

# Design of an Embedded Controller for a Bipedal Robot

Presentation by Muhsin King

## Introduction

### Objectives

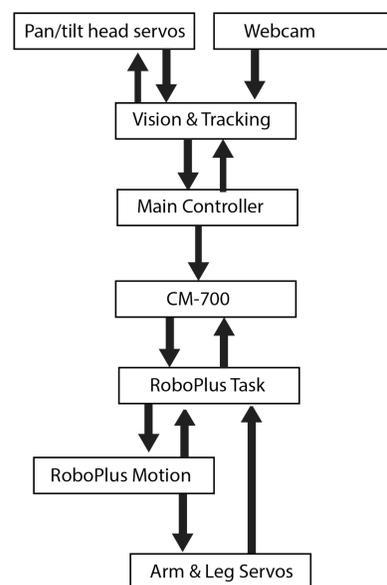
- ❖ Create a soccer-playing humanoid robot for RoboCup 2015 in Hefei, China (July 15).
- ❖ Design a controller that allows the team to create high-level commands and play strategies
- ❖ Must also be able to manipulate motions on the level of individual servos

### Method

- ❖ Designed a controller that could be built from the ground up in only two months
- ❖ Devised a 3-tiered control schema
  - Sensing
  - Strategy
  - Motion
- ❖ Worked with members of the HEIR lab team to implement this schema on the bipedal robot they were building

## Design

- ❖ Abstracts control of servos and sensors
- ❖ Enables high-level controller programming
- ❖ Let us adapt Bioloid Premium servo poses for low-level control
- ❖ Distinct control of head motors prevents locking between walk & vision/tracking



## Approach

### Primary Controller

- ❖ Intel NUC running Linux
- ❖ Interprets vision
- ❖ Makes high-level decisions
- ❖ Relays commands to CM-700 via LN-101 serial cable
- ❖ Encodes data to imitate an RC-100 controller



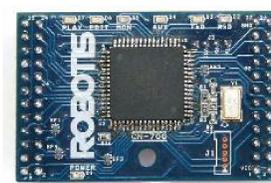
### Vision & Tracking

- ❖ HSV ball detection
- ❖ Tracks ball motion
- ❖ Directly controls servos in the head
- ❖ Relays info to primary controller
  - Motor Positions
  - Ball angle
  - Ball distance
  - Time since ball seen



### CM-700 Microcontroller

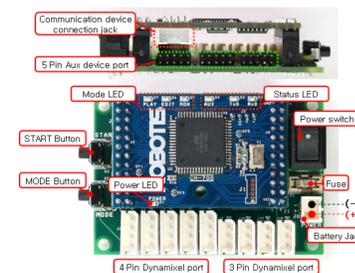
- ❖ Task file calls motion pages
- ❖ Motion file, consisting of...
  - ↳ linked list of motion pages
  - ↳ ordered list of poses
  - ↳ unordered list of servo positions



CM-700

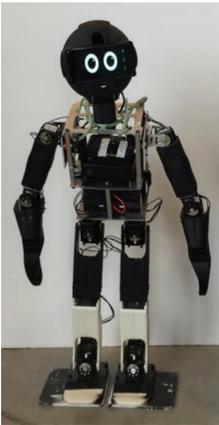


CM-700 SUB Board



## Evaluation

- ❖ Imitating an RC-100 allowed us to utilize the Bioloid's motion files, saving time required to build our own
- ❖ Asymmetrical dynamics between the platforms meant that the motion files required significant reworking
- ❖ Parallel sensing/motion structure prevented servo lag
- ❖ 3-tiered control structure allowed us to focus on high-level game strategies



## Conclusions & Future Work

- ❖ Mapping motions from one robot to another, while time-saving, is not an effective long-term strategy
- ❖ Microcontrollers are an effective means of prioritizing stability and basic functionality over high-level strategy
- ❖ Future work
  - Design motion files specific to the MU-L8
  - Build new firmware for the CM-700 to free us from RoboPlus
  - Apply our 3-tiered structure to multirobot systems

## Acknowledgements

**Mentor:** Dr. Andrew Williams  
**The HEIR Lab team**

**Team leader**  
Matthew Morris  
**Hardware expert**  
Andrianna Williams  
**Vision & tracking**  
Ryan Walsh  
**Embedded systems**  
Muhsin King  
**Galileo exploration**  
Ron Moore

