

Team 6: Artificial Muscle-Based Sociable Robots

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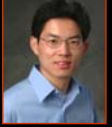
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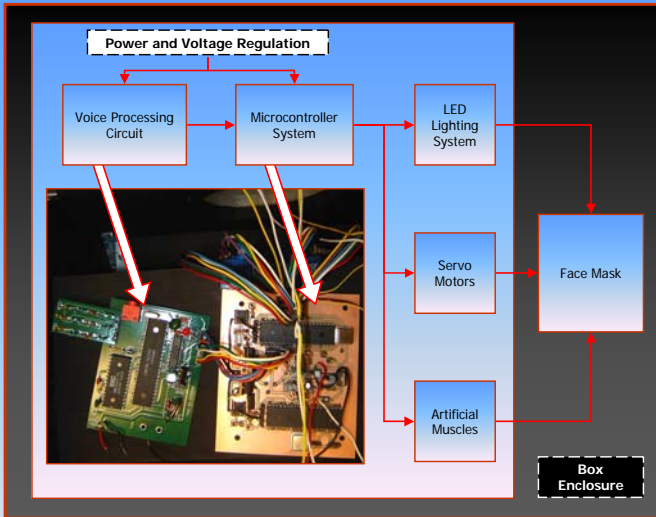


Dr. Xiaobo Tan

Introduction:

- Team 6 developed a robotic face capable of expressing humanoid emotion in response to voice commands
- Facial expressions generated using Ionic Polymer-Metal Composite (IPMC), an electroactive polymer (EAP), also known as artificial muscles
- IPMC is silent and large displacements are obtained with low voltages
- LEDs were used to provide accentuating color for facial expressions
- Artistic face design, efficient signal processing, and synchronous IPMC control were implemented to form convincing facial expressions

Design:



Design Requirements:

- Aesthetically pleasing face
- Utilization of IPMC material to convey facial expression
- Effective voice recognition and Signal processing

Technical Approach: General

Housing/Face Design:

- Must be easily accessible to provide support and house unit compactly
- Flat black paint to accentuate LEDs and draw attention to face
- Face must be expressionless to provide proper background, semi-transparent to show LEDs



Housing Unit

Happy:

- Outside of eyebrows bent down, outside of mouth bent up
- Yellow LED glow



IPMC Generated Happy

Sad:

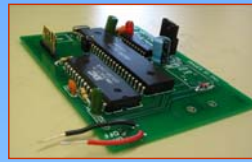
- Inside of eyebrows rotated and bent up, outside of mouth bent down
- Blue LED glow



IPMC Generated Sad

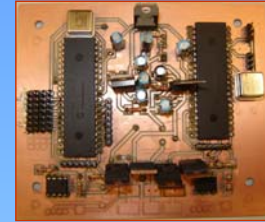
Technical Approach: Individual Components

Voice Processing Unit:
Outputs values of stored commands as binary signals

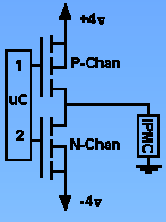


SR-07 Voice Circuit

Driving Components:
Drivers switch current from microcontroller to battery, MOSFETs switch polarity across IPMC for bidirectional movement



Microcontroller System

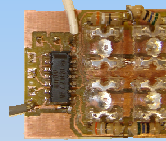


IPMC Driver

Microcontroller System:
Processes voice input and outputs state signals

LEDs:

Enhance expressed emotion with specific color



LED PCB

Servo Motors:

Enhance facial expression through angular rotation complementary to IPMC



Servo Motor

Testing Approach:

- Components fabricated on separate protoboards to ensure functionality
- All circuitry, including two microcontrollers, placed on PCBs
- Errors in code and timing compatibility issues resolved

Ionic Polymer-Metal Composite (IPMC):

While lightweight and quiet, IPMC generates large displacement from low voltages (~3.5 V)



IPMC Bent in Frown Position



IPMC Bent in Smile Position

Budget:

Component	Quantity	Cost
HM2007 Voice Processing IC	1	\$10.00
6264 8x8 SRAM	1	\$8.00
SR-07 PCBs	1	\$30.00
HS-55 Standard Feather Servo	3	\$49.50
Multi-Color S-Flux LEDs	30	\$18.00
9 Volt Battery	8	\$8.00
Ionic Polymer-Metal Composite	5cm x 5cm	\$500.00
Box & face Material	N/A	\$218.82
Chemtronics Conductive Epoxy	1	\$24.85
MOSFETs	6	\$39.15
PIC 16F874 Microcontroller	2	\$25.98
Total		\$932.30

Final Project Results:

- IPMC based sociable robot that responds to user independent voice commands with humanoid expressions
- Controlled by two microcontrollers, IPMCs move in conjunction with servo motors and fading LEDs to visually display emotion
- Insight and research into IPMC's and EAP potential to revolutionize a wide variety of engineering fields

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