COBOT

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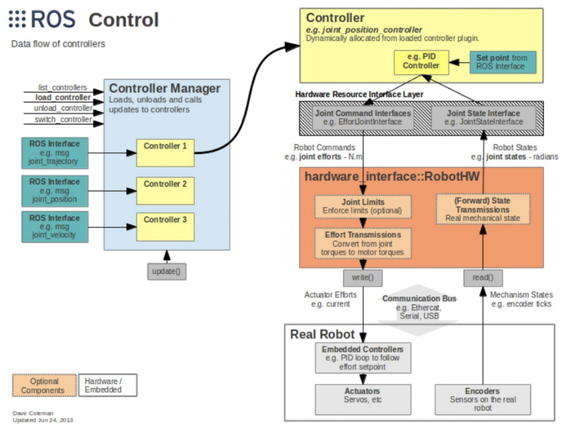
Vision Statement

The purpose of this project is to establish a human-assisted robot arm capable of operating with minimal user effort. Multiple sensors are used for the arm to make movements. To elicit finite movement, the arm performs a chess demonstration. The chess pieces' locations on the board are detected with photo-resistors on each of the 64 spaces. A chess API enables auto-performance.

System Overview

- **AR3 Arm -** robot arm designed at Annin Robotics
- **Chess Board -** chess board integrated with array of photoresistors and chess pieces
- **Control System -** Robot Operating System (ROS) in combination with chess playing API
- **Computer Vision -** Time of Flight (ToF) cameras paired with Xbox Kinect camera
- **Manual Interface -** Xbox 360 controller connected to ROS control system to enable arm movement

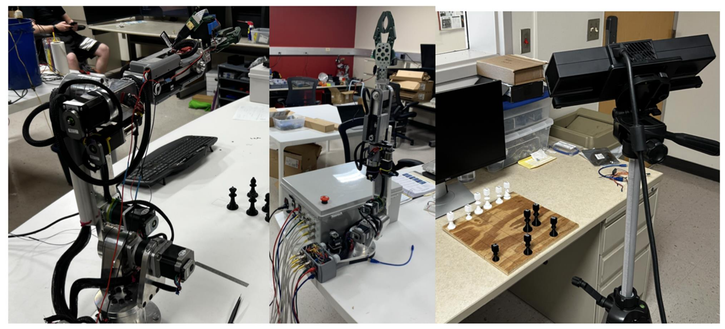


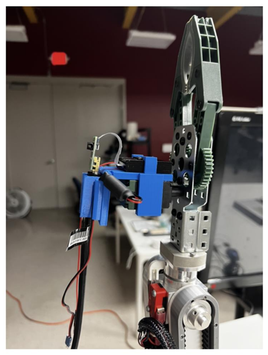
Interfaces

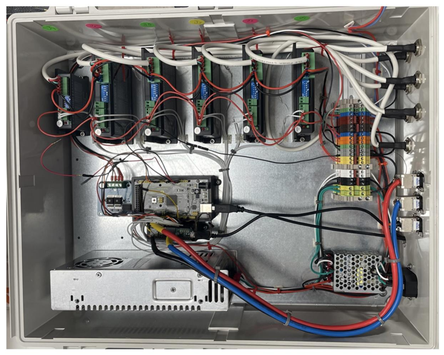
- **ARCS Calibration Software -** software used to control the AR3 using XBOX controller
- **VEX Claw -** used to grip and place objects
- **Time-of-Flight Camera Control -** ToF cameras used to find distances from the gripper using RaspPi
- **Arduino, Teensy, Raspberry Pi Scripts -** files used to control grippers, motor drivers, encoders, etc.

Hardware

- **AR3 -** physical robotic arm used for movement
- **Drivers -** designed for motors to communicate with one another, as well as the computer
- **Stepper Motors -** six main motors for movement
- **Sensors/Cameras -** Time of Flight (ToF) cameras
- **Microcontrollers -** Arduino Mega, Arduino Uno, Raspberry Pi, and Teensy 3.5 used to interface
- **Chessboard -** with a photoresistor at each of the 64 spaces, the system is able to detect each piece

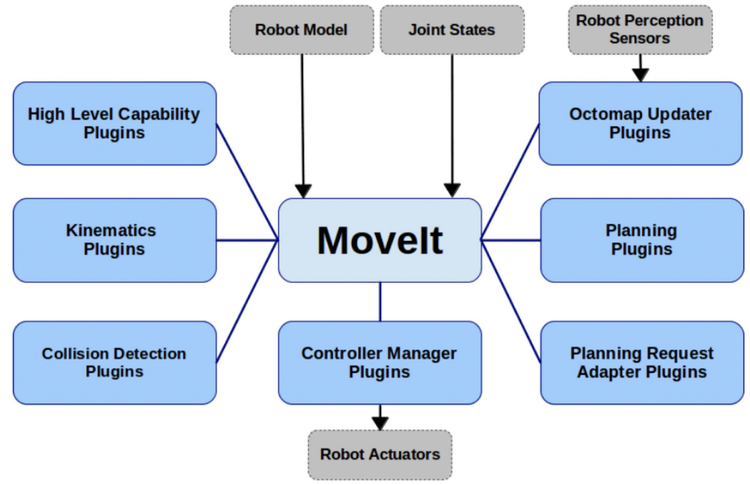






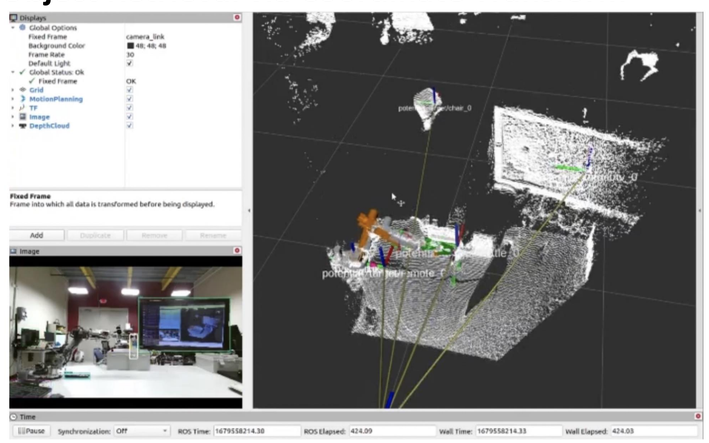
Software Framework

- **ROS Noetic Ninjemys -** set of packages including controller interfaces, managers, transmissions, and hardware interfaces are applied; packages use encoder data and a point for joint position control
- **AR3/Gripper Interface & Driver -** hardware interfaces are used in conjunction with drivers, which send and receive commands to the controllers to command position-based joints
- **MoveIt and Rviz -** motion planning framework uses plugin to access the ros_control nodes; MoveIt Rviz plugin makes a virtual environment possible



Computer Vision

- **Kinect Camera Driver -** uses a driver to support RGB & IR depth image transfer and registration
- **ROS Interface to Kinect and Img. Broadcaster -** IAI Kinect2 package includes a bridge between driver and ROS, receiving data from the sensor and publishes topic of sensor_msgs with HD images
- **CenterNet Keypoint Triplets for Obj. Detection -** Tensorflow Object Detection API with a centernet SSD model
- **Object Retrieval via Coordinate Transform**



Future Work

- **Multi-Arm Collaboration –** with both arms assembled, can now find ways for them to interface
- **Full Chess API Implementation –** autonomous play
- **Interdisciplinary Work –** biomedical applications