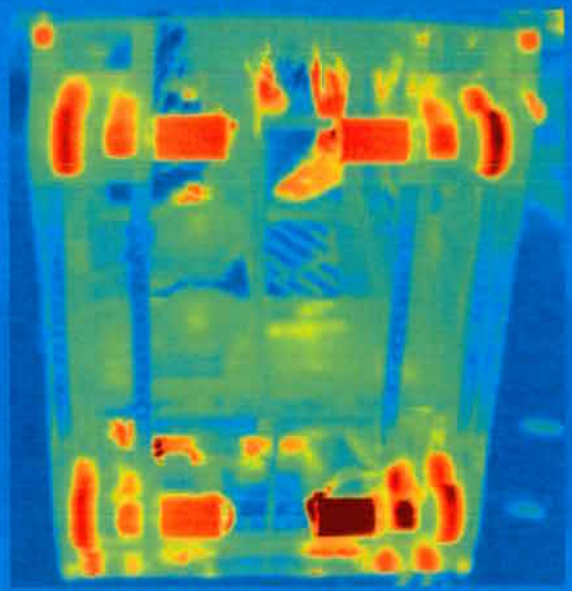

Purpose

SUPERIOR **TECHNOLOGY** FOR A SUPERIOR **ARMY**

- Annotate a method employing thermal imaging devices to identify potential mechanical/electrical failure modes and validate system design of unmanned ground vehicles

- End Result:
  - Improved reliability and durability of unmanned ground vehicles
  - Improve system design by identifying overworked components
  - Identify components with failure modes during preventative maintenance checks and services

Background

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- TARDEC Outreach
  - Ecybermission (http://www.ecybermission.com/)
  - Explorer Post 1928 (http://www.scouting.org/)
  - Mini Baja Competition (http://www.sae.org/)
  - Intelligent Ground Vehicle Competition
  - First Robotics Competition (http://www.usfirst.org/)
- First Robotics Competition
  - Objective: to inspire high school students to pursue a career in science and technology
  - Goals: Robots compete to finish a given scenario
  - Governance: Standardize rule for all competitors

First Robotics Competition

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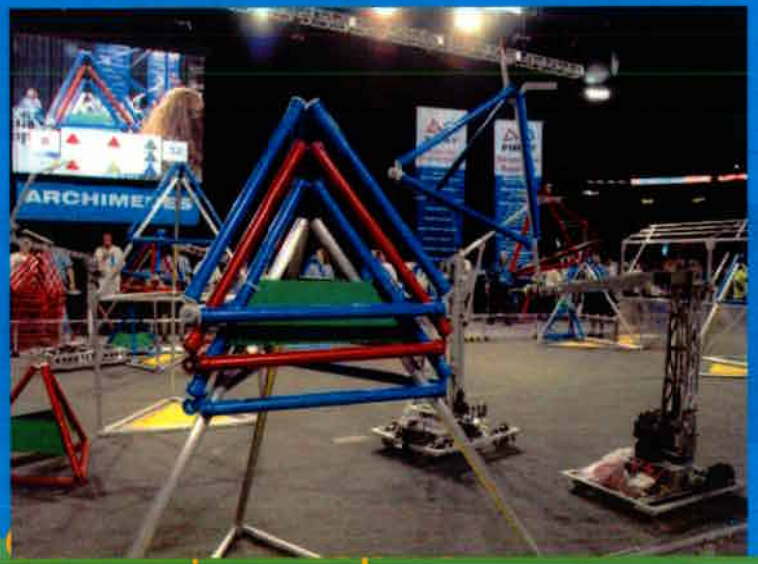
- A multinational competition that teams the scientist and engineers of tomorrow with professionals to solve engineering design challenges
  - Standard kit of parts
  - Six week time frame
  - More than 28,000 high school participates in 2006



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Process Improvement

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- TARDEC Engineers' fielded the Groves Robot to the competition
- TARDEC Engineer decided to have a Technology Demonstration of a Forward Looking InfraRed (FLIR) device (Detects hot spots)
- The FLIR was used for design reviews of student's robots
  - Identifying areas of concern for each group
  - Identified a potential failure for the Groves Robot

Drive Assembly Results

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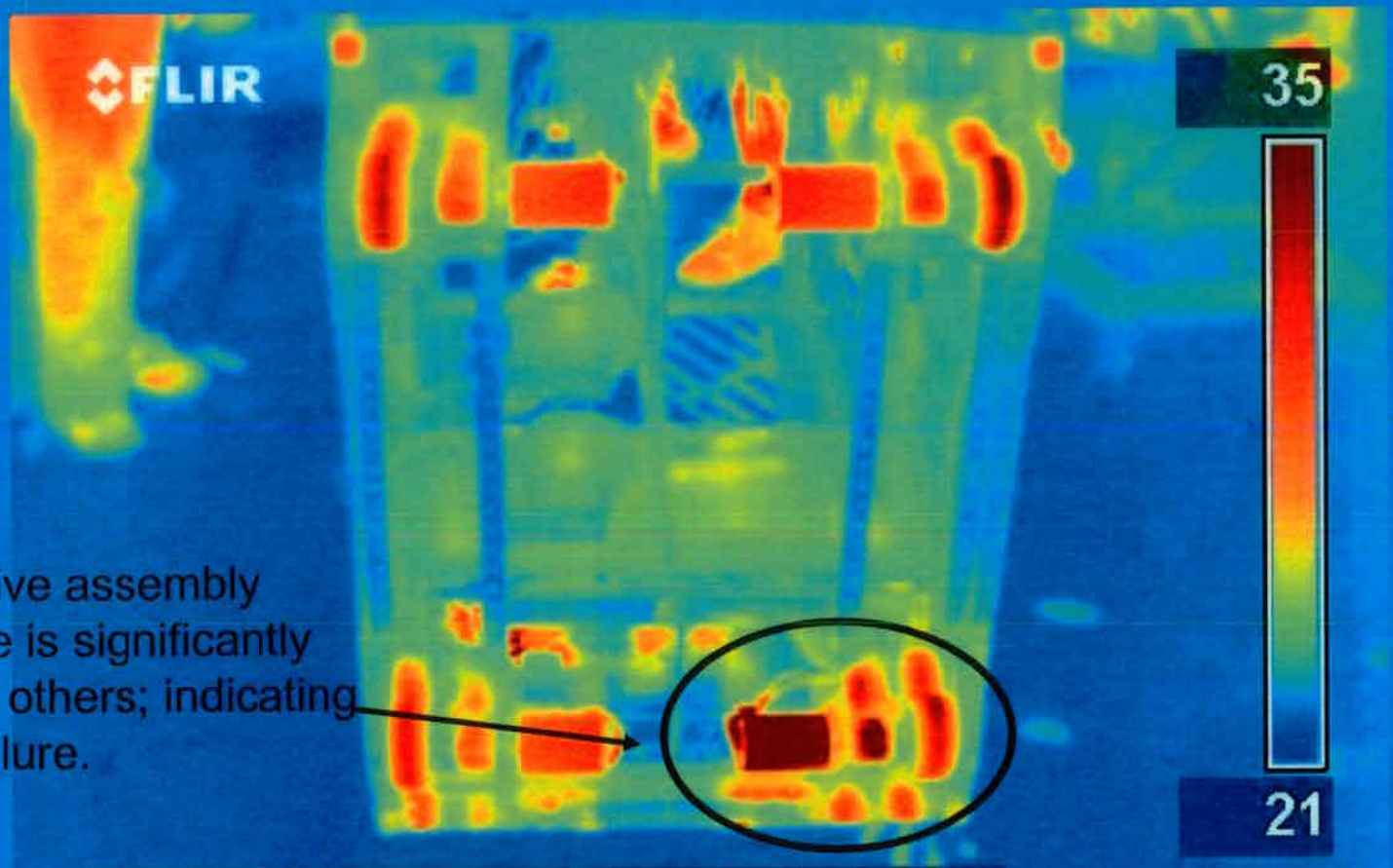

The rear drive assembly temperature is significantly higher than others; indicating potential failure.

System Design Analysis

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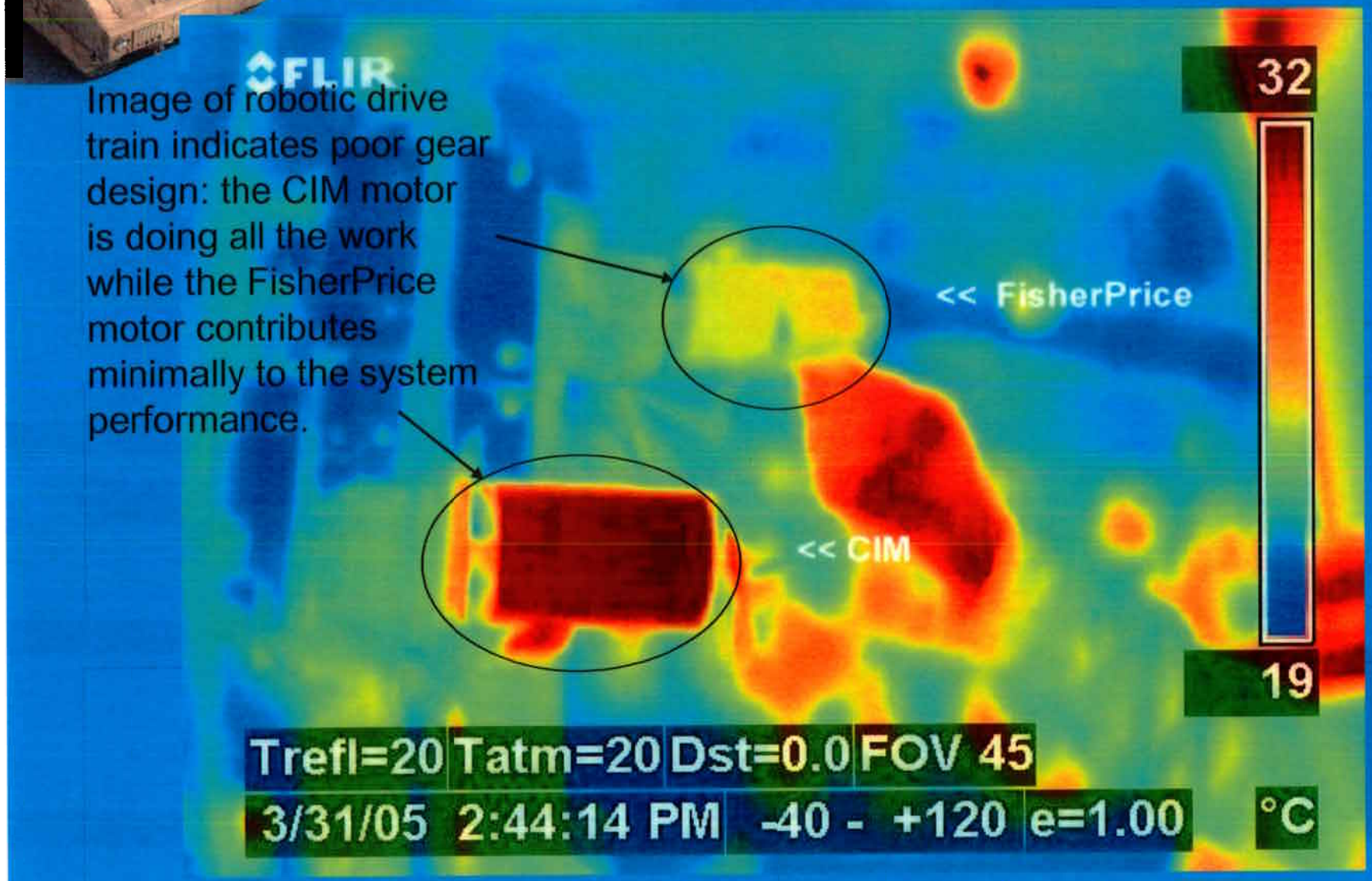

Image of robotic drive train indicates poor gear design: the CIM motor is doing all the work while the FisherPrice motor contributes minimally to the system performance.

Methodology

- FLIR Technology
  - Technology demonstration turned into powerful tool.
  - Able to diagnose failure modes before component failed during competition
- Components sometimes fail during match
  - This method allowed to foresee possible failure
  - Components replaced or design changed to lower failure possibility
- FLIR devices detected hot spots
  - Hot spots indicated more work being done (e.g. extra heat generated by extra friction)
- FLIR can be used to change designs to reduce the hot spots

Applying FLIR Process

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- Critical Elements to apply FLIR technology Failures Modes:
  - Quantified normal system operating conditions
    - Operating temperatures for motors, drive line assembly, etc.
  - Analyze thermal imagery of Robot
  - Detect points of interest (Hot Spots)
  - Analyze conditions of environment
    - External factors (e.g. surface grades, surface friction)
    - Internal Factors (e.g. airflow blockage, etc.)
  - Compare hot spots with baseline system results

Application of Technology

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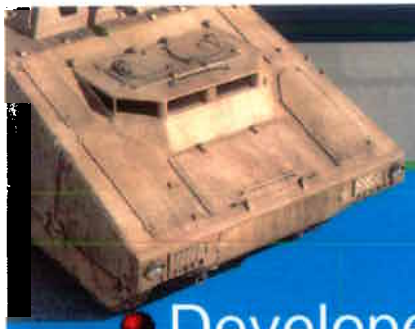
- FLIR Imagery is used within the Army and industry for thermal management of various systems to include circuit design and thermal management of heat producing elements
  - Video and IR data collect provides the engineer the operating conditions and system characteristics
  - MuSES (Multi-Service Electro-optic Signature) software allows engineer to model thermal management of the system to include signature aspects
- Design changes are model to determine the impact on thermal management and signature of the system
  - Identify design within the thermal management of the system before developed



Additional Developments

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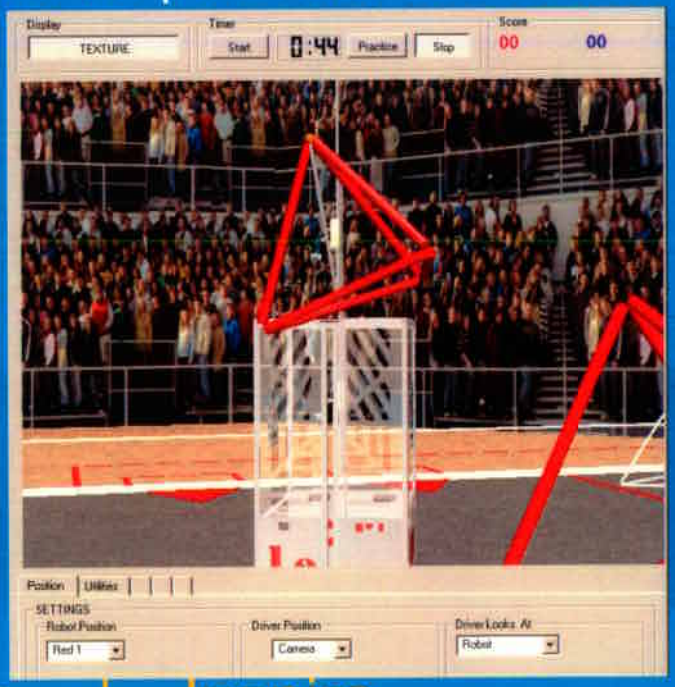
- Developed Dual use technology
  - Initially developed by TARDEC and Student's to create a training environment to determine thermal profiles for competition tasks.
  - Now under review at STRICOM for its potential use in training



Summary

- Application of Infrared device effect the unmanned system throughout various aspects of development:
  - Design: Optimize component and system design
  - Fielding: Identified failure modes before failures occur
- Application of a Simulator:
  - Produce thermal situation to identify potential failure modes
  - Identify thermal situational profiles to analyze system design
- Impact the reliability of unmanned ground vehicles

Questions

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"There are no foolish questions and no one becomes a fool until they have stopped asking questions."

~ Unknown