

# ARTSI Robotics Competitions at Tapia

Sponsored by iAAMCS

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<http://www.cs.cmu.edu/~dst/ARTSI/Robotics15>

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# Goals

1. Foster student excitement about computer science by exposing them to sophisticated robotics technologies and engaging them in a friendly competition.
2. Offer beginning students a chance to get started in robotics by solving some non-competitive challenge tasks.

# Goals (cont.)

3. Help students develop the skills necessary for better research opportunities:
  - Familiarity with Linux
  - Proficiency in C++
  - Experience working with large software systems
  - Experience working in teams
  - Exposure to computer vision

# Goals (cont.)

4. Improve the quality of robotics education available to computer science majors.
  - Touretzky, D. S. (2013) Robotics for computer scientists: what the big idea? *Computer Science Education*, 23(4):349-367.
  - Touretzky, D. S. (2012) Seven big ideas in robotics, and how to teach them. Proceedings of SIGCSE 2012.
  - Touretzky, D. S. (2010) Preparing computer science students for the robotics revolution. *Communications of the ACM*, 53(8):27-29.

# History

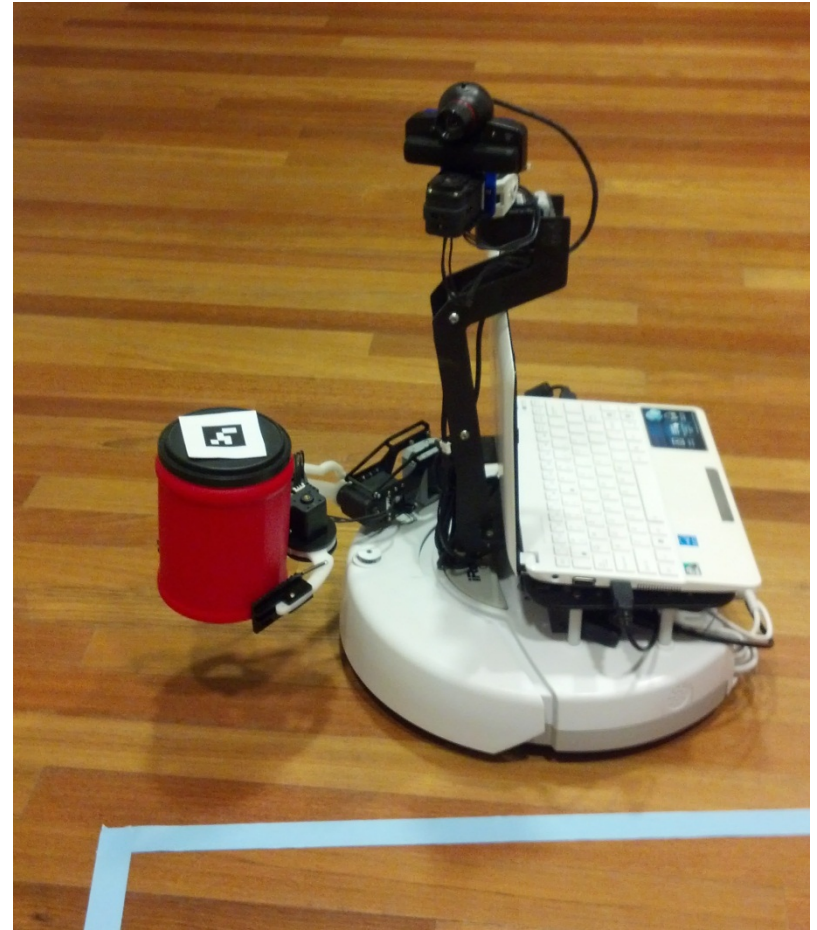
- C.A.R.E. Demonstration project (2007-2009)
  - CMU, Spelman, Hampton, UDC, and FAMU
  - Sony AIBO robot dogs
- ARTSI Alliance (2009-2013)
  - 17 HBCUs and 9 major research universities
  - Leads: Spelman+CMU, then Hampton+CMU
  - Calliope robots, later upgraded to Calliope2SP

# Robotics Courses at HBCUs

- With assistance from CARE and then ARTSI, new robotics courses were created at the member HBCUs.
- CARE/ARTSI provided hardware, software, faculty training, and technical support.
- ARTSI's Summer REU program gave students opportunities to work in robotics research labs at R1 schools.

# The Calliope2SP Robot

- iRobot Create base
- Sony PS3 Eye webcam on pan/tilt mount
- 2-dof arm w/gripper
- ASUS or Acer netbook
  - Ubuntu Linux
  - Tekkotsu robot software
- \$2500 retail – no comparable robots in this price range.

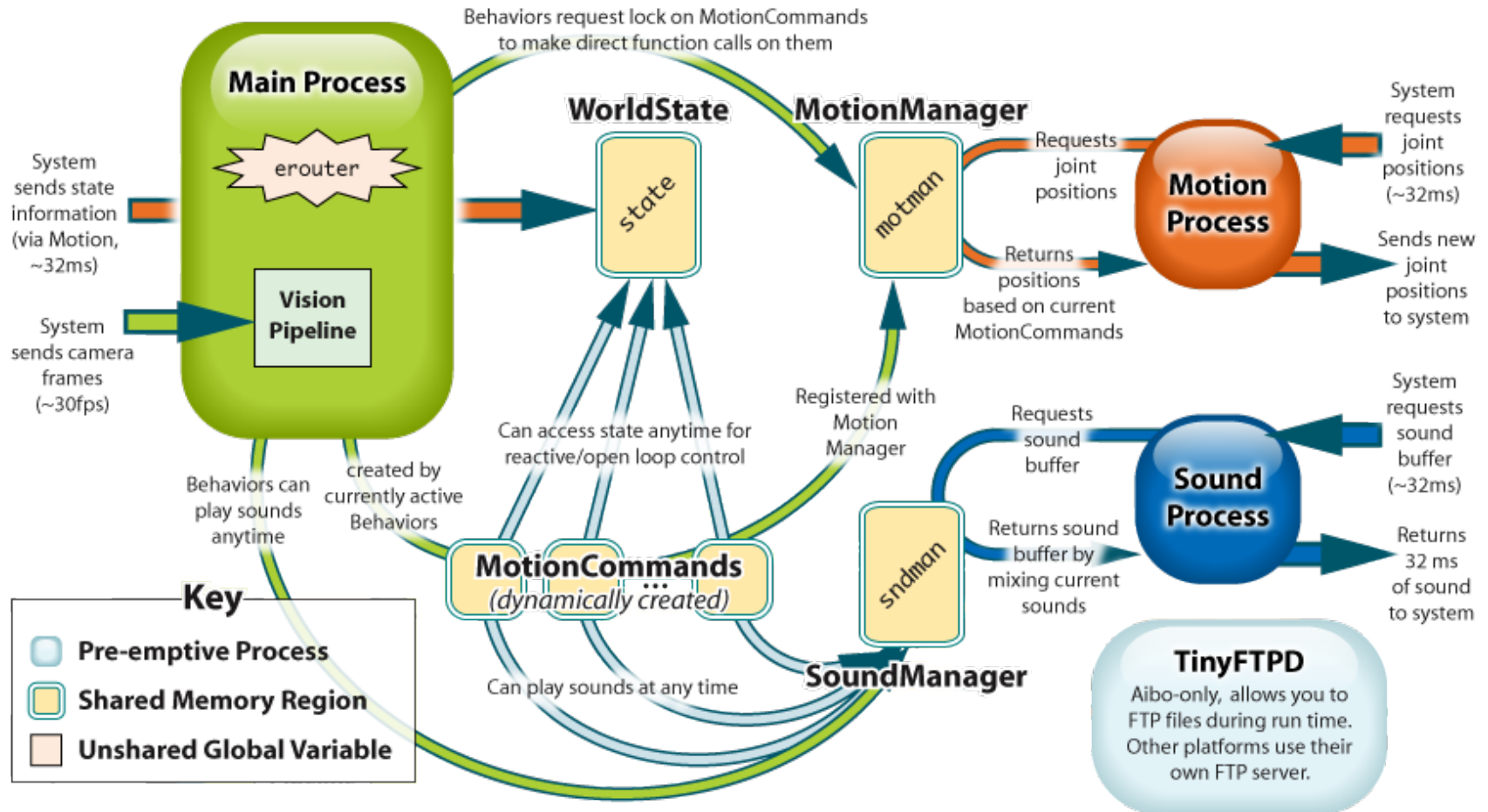


# The Tekkotsu Robotics Framework

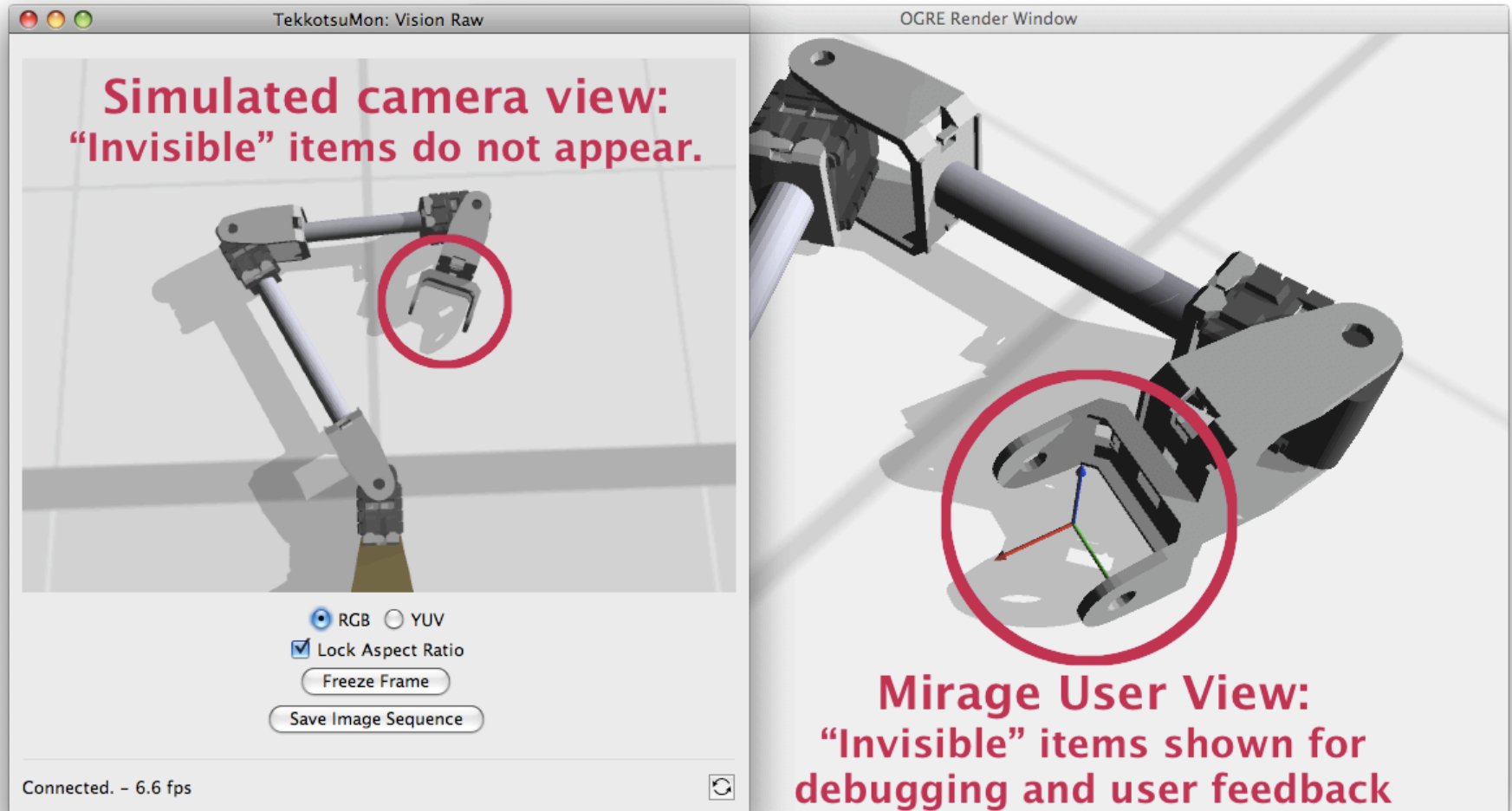
- Open source: visit [wiki.Tekkotsu.org](http://wiki.Tekkotsu.org).
- Written in industrial strength C++:
  - Templates, multiple inheritance, polymorphism, namespaces, coroutines, shared memory.
- GUI tools for teleoperation and monitoring written in Java.
- State machine language for robot behaviors compiles to C++.



# Tekkotsu Architecture Overview



# The Mirage Simulator



# ARTSI Competitions at Tapia

- Organized by **Dave Touretzky** (CMU) in collaboration with **Tamara Rogers** (Tennessee State). Additional help from **Monica Anderson**.
- Teams can have up to four students; at most one can be a graduate student.
- Each team must submit qualifying code (a simple challenge task) in order to register.
  - Can be done on a real robot or in the simulator.

# ARTSI Competitions (cont.)

- Travel support is provided for qualified teams.
- Loaner robots are available for teams that need one and have qualified.

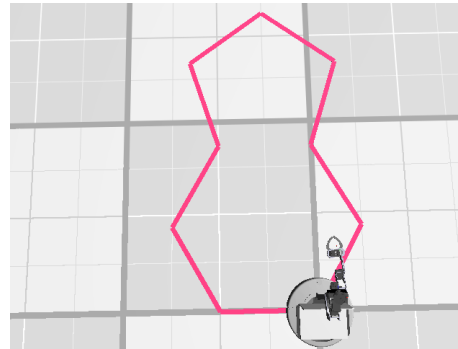
# The 2014 Competition

- Nine teams from eight schools:

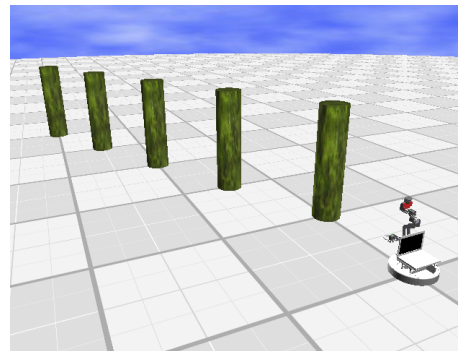
Elizabeth City State	Florida A&M
Fort Valley State	Hampton
Norfolk State	Tennessee State
Virginia State (2 teams)	Winston-Salem State
- Three events:
  - Challenge Tasks (for beginners; non-competitive)
  - Simulator Competition (angry birds)
  - Physical Robot Competition (cylinder sorting)
- Prizes supplied by Seagate.

# 2014 Challenge Tasks

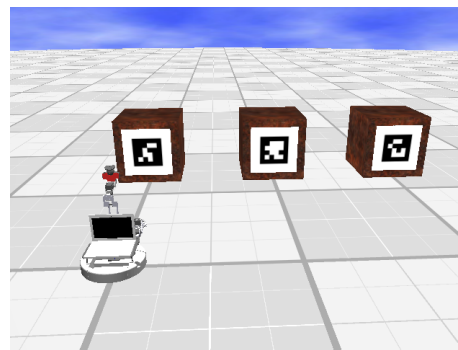
1. HexPent trajectory:



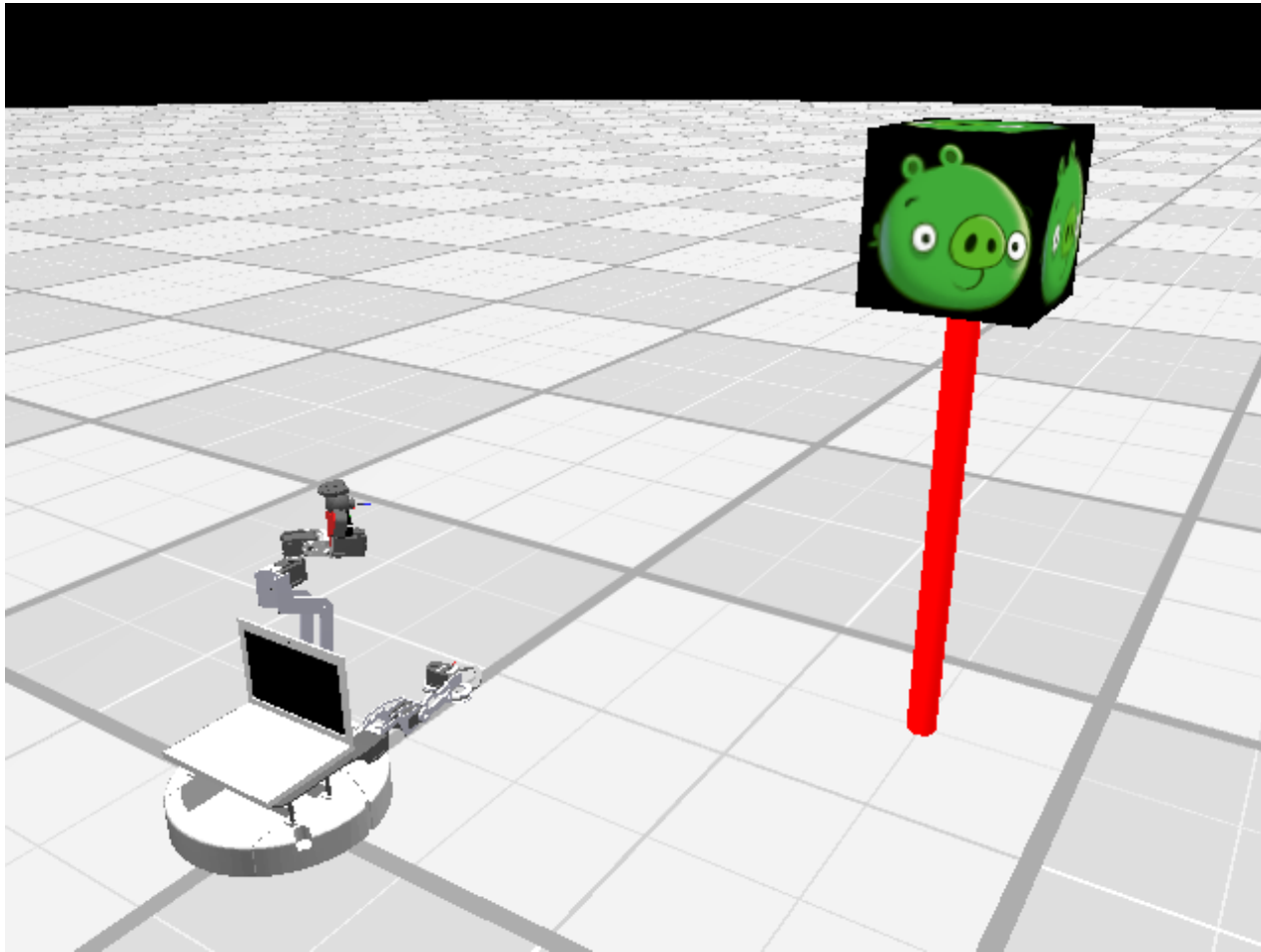
2. Slalom course:



3. AprilTag reader:

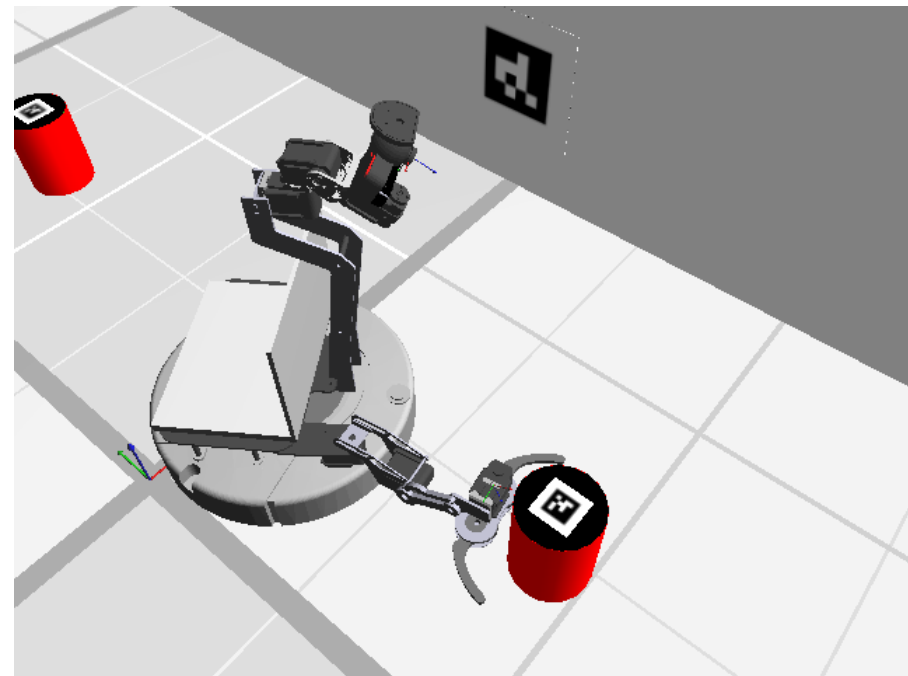
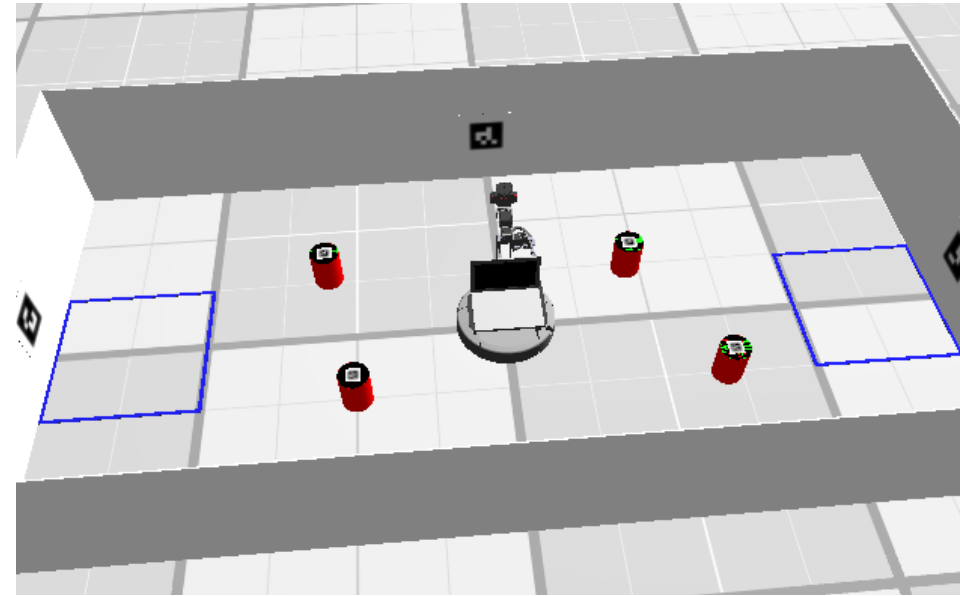


# 2014 Simulator Task: Angry Birds



# 2014 Robot Task: Cylinder Sorting

Shown here in simulation,  
but done on real robots.





# At Tapia 2014 in Seattle



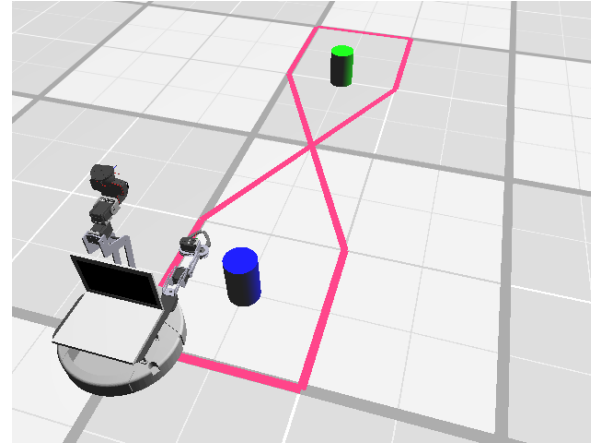
# The 2015 Competition

- Eight teams from six schools:

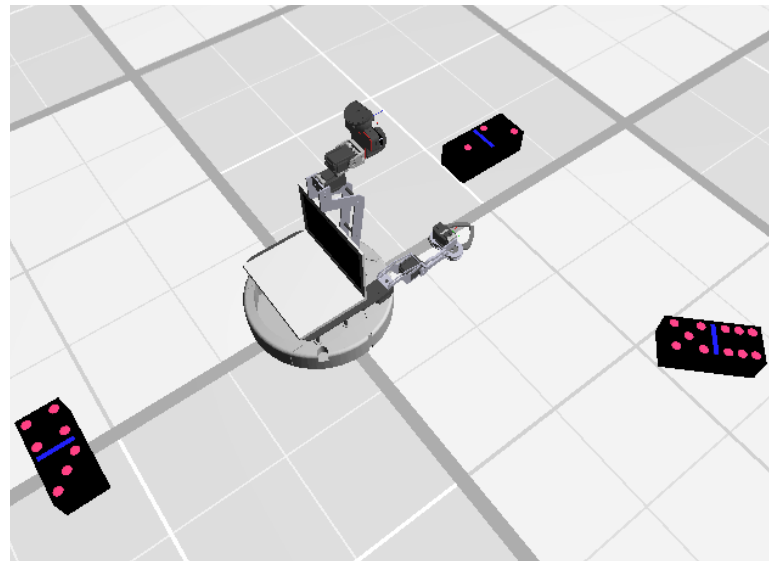
Bunker Hill CC	Fort Valley State
Norfolk State	Tennessee State
Virginia State (2)	Winston-Salem State (2)
- Three events:
  - Challenge tasks (non-competitive, for beginners)
  - Simulator event (Shakey the Robot)
  - Physical robot event (domino sorting)
- Prizes funded by a previous gift from Seagate.
- Some hitches: weather (TSU), transfers (BHCC)

# 2015 Challenge Tasks

- Square8 trajectory:

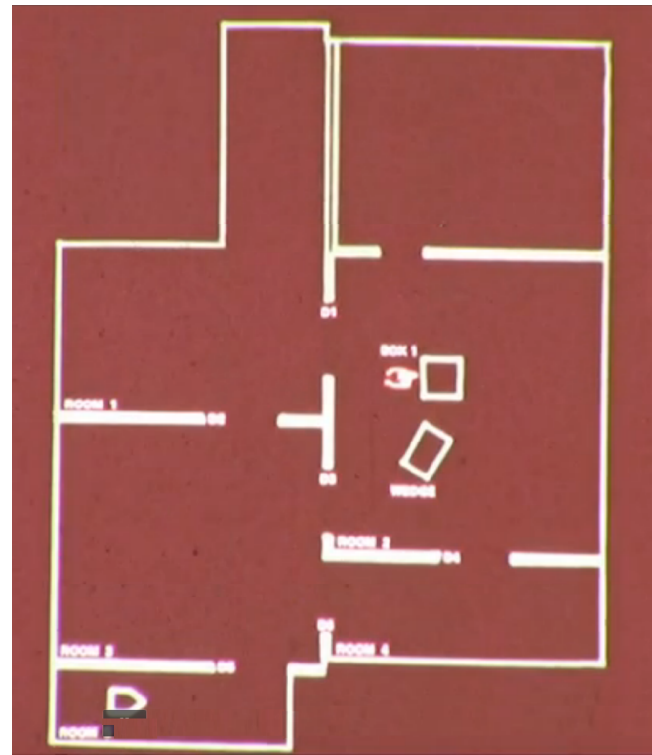


- Domino sum:



# 2015 Simulator Task

Shakey the robot's 50<sup>th</sup> anniversary:

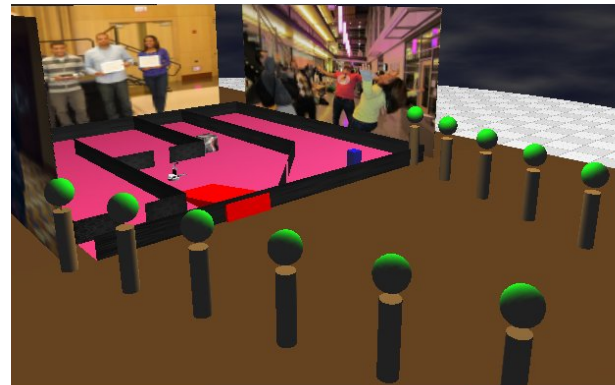


# Winning Simulator Entries

1. Winston-Salem State coded two robots (Shakey and the goblin) interacting in Mirage.
2. Virginia State team 2:



3. Virginia State team 1:



# At Tapia 2015 in Boston

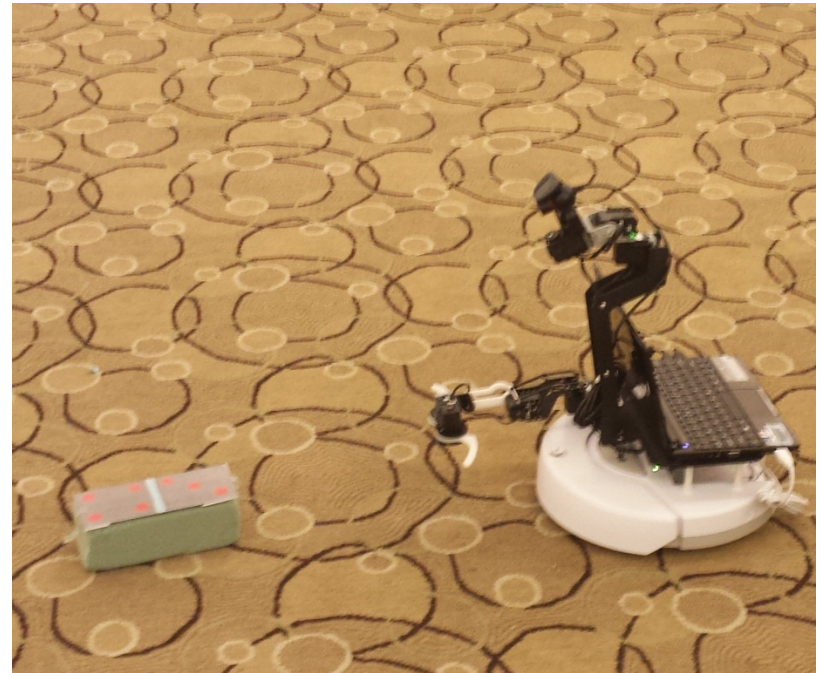


Norfolk State



Virginia State

# Robot Event: Domino Sorting



# Simulator Display





# 2015 Team Photos



Winston-Salem State University



Fort Valley State University

# 2015 Team Photos



Virginia State University



Norfolk State University

# Future Plans

- Attract more non-HBCU schools to participate in the competition.
- Develop a cheaper yet more capable successor to the Calliope2SP, since several components are now obsolete.

# The Calliope3 Robot

- New Create 2 base (remanufactured Roomba).
- Higher resolution webcam.
- Larger gripper with four-bar linkages for the fingers (modeled after Robotiq gripper).
- Water jetted plastic body; no welding.
- Off-the-shelf electronics (power, servo interface).
- Chromebook with Ubuntu Linux.
- Open source design.
- Target price under \$1,000.