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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Convoy Active Safety Technology - Information Brief

Edward Schoenherr
April 2010

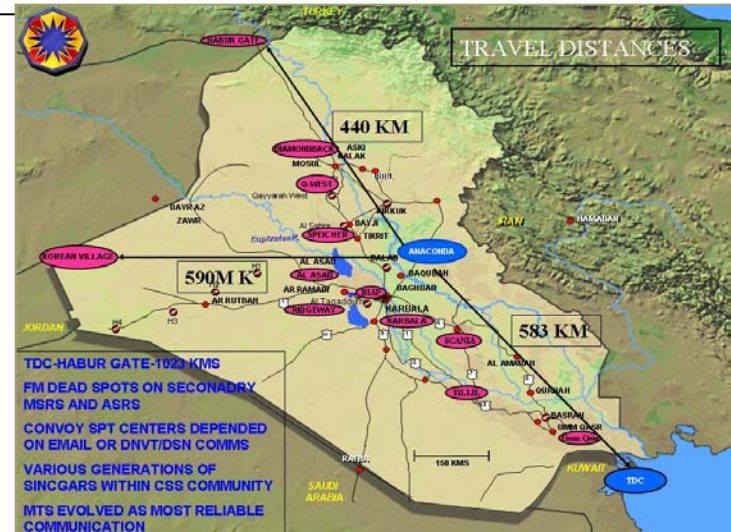
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Convoy operations are inherently dangerous due to numerous threats on the battlefield while having limited defensive capability. Increased situational awareness and reduced fatigue can mitigate threats resulting in improved survivability and sustainment throughput.



- Convoy operations
 - Limited MSRs/ASRs
 - Long / Short Haul duration
 - High speeds
- Operating conditions
 - Visibility
 - Extreme Climates
 - Threat
 - Terrain
- Multiple range of operations
 - Peacetime Military Engagement
 - Major Combat Operations
- Limited situational awareness
 - Operator and Co-operator (Observer)
 - Limited comms

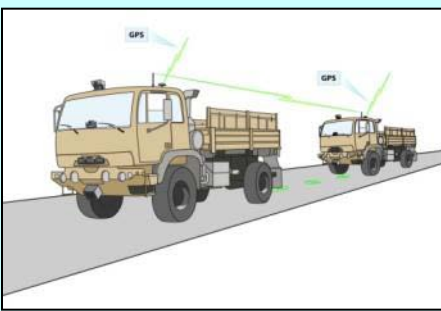


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Employing a semi-autonomous (hands-off) operator-in-the-cab enabler, CAST provides the following:

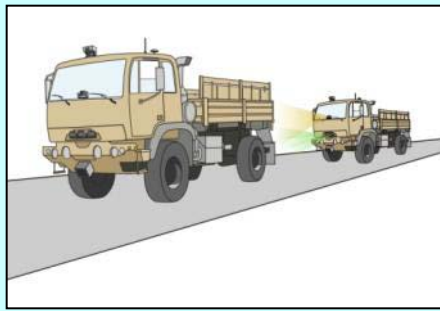
- Increase Safety and Security
 - Disciplined speeds, proper distance between vehicles
 - Less accordion effect, less bunching
- Increase Situational Awareness
 - Dedicate time to observe activity
 - Increase readiness and reaction time to relevant information
- Decrease Fatigue/Stress
 - Decrease multi-tasking time
 - Focus concentration on a single set of operations
- Accident Avoidance
 - Collision
 - Rollover





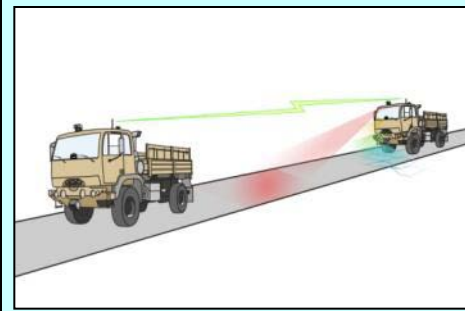
GPS Leader-Follower

- Lead Vehicle Provides Trail of GPS Waypoints
- Simple Approach Available in Most Locations



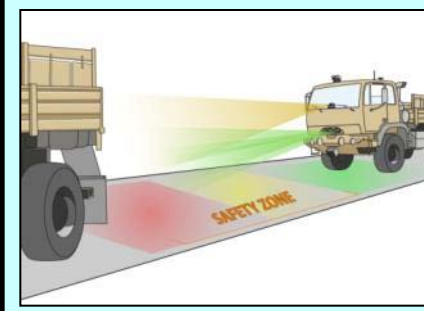
Radar/Vision Tracking

- Follow Vehicle Uses a Combination of Radar and Vision to Estimate Trajectory of Lead Vehicle
- Enables High Speed Following at Close Distance
- Reduces 'Cut in' Disruption



Vision Based Route Following

- Lead Vehicle Reports Position on Route
- Follow Vehicle Uses Road Following and Obstacle Avoidance to Navigate on Route
- Enables Following at Large Separation Distances



Safe Distance Maintenance

- Safety Aid to Prevent Rear End Collisions

Multiple Modes Enable Operations in GPS and Communications Denied Areas



- High algorithmic confidences
- Full sensor data usage
- 55 mph capability

- High algorithmic confidences
 - UWB, IR tracking
- Nominal algorithmic confidences
 - Color camera road / vehicle following, LADAR tracking
- 35-45 mph capability





- High algorithmic confidences
 - UWB, IR, LADAR
- Low algorithmic confidences
 - Color camera road / vehicle following
- 15-30 mph capability

- Friendly blue-on-blue collisions current operational hazard
- Accordion effect mitigation
- Statistically relevant improvement





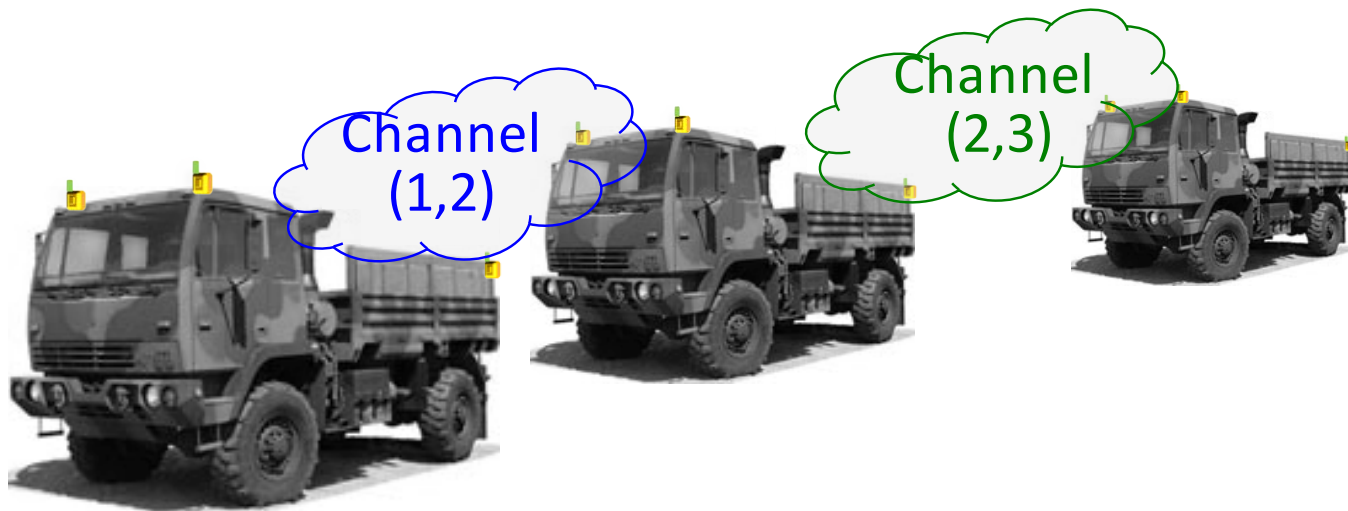
- Relative sensing of non-convoy vehicles
- Active response to “cutting in” convoy formation

- LADAR / MMW sensor usage
- Range / speed considerations
- Rollover considerations
- Other sensing modalities



Development of Capability to Track Multiple Vehicles

- Operate Multiple Tracking Channels Simultaneously
- Reorder Vehicles and Detect New Vehicle Ordering
- Requires Adaptive Power Management to compensate for near – far problem caused by channel delay spread

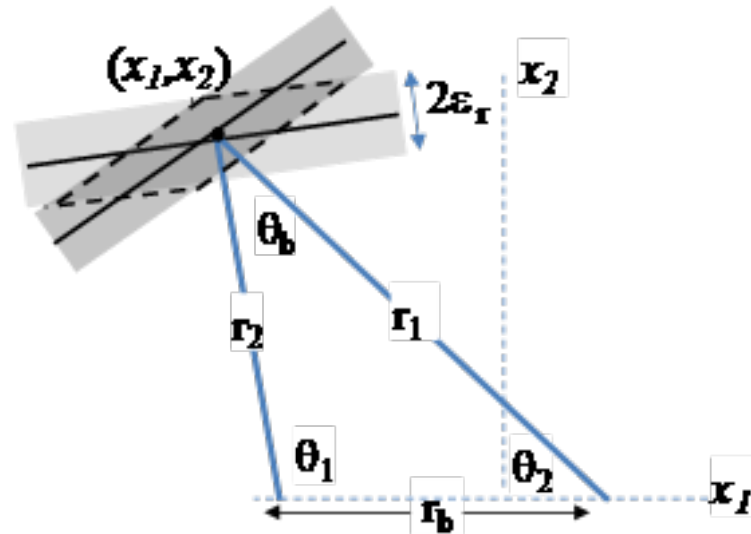
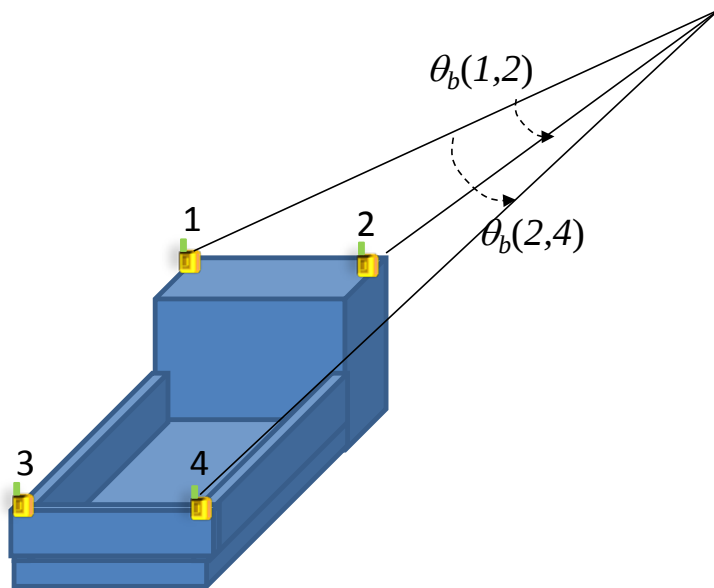


2. Development of Novel Capability that minimizes Geometric Dilution of Precision (GDOP)

- GDOP is related to the area of the parallelogram formed by 2 range errors and is proportional to

$$\left(\frac{\varepsilon_{r1} \varepsilon_{r2}}{\sin \theta_b} \right)$$

- this area is minimal for the minimum vertex angle, $\theta_b(x,y)$
- the controller selects radii that minimize the angle $\theta_b(x,y)$





Warfighter Experiment 1&2 Synopsis



Experiment I

- 6 weeks @ Ft. A.P. Hill, VA
- 12 drivers – retired Army
- Speeds varied from 20Kph to 60 Kph
- Terrain included paved and dirt roads
- Participants completed 6 driving trials
 - 3 with CAST engaged (4 hours)
 - 3 with CAST disengaged (4 hours)
- Participants were asked to:
 - Scan for targets
 - Maintain a set following distance
 - React to unanticipated stops
- Vehicle performance tracked:
 - Cross- track error
 - Gap distance maintenance

Experiment II

- 5 weeks @ Nevada Auto Test Center, NV
- 25 drivers – active duty 88 Mike
- Speeds varied from 30Kph to 85 Kph
- Participants completed 4 driving trials
 - 2 with CAST engaged
 - 2 with CAST disengaged
 - each mode in day and blackout
- Participants were asked to:
 - Scan for targets
 - Maintain a set following distance
- Vehicle performance tracked:
 - Cross- track error
 - Gap distance maintenance
- EEG and eye – tracking data collected

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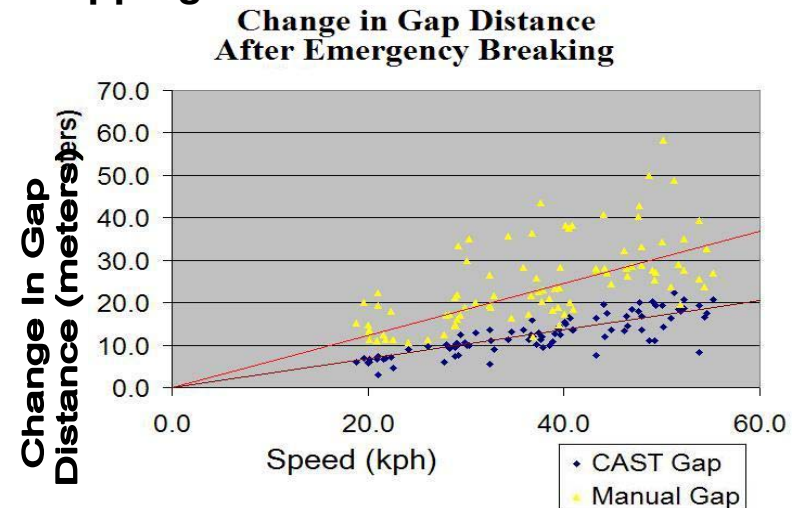
Physiological Effects

- No reported central, peripheral, gastrointestinal motion sickness issues
- 20-25% Increase in number of threat detections while CAST engaged
- 3-5 second increased response time
- Participants reported with significance less fatigue and ease of convoy execution while CAST engaged

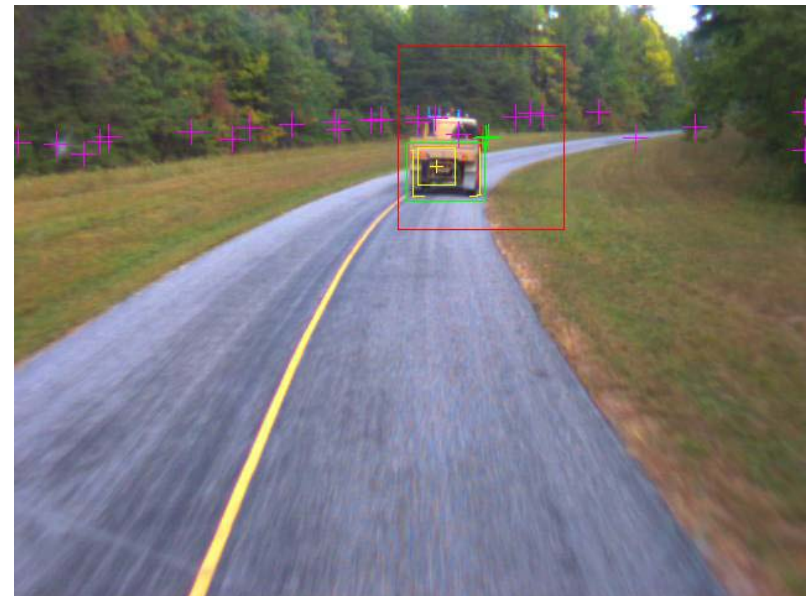
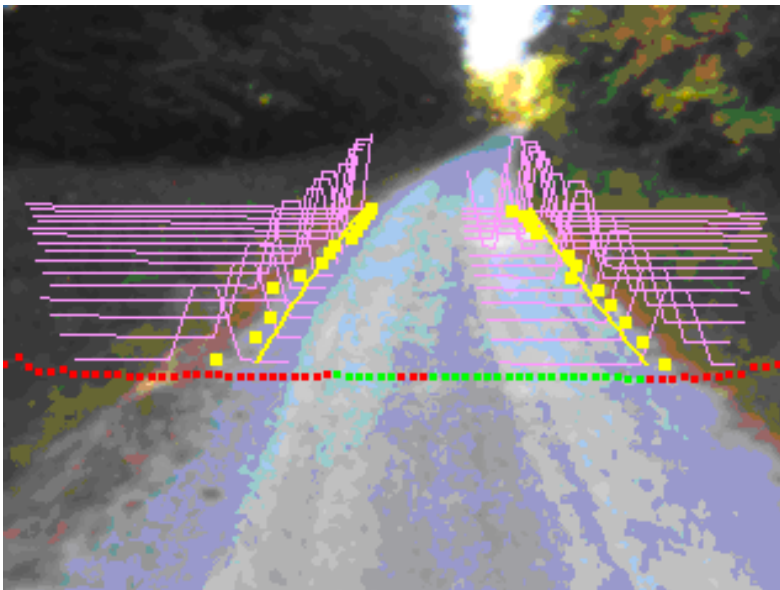


Vehicle System Performance

- Gap distance formation maintenance shows 150% improvement with CAST
- Cross track error consistency data shows 15% improvement with CAST
- Successful daylight driving at 85kph
- Successful blackout driving at 70kph
- Data shows 85% improvement in panic stopping distance with CAST



- **FY10 Development Phase**
 - Dynamic rollover mitigation
 - Intelligent tele-operation of lead vehicle
 - Robust networking implementation
 - Fuel efficiency study



- **Enhanced Situational Awareness**

- Visual scanning
- Monitoring network comms

- **Increases probability of IED detection and avoidance**

- Mitigates loss of life/limb
- Mitigates lost of equipment and cargo
- Fewer rescue and recovery operations

- **Improved convoy discipline and operational effectiveness**

- Convoy integrity (no accordion effects)
- Fewer lost/broken convoys
- On-time arrivals/mission completion

- **Soldier effectiveness increased**

- Cognitive skills
- Physical bearing