Technology Work Session for the South African Army; Hosted by the CSIR

Autonomous and Remotely Controlled Systems

Intelligent Autonomous Systems

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Outline of Presentation

- Introduction to Autonomous Systems
- DARPA's Contribution to the Field of Autonomous Systems
- Existing Capabilities in Autonomous Systems
- From Teleoperation to Full Autonomy
- Novel Ground-based Platforms
- Existing Autonomous Systems
- Future of Autonomous Systems
- Local R&D Initiatives
- Potential Applications of Intelligent Autonomous Systems

Introduction to Autonomous Systems

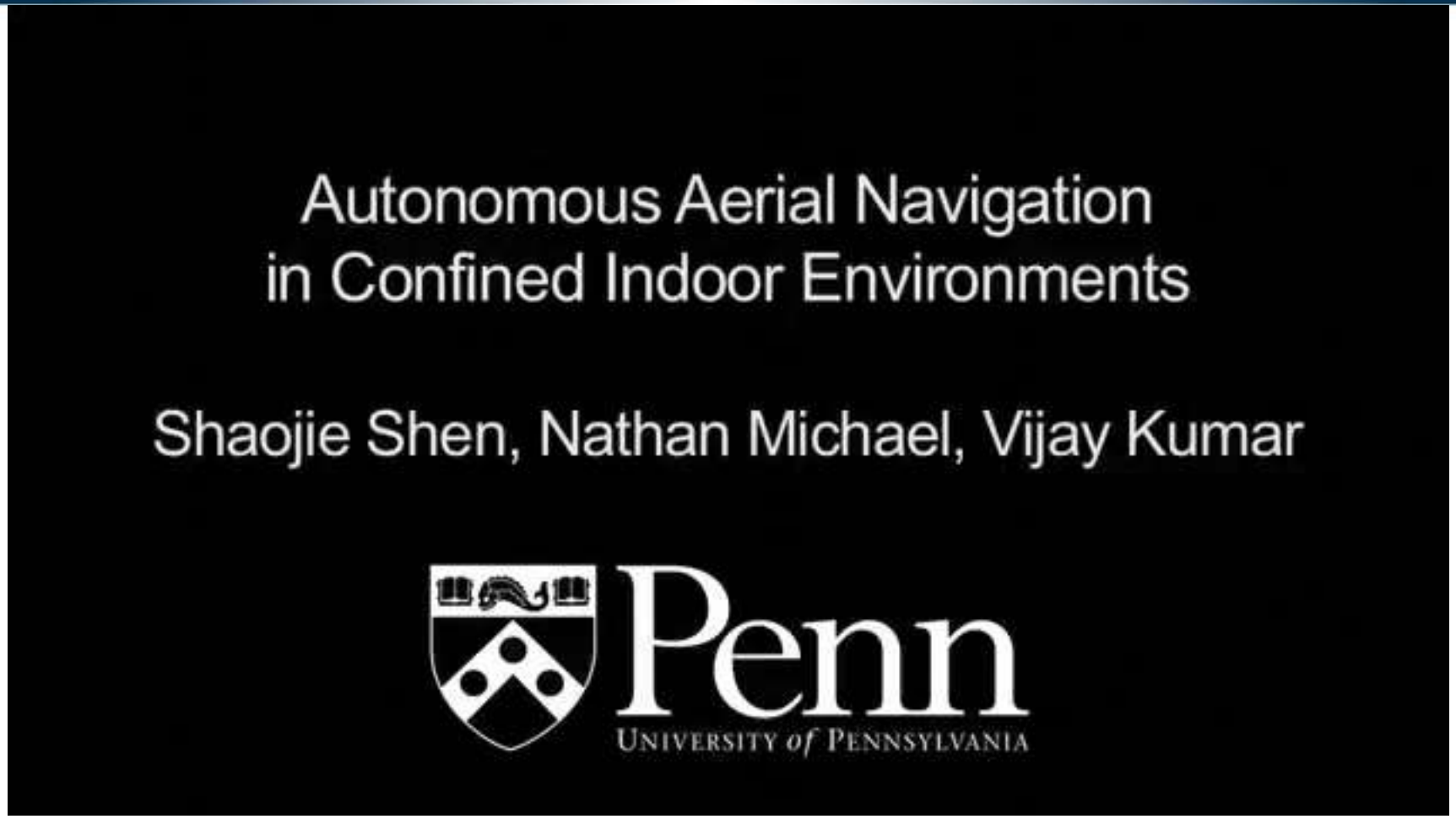
- What is an intelligent autonomous system (robot)?
  - Independent operation
  - Capable of reasoning about environment
- Advantages of autonomous systems:
  - Operate in extreme environments
  - Do not suffer from fatigue
  - Not bored by repetitive tasks
  - Expendable
  - Require less support infrastructure on site

Introduction to Autonomous Systems

- An intelligent autonomous system comprises three distinct components
  - **Platform**: The physical robot including any sensors and 3rd party components
  - **“Intelligence”**: The ability to perform tasks autonomously
  - **User Interface**: How the operator interacts with the system

DARPA's Contribution to Ground-based Autonomous Systems

Existing Capabilities in Autonomous Systems Mapping



Existing Capabilities in Autonomous Systems Planning

From Teleoperation to Full Autonomy

- Transistion to full autonomy has problems:
  - Reliability and robustness
  - Adversity to change
- Need a testing ground for developing technologies
- Slowly introduce autonomy as an optional component to build trust with users

Partial Autonomy Examples
Improved Situational Awareness for Teleoperation

- Teleoperation of a vehicle presents problems in the form of situation awareness and immersion
  - Limited field of view
  - No 3D environment perception
  - Delays in control and sensor feedback
- To alleviate this problem, researchers created a virtual operating environment.
- Operating speed of vehicle increased by 20% without reduction in control performance

Partial Autonomy Examples
Reduction of Operator Load – Tramming

- Teleoperated driving requires a large degree of concentration but is very laborious and boring.
- Solution is to automate the task of driving between different locations (goto functionality)
- Operator is now free to perform more complicated tasks

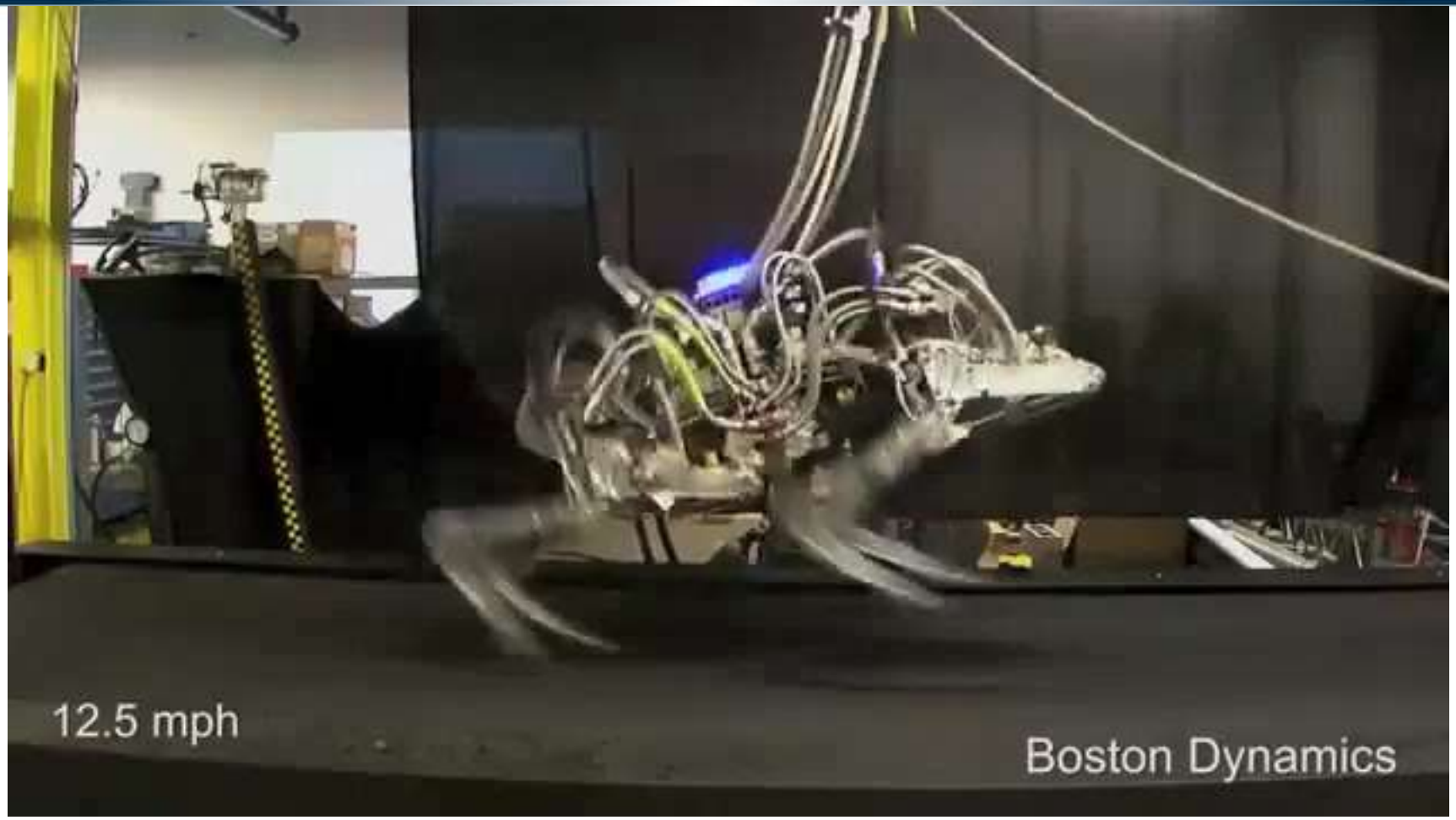
Partial Autonomy Examples
Reduction of Operator Load – Task Autonomy

- Simple tasks performed through teleoperation become very difficult. Eg. Removing a screw, picking up something.
- Task autonomy gives the robot the ability to perform these simple single tasks autonomously.
- Example in the BEAR robot which we will look at next.

Novel Platforms – Vecna Robotics' BEAR
Battlefield Extraction Assist Robot

Novel Platforms – Boston Dynamics' BigDog

Novel Platforms – Boston Dynamics' Cheetah



Novel Platforms – Boston Dynamics' Sand Flea

Novel Platforms – CMU Crusher

Existing Systems – iRobot Packbot & FirstLook

- iRobot Packbot 510 and Warrior are tried and tested technology on the battlefield with more than 1000 units in operation.
- Teleoperated vehicle used for exploration, EOD and urban warfare
- Packbot is designed to be carried by a single soldier

Existing Systems – iRobot Packbot & FirstLook

- FirstLook is a new platform from iRobot, designed to be a personal scout
- Platform is lightweight (< 2kg) and small (23cm x 25cm x 10cm) with several wireless cameras.
- Designed to be used in built up areas to explore unknown environments
- Remote control from small operators console

Existing Systems – General Dynamics MDARS (Mobile Detection Assessment and Response System)

- MDARS is an autonomous border patrol and surveillence robot.
- Can be equipped with a assortment of weapons and sensors.
- Reports identified threats to control room where operator can command response.
- Top speed 30km/h with 16 hour operating time
- Robot has been deployed in active service in the US since 2004

Existing Systems – G-NIUS Guardium

- G-NIUS Guardium is a border patrol robot similar to General Dynamics MDARS platform.
- Top speed of 50km/h, capable of on-road and off-road travel for several days of continuous operation.
- Reports threats to human operator for response
- Can participate in convoys for look-ahead scouting
- Is currently in use in Israel for border patrol and evaluated for patrolling international airports.

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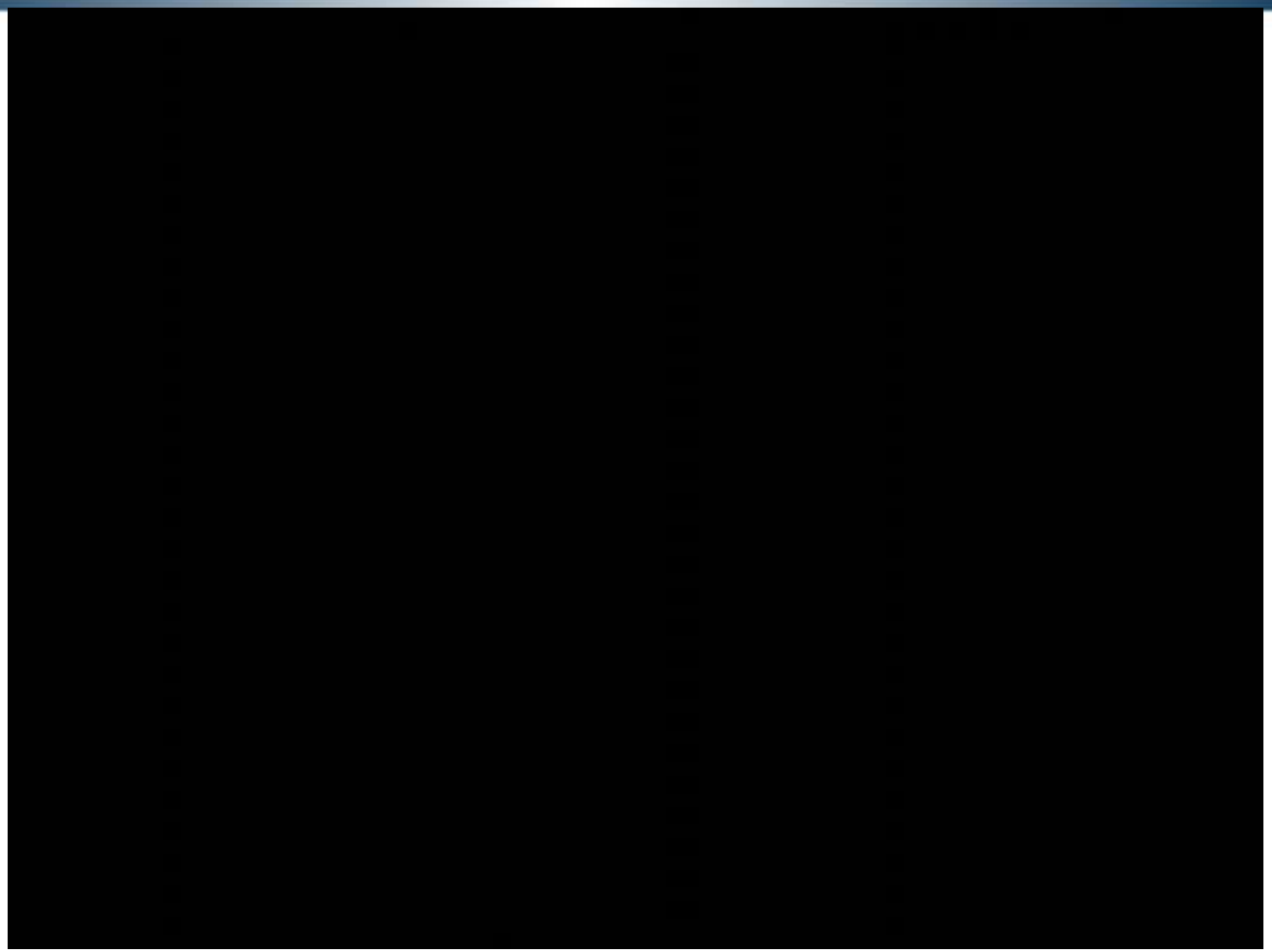
Existing Systems – Lockheed SMSS (Squad Mission Support System)



Future of Autonomous Systems

- DARPA is continuing to fund novel research in the field of autonomous systems
- New projects include:
  - Surrogate project
  - Next Grand Challenge – Autonomous robots in a human world

Local R&D Initiatives

- Some work has been undertaken towards a soldier support vehicle, this includes:
  - Platform design
  - High-speed dynamics and control
  - Target detection and tracking
  - Mapping, path planning and navigation

- Most of this work has been undertaken on grant funding – low priority research.
- Some of this work was demonstrated at the exhibits.

Conclusions

- Autonomous systems can provide assistance or a viable alternative to manned operations.
- Already seeing examples of fully autonomous ground-based vehicles in operation around the world – although mostly in controlled environments.
- As capabilities improve, we are likely to see these systems operating in built-up and high population areas (including civilian applications)
- Pressure to develop new and improved technologies is continuing and unlikely to ease over the near future, leading to new prospects for future battlefields.

Potential Applications within the South African Military

- Warrior Load Carriage
  - Soldier Systems' presentation (Session 3) stated that soldiers are expected to carry around 35kg to 75kg. Squad support vehicles could assist in reducing this.
- Border Patrol
  - Vehicles similar to MDARS and Guardium could be used to patrol borders and other key areas (Kruger Park rhino poaching)
- Autonomous Convoys
  - Autonomous tramming and target following robots could reduce the man-power requirements in convoys

Thank You

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