ROBOX

Intelligent Automated Bipedal Humanoid Robot

First Humanoid Robot of Pakistan

by
Hasan Faiq Minhas

ROBOX

UET
ELECTRICAL ENGINEERING DEPARTMENT
A.I.
ARTIFICIAL INTELLIGENCE
VOICE RECOGNITION
hfm company
Digital Image Processing
GENERATING IdEAS IN THE WORLD OF TECHNOLOGY
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ROBOX
THE FIRST COMPLETE HUMANOID ROBOT OF PAKISTAN

OUTLINE:

- Introduction
- Objectives, Dimensions and Features
- Mechanical Design
- Control
- Sensors
- Electronics
- Actuators
- Softwares
- Kinematics and Inverse Kinematics
- Computer Vision and Image Processing
- Speech

INTRODUCTION

- What is Robot?
  - Combination of Machine, Electronics and Computational Technologies.
- What is Humanoid Robot?
  - A Human with its overall appearance based on that of human body.
  - A Human in cybernetics, whose actions are similar to that of human actions and can replace a human in a few but defined tasks.
  - It must be intelligent to interact with environment and adapt to changes.
  - It must interact with humans in friendly environment.

Where World Stands Today In Humanoid Robots:

- A Cybernetic Generation that can Walk like a human, Talk a like human, Think like a human and at the peak, can romance like a human.
- Prominent Names: Japan, Korea, France, UK, USA

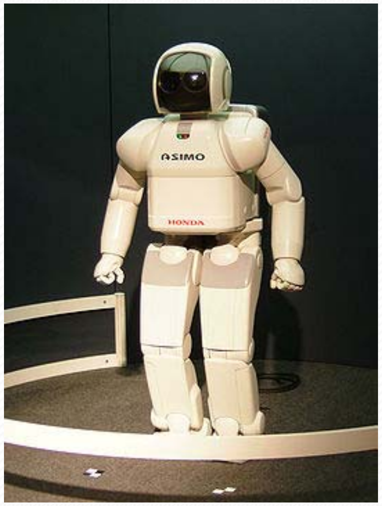
APPLICATIONS:

- Hospital
- Offices
- Homes
- Space Projects
- War Fields
- Industries
- Research Fields
- To all places where we find a human menace

Successful Humanoid Robots

- Asimo (by Honds Motors)
  - Walk independently and Climb stairs
  - Programmed Gestures
  - Carry Objects and Push Carts
  - Turn on lights, open doors
- Topio
- Flame Robot
- Atom-7

(Future Robots)



Artificial Intelligence (1/2)

Automated Machine + Artificial Intelligence = Automated Intelligent Machine

- Intelligence that is developed artificially (non natural)
- Learning and adaption in machines
- Includes: Control, Planning and Scheduling
- Programming, Algorithms..
- Sensors (Camera…)
- Answer diagnostic and consumer Questions, hand writing, speech, facial recognition

Artificial Intelligence (2/2)

- Copying actions
  - Behavourial Approach
  - Calculating actions of environment
  - Development of Algorithms
  - Planning
  - Executing
  - Improvement (Repeating and Observing in closed loop)

- Can We become Slave of our own Creation.

- **OBJECTIVE**

The object of this project is to build a bipedal humanoid robot having height and weight about 2/3rd of a human (average). It can interact with human and can work with them in their own way

- **FEATURES**
  - Walking on two legs (Bipedal)
  - Talking like Human (Environment Interaction)
  - Autonomous
  - Decision Making
  - Hand Movements (Objective oriented)
  - Image Recognition
  - Memory Development (Brain)

DIMENTIONS

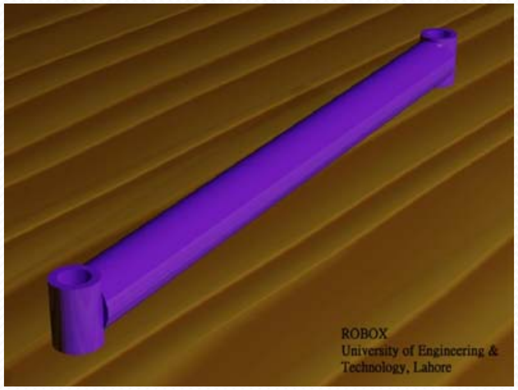
Height	1422 mm
Width	635 mm
Power Supply	12 Volts
Working Environment	Plain surface areas like office, home etc
Head	1 DOF
Arms	432 mm with 3 DOF
Legs	711 mm with 4 DOF
Sensors	Sonar sensor, camera
Actuators	DC motor

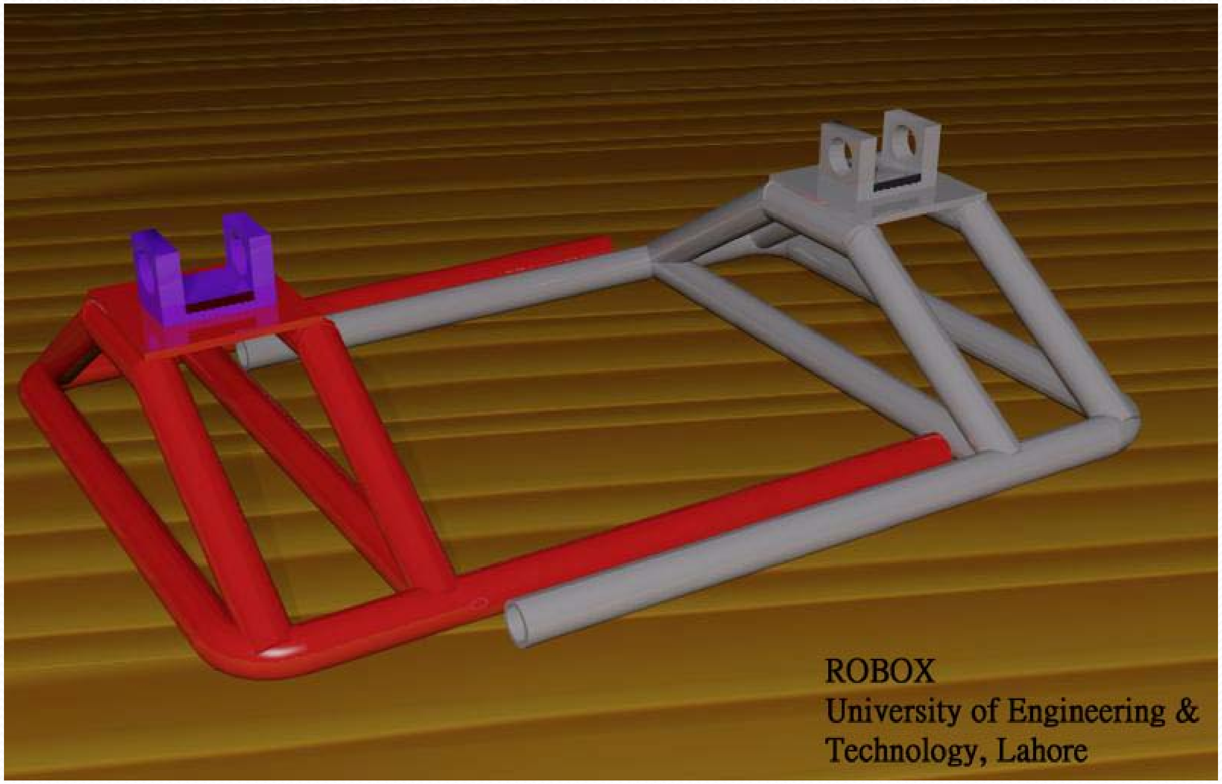
MECHANICAL DESIGN

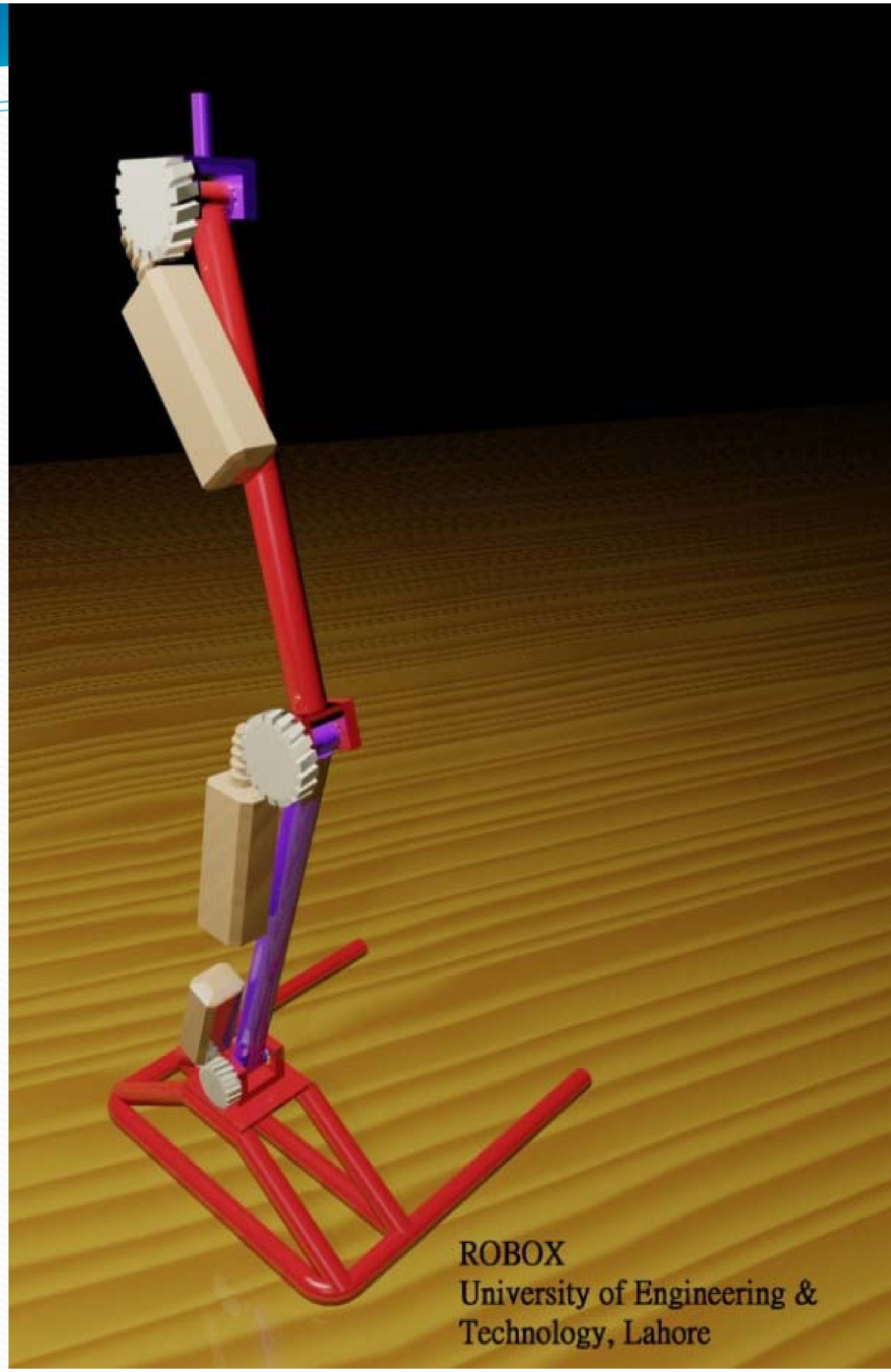
- Body Material: Aluminum (Light weight, fulfills desired strength)
- Motor Fixing Material: Steel
- Legs: (4 DOF) x 2
- Hands: (3 DOF) x 2
- Head: (1 DOF) x 1
- Torso: (2 DOF) x 1
- Total DOF: 17
- Gears: Worm, Spur (Steel and Plastics)
- Friction Solution: Ball Bearings
- Material Shapes for desired strength: C - U - L

LEGS

- 4 DOF
- Walking Technique
- Gait
- Balancing of COG
- Turning Algo



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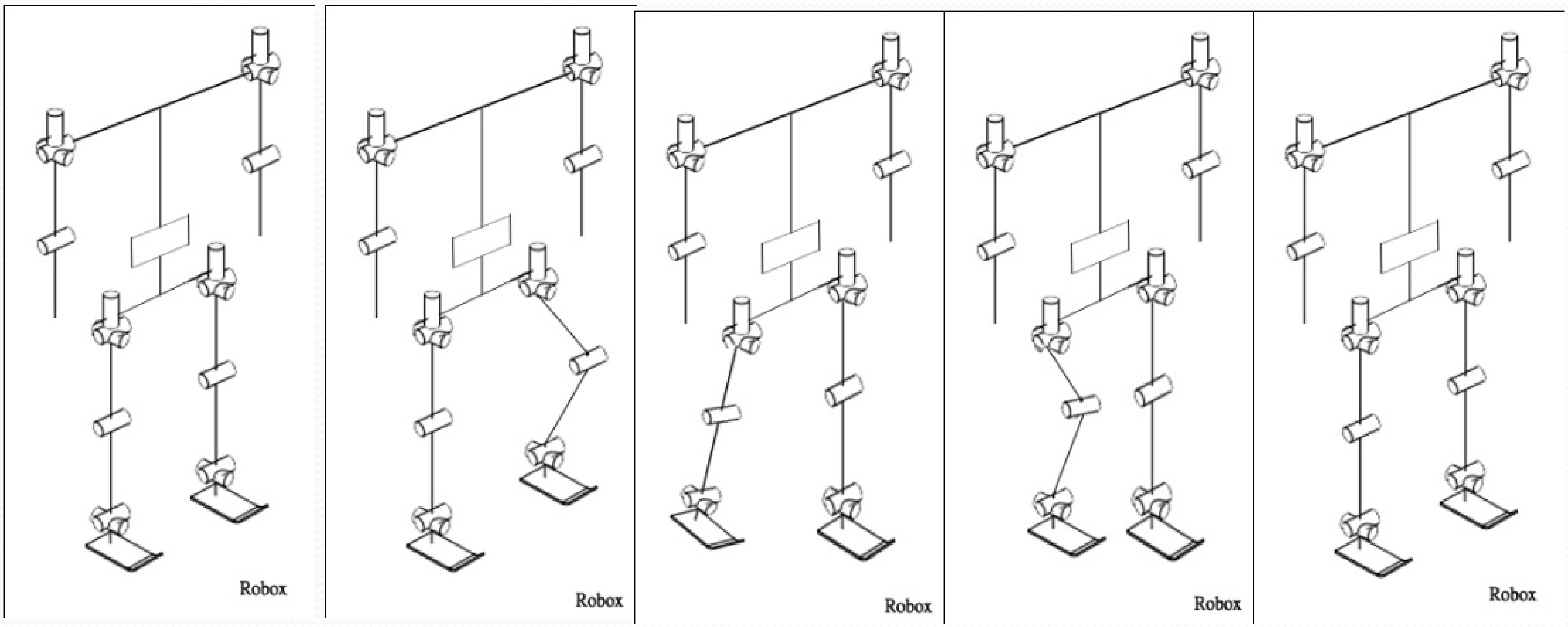
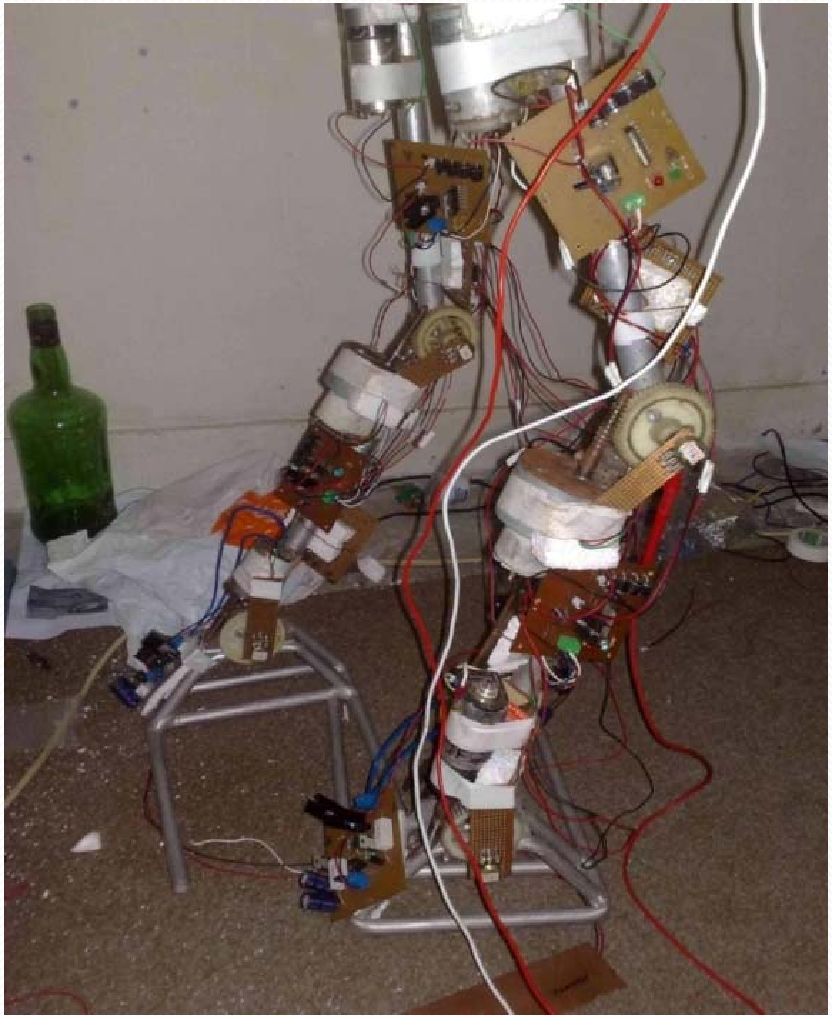
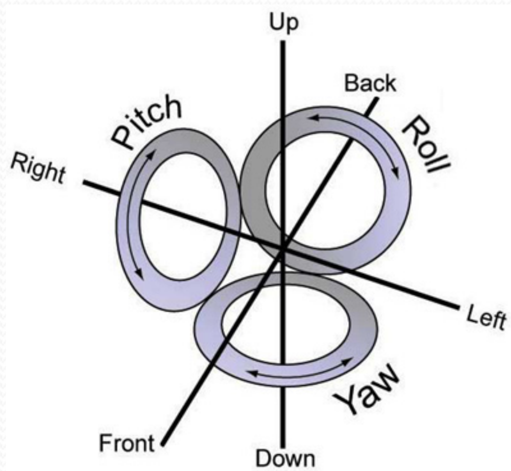
TRAJECTORY



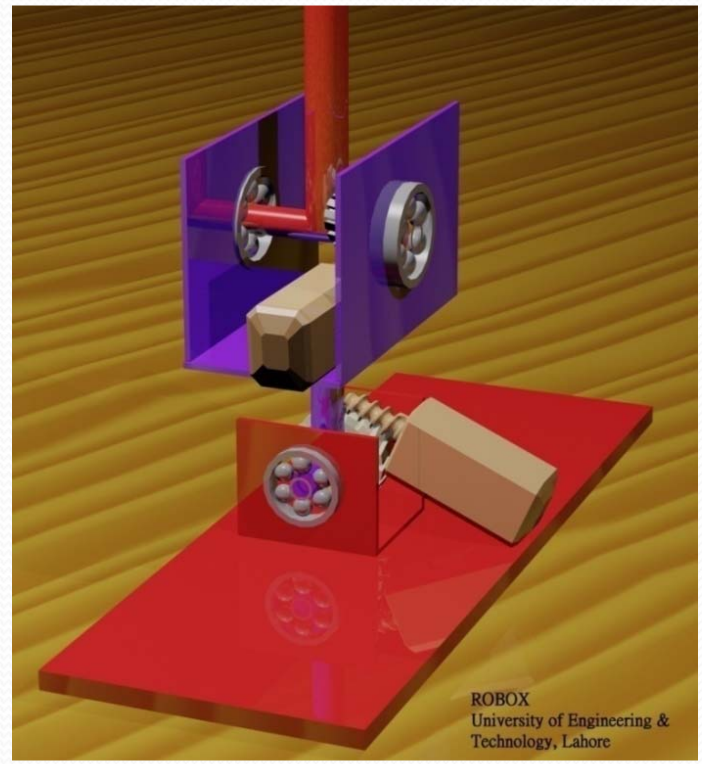


TORSO

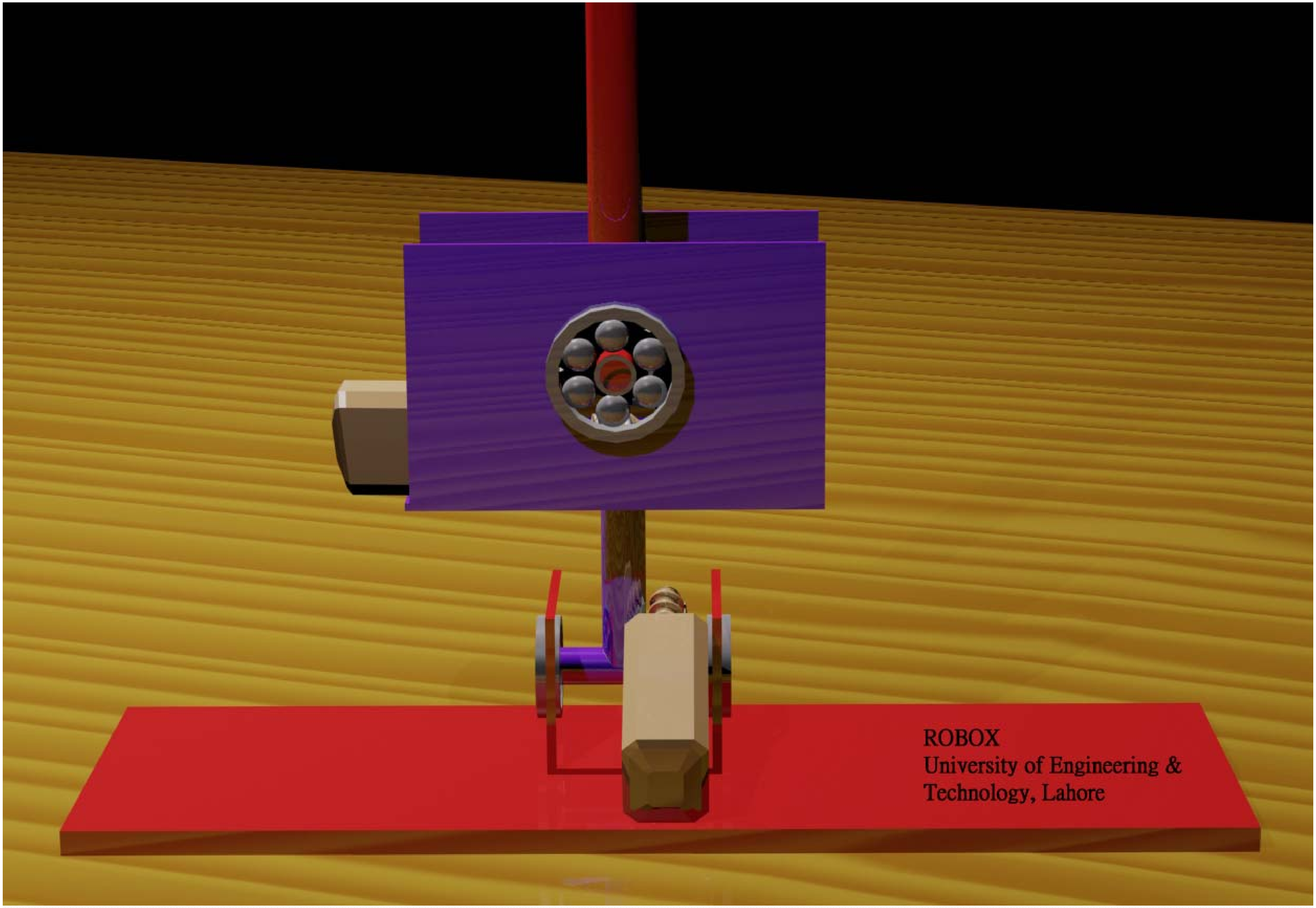


- 2 DOF
- Roll and Pitch
- Walking
- Balancing

  (Weight Shifting)
- Turning
- Flexibility
- Running



- A connection b/w Leg Base and Shoulder Base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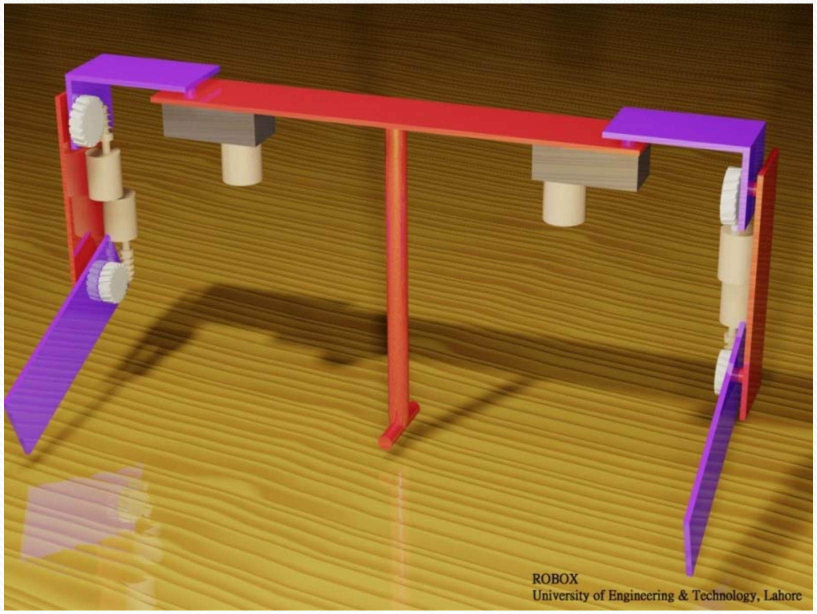
ARMS

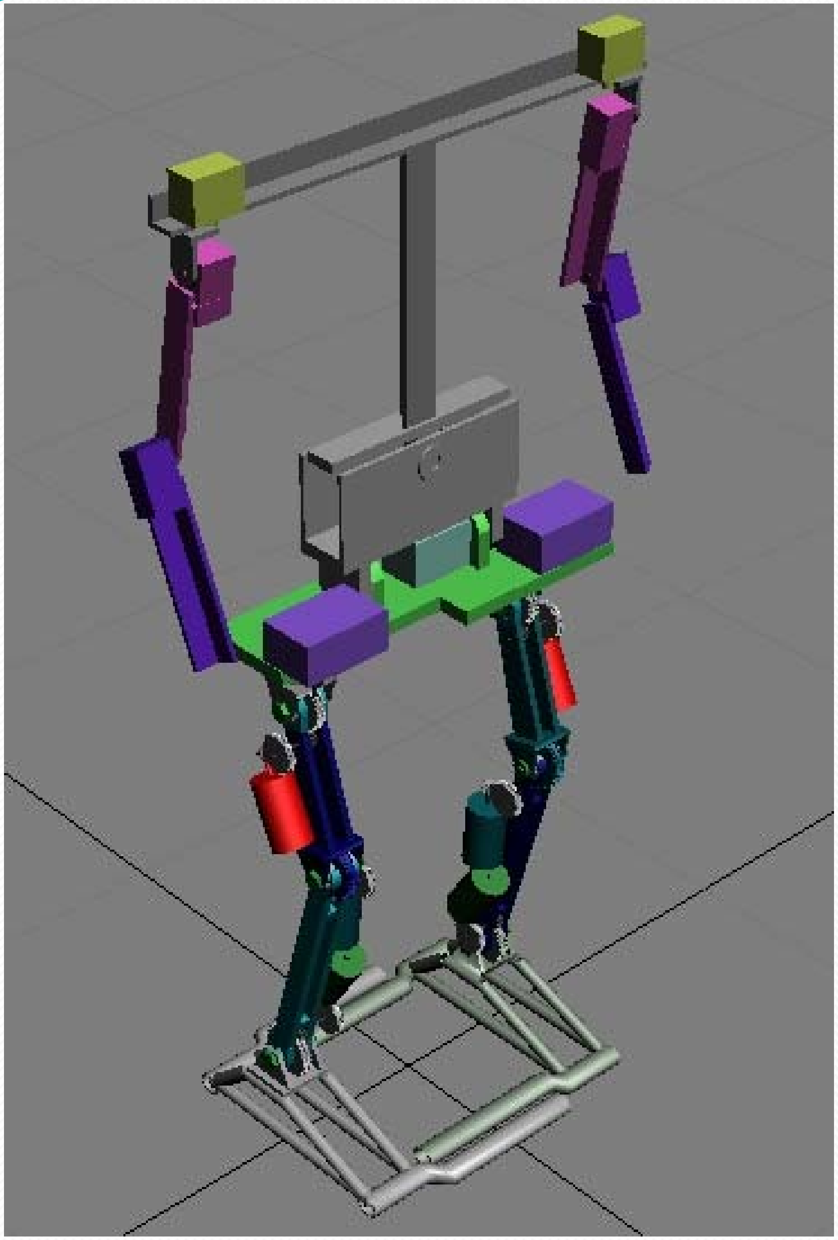
- 3 DOF
- Weight hanged to shoulders (Weight Shifting)
- Must not be over-weighted to burden driving motors
- End-effector (multi-purpose)

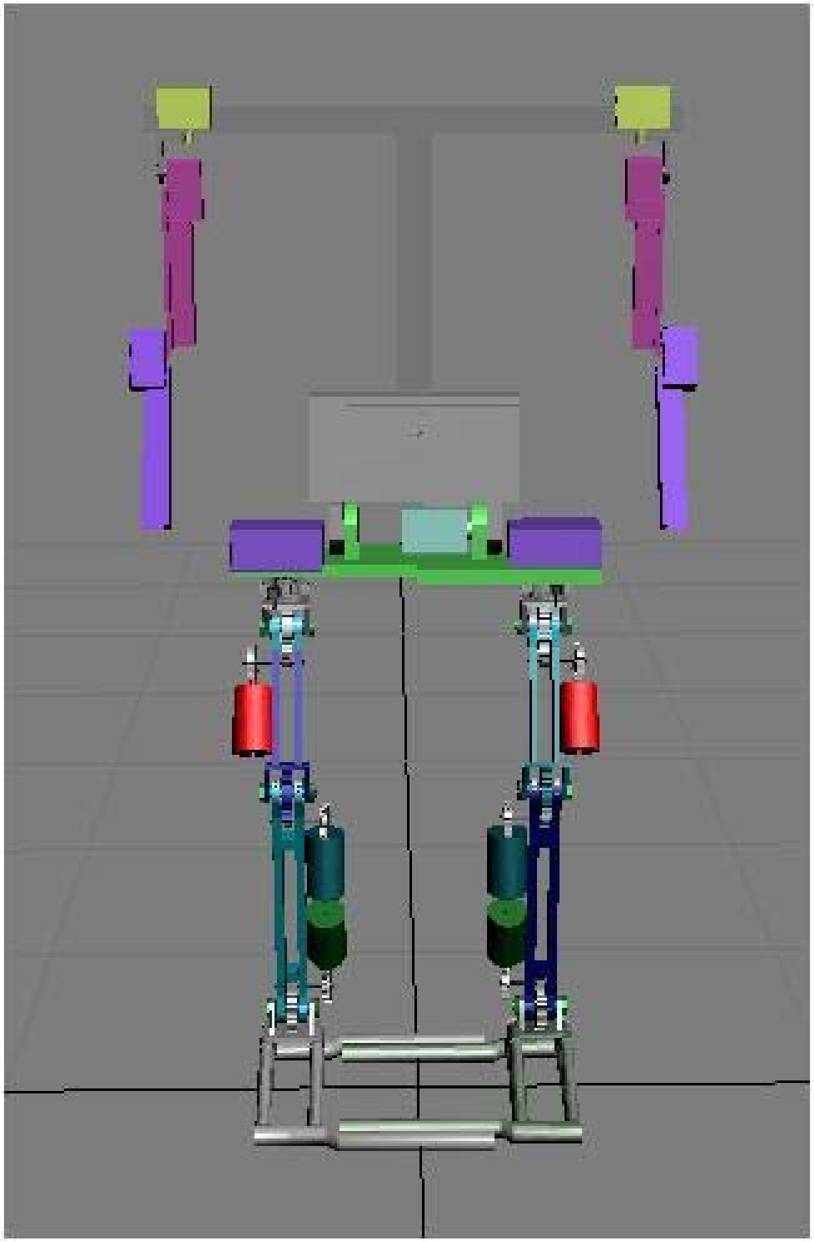


HEAD

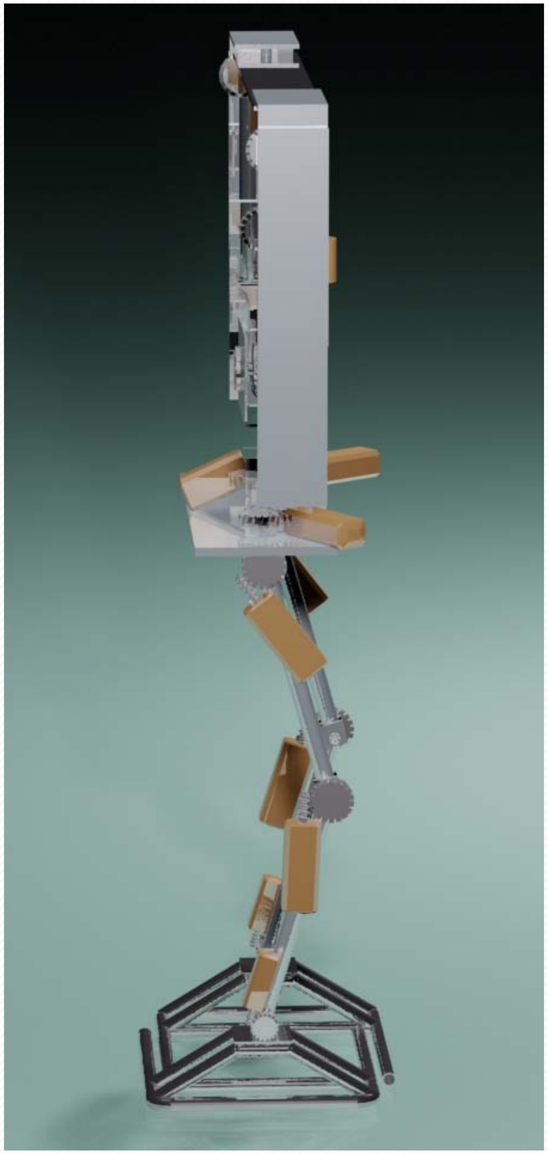
- 1 DOF
- Camera attached

INITIAL DESIGN



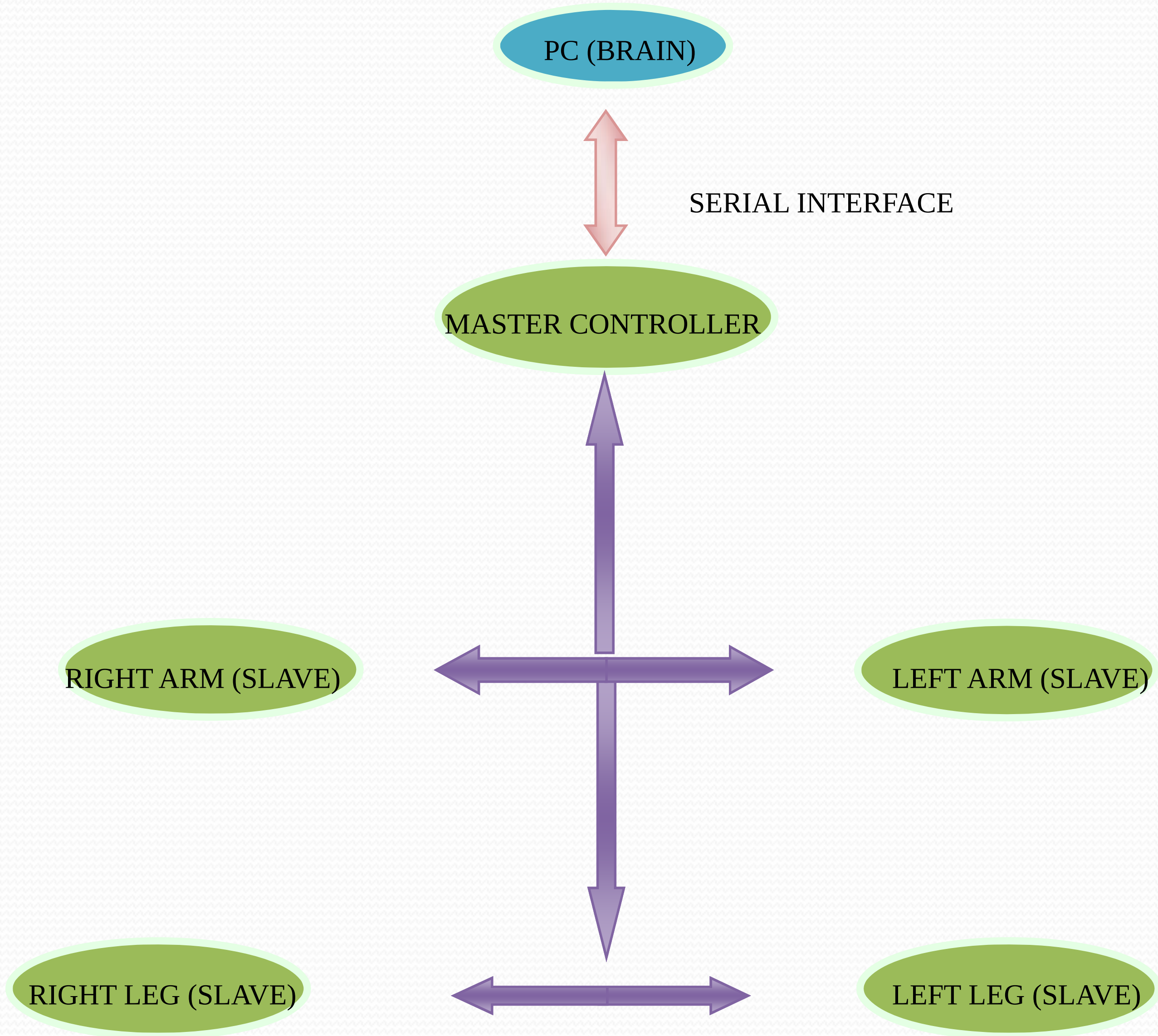


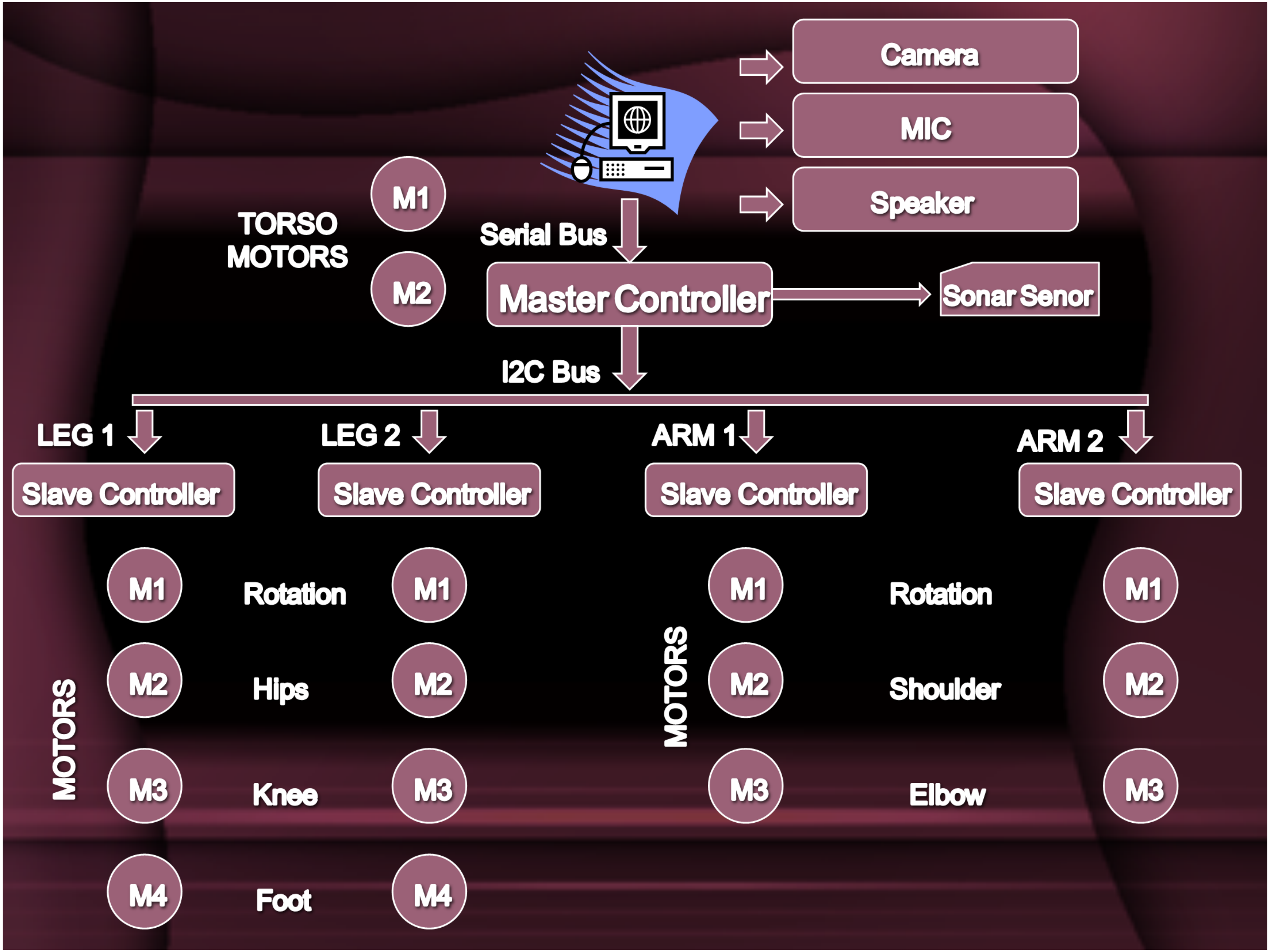
FINAL DESIGN



CONTROL

- Brain: Intel® Core™ 2 Duo CPU 2.20 GHz
- Controller: PIC 18F452
- Communication: - Serial Communication
  (USART, RS-232 Protocol, Max 232)
  - i2C Communication
  (Master-Slave Approach)
- Modular Interaciton

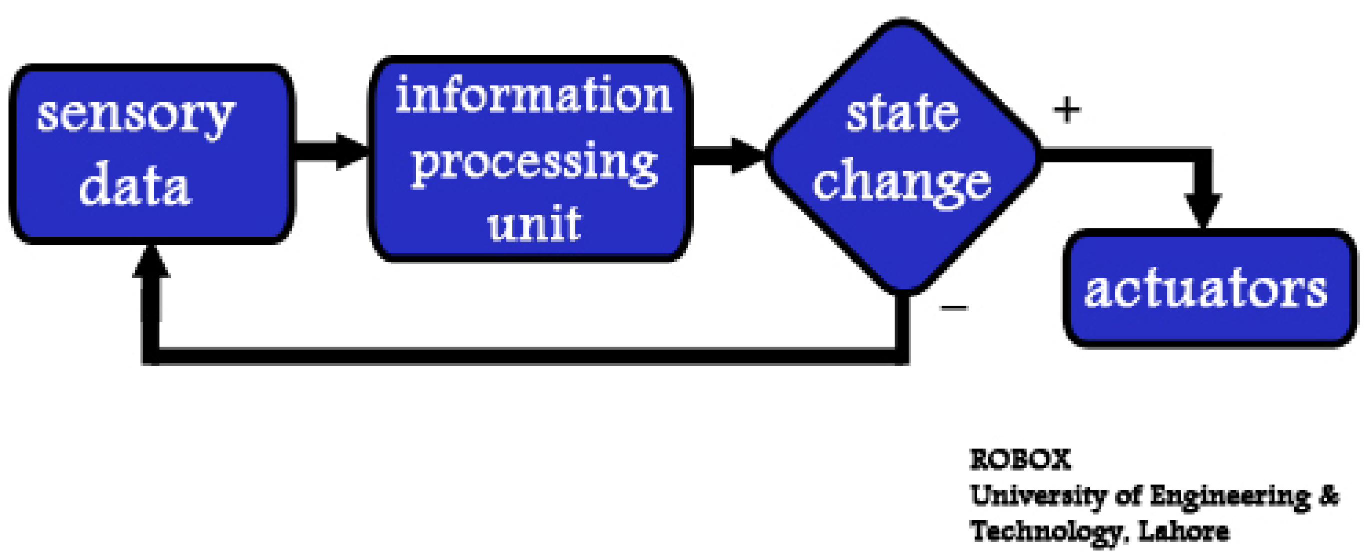

PC (BRAIN)
SERIAL INTERFACE
MASTER CONTROLLER
RIGHT ARM (SLAVE)
LEFT ARM (SLAVE)
RIGHT LEG (SLAVE)
LEFT LEG (SLAVE)



Camera
MIC
Speaker
TORSO MOTORS
M1
M2
Serial Bus
Master Controller
Sonar Senor
I2C Bus
LEG 1
LEG 2
ARM 1
ARM 2
Slave Controller
Slave Controller
Slave Controller
Slave Controller
MOTORS
M1
M2
M3
M4
Rotation
Hips
Knee
Foot
M1
M2
M3
M4
MOTORS
M1
M2
M3
Rotation
Shoulder
Elbow
M1
M2
M3

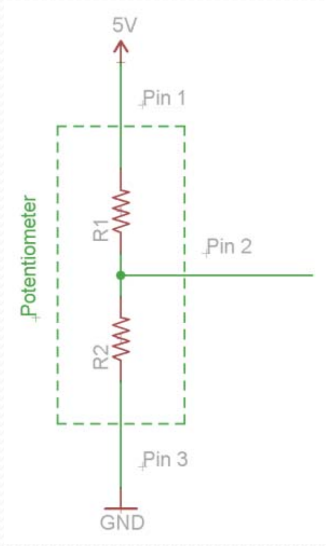
SENSORS

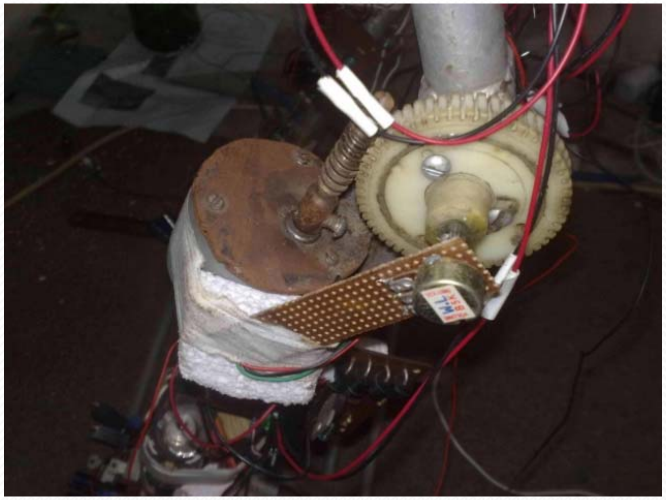
- POSITION SENSORS
- Sonar Sensor
- Camera



POSITION SENSOR

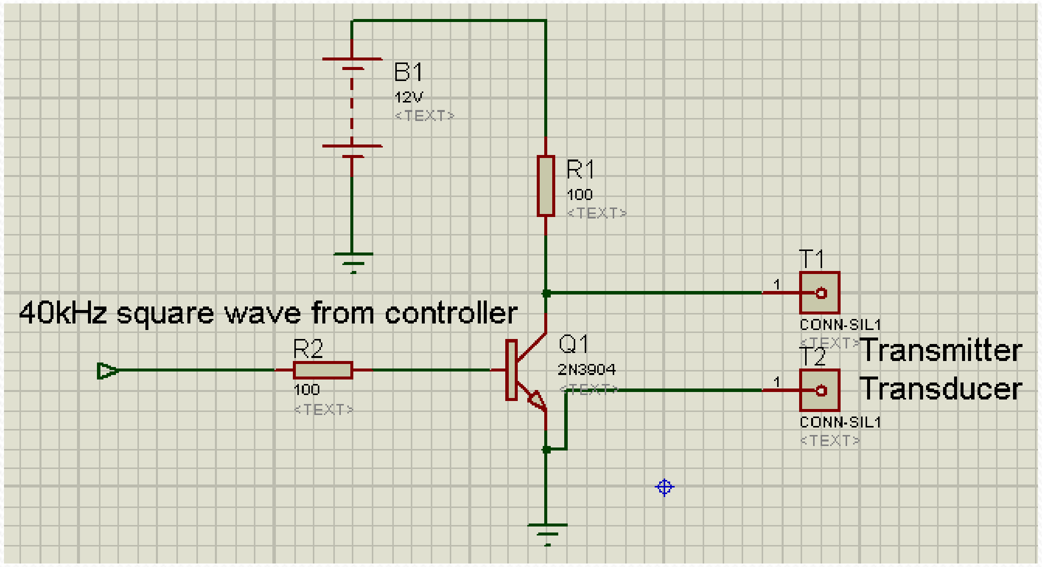
- Potentiometer
- Vout = Vcc * (R1 / R)
- Division of degrees
- ADC
- Comparison with Opto-Coupler Sensor





SONAR SENSORS

- 40 kHz square wave
- speed of sound in air is 343m/s
- Time for the signal to reach the object = t = (value of the timer) / 2
- Distance = speed * time



ACTUATORS

- Actuators are the physical devices that convert electrical, chemical and thermal energy into mechanical energy.
- Muscles of body

TYPES:

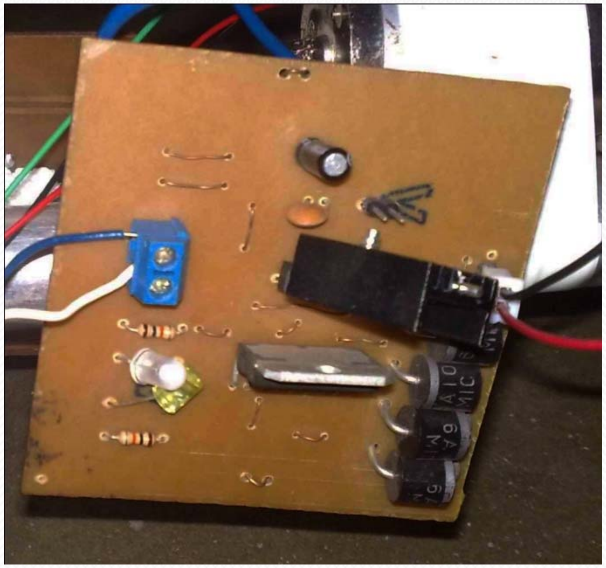
- Pneumatic actuators
- Linear actuators
- Hydraulic actuators
- Electrical motors

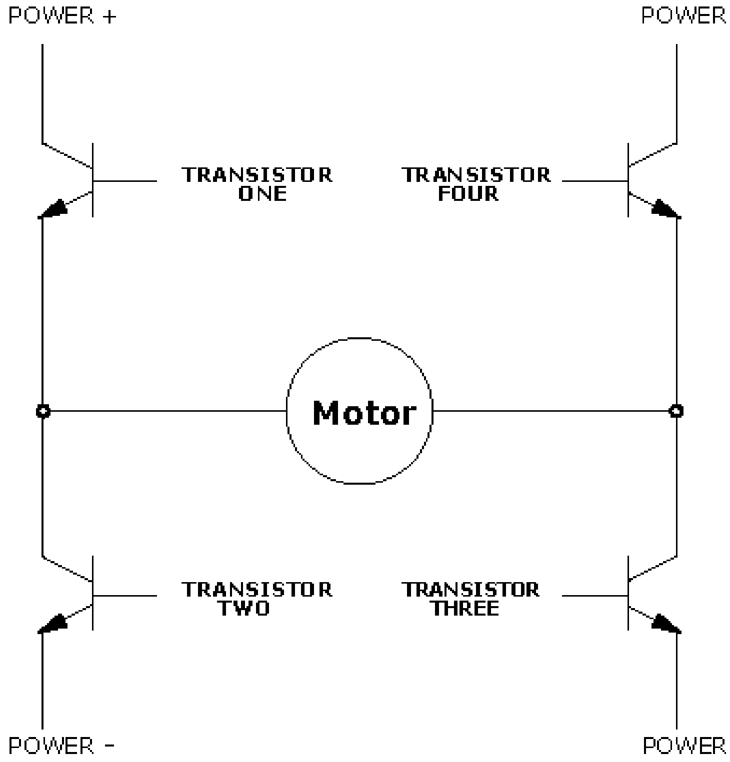
- Electric Motors:
  - AC Motors
  - Servo Motors
  - DC Motors

- Conversion of DC motors into Servo by attaching position sensors and gear box.

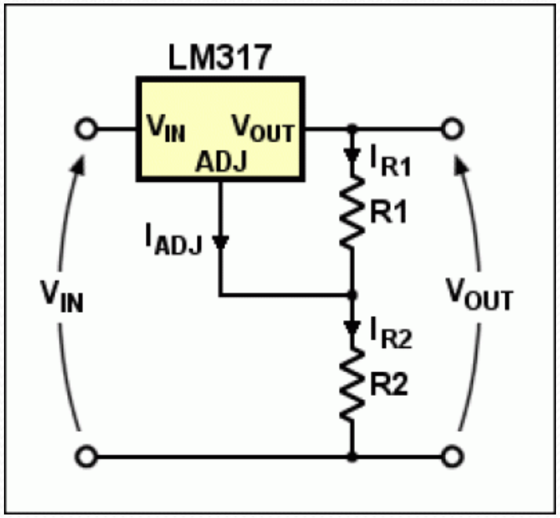
ELECTRONICS

- Modules
- H-BRIDGE MOTOR DRIVERS
  - L298 (2A to 4A)





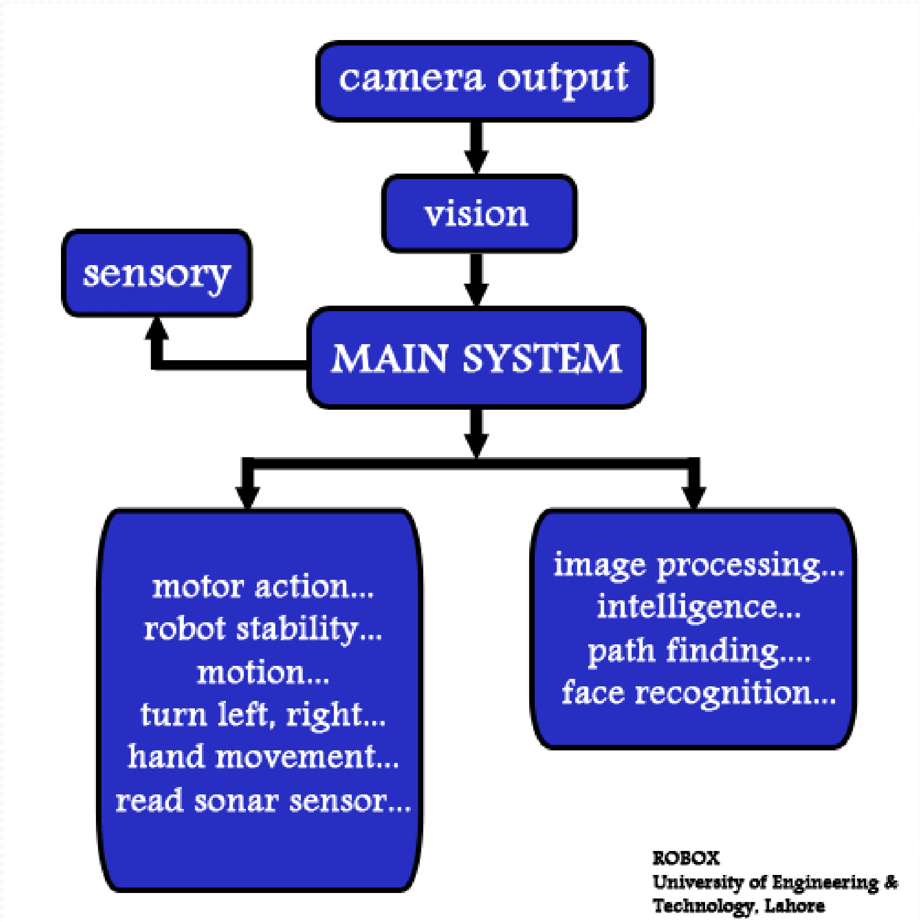
- SPEED CONTROLLING OF THE MOTOR
  - some motors need different speeds at different levels
  - to control the initial push of the motor
  - LM317
  - REGULATOR



- PIC CIRCUIT BOARD
  - 5 microcontrollers
  - Master-Slave configuration

- POWER SUPPLY CIRCUIT BOARD

ALGORITHM


camera output
vision
sensory
MAIN SYSTEM
motor action...
robot stability...
motion...
turn left, right...
hand movement...
read sonar sensor...
image processing...
intelligence...
path finding....
face recognition...
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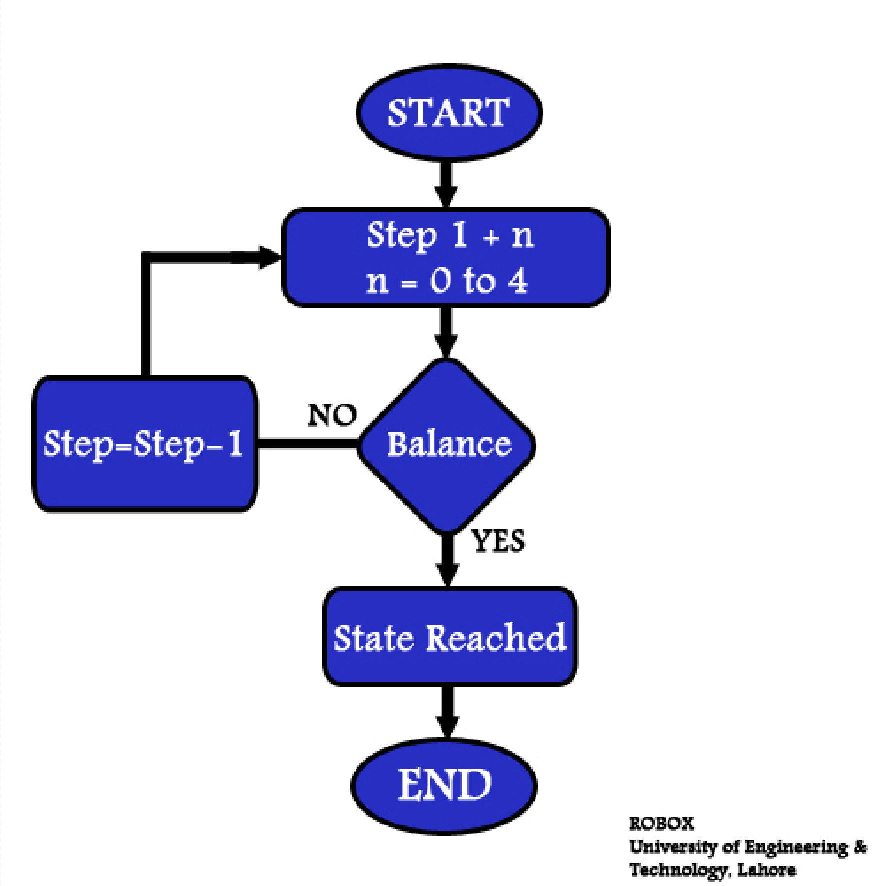
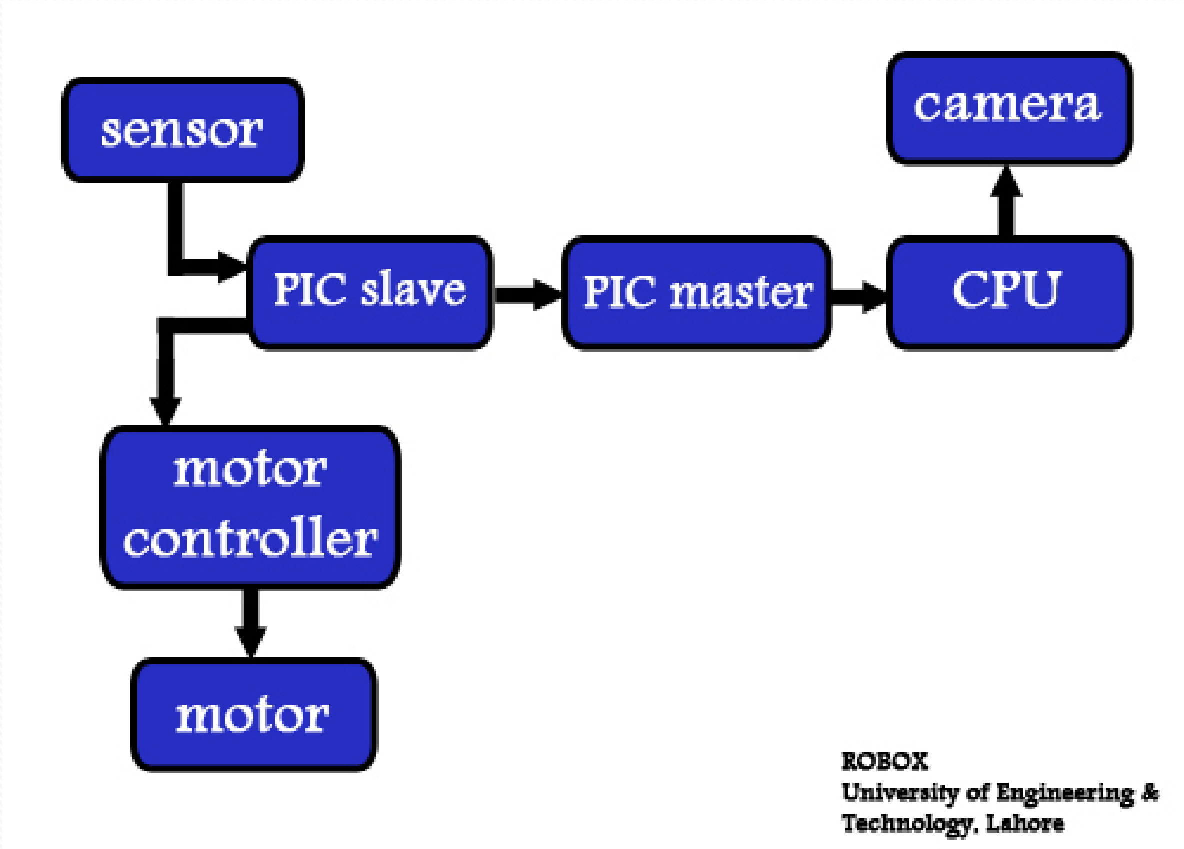
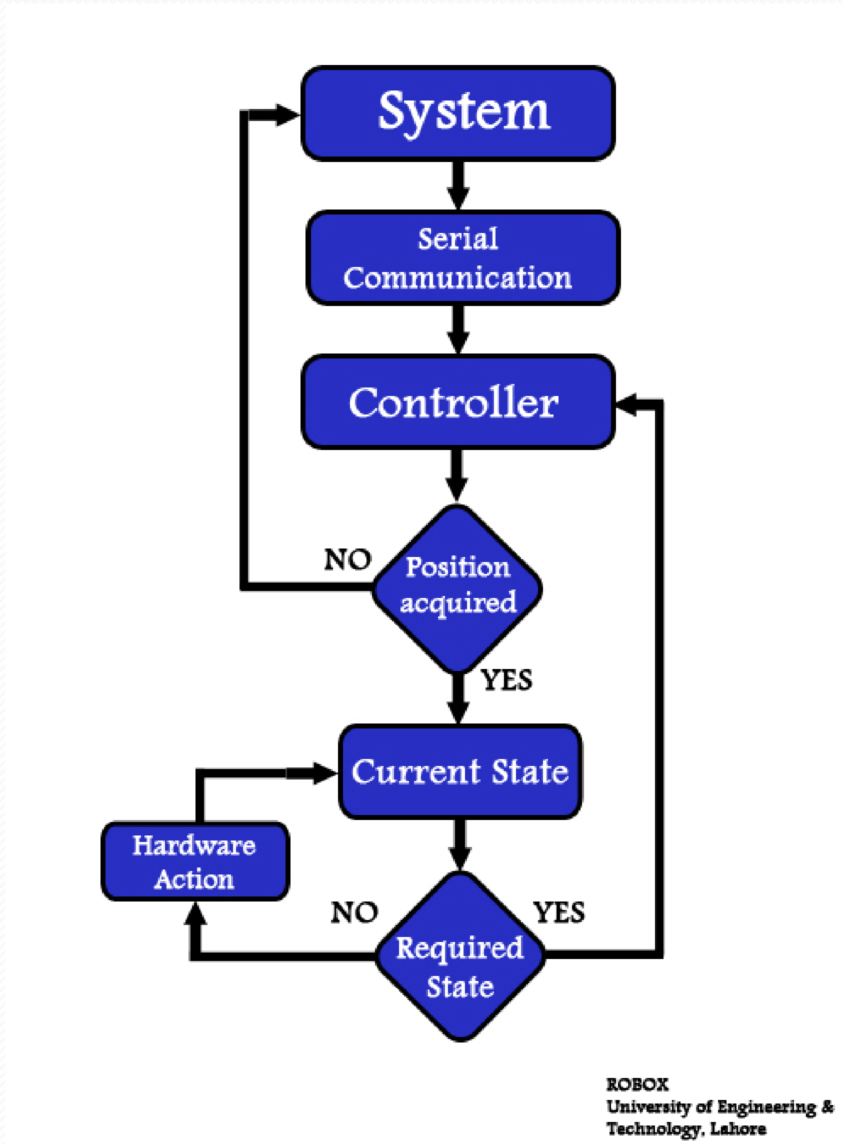
WALKING ALGO



System Control algorithm



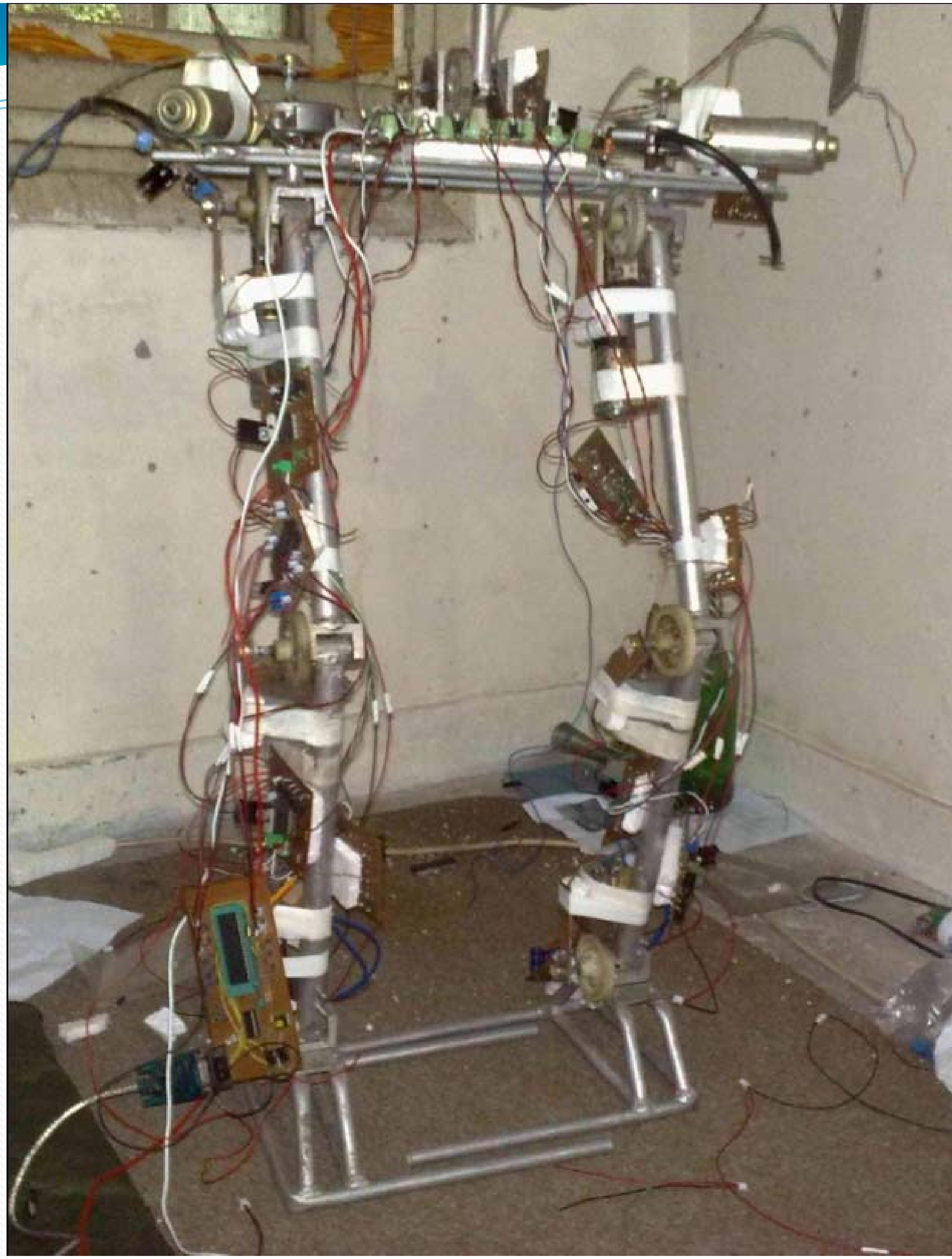
Overall control flow Diagram

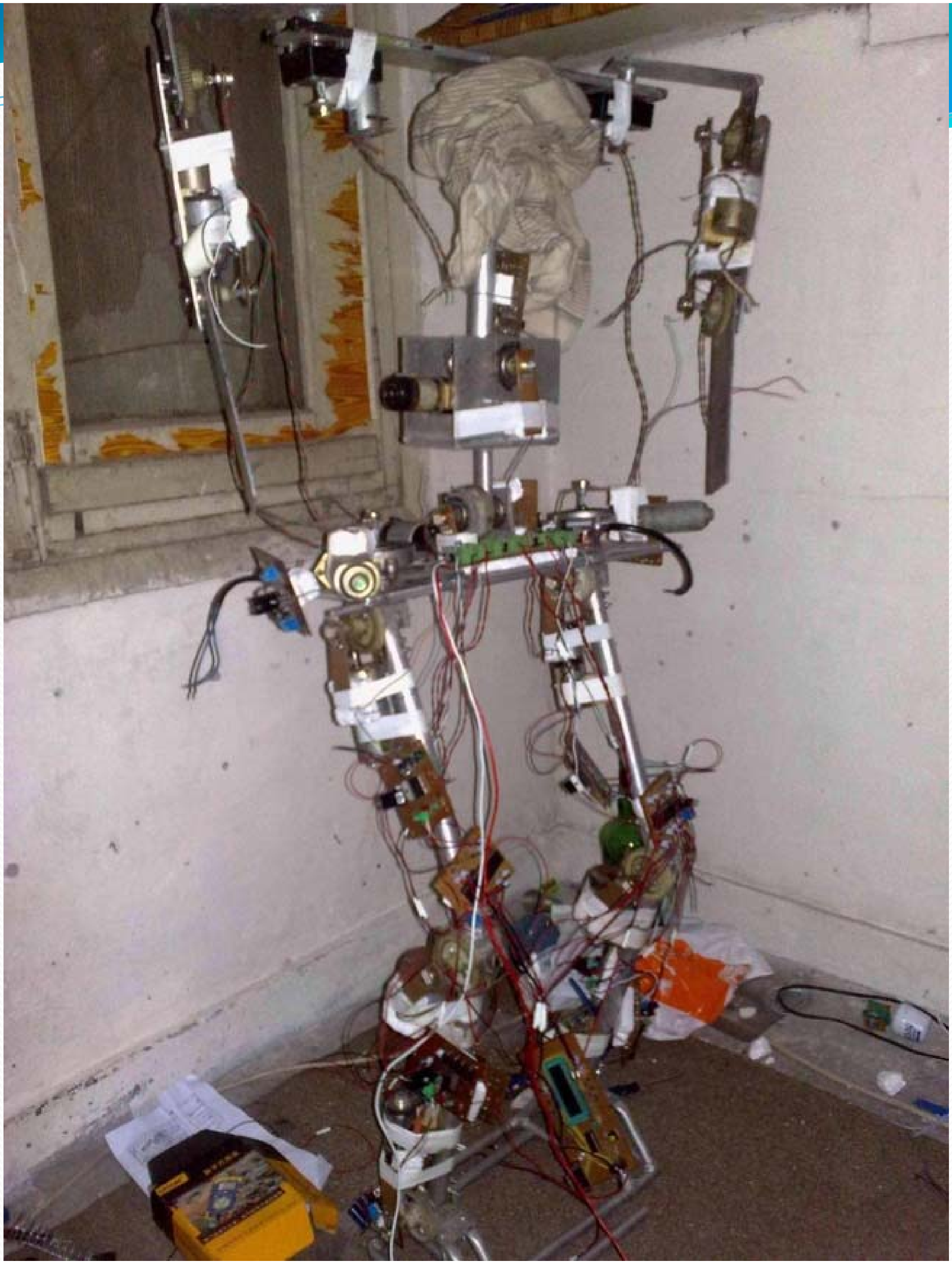


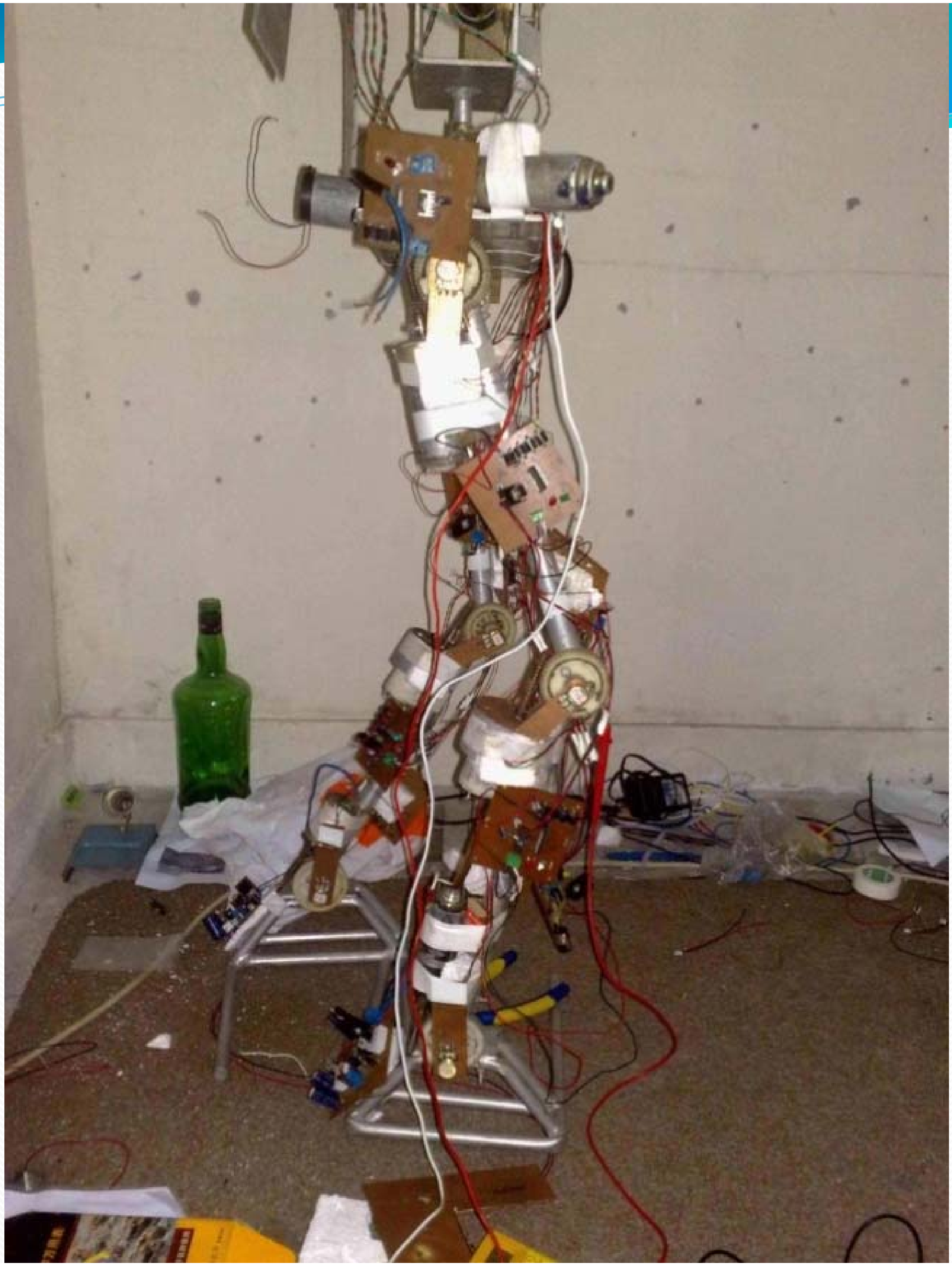
SOFTWARES

- Microsoft Visual Studio C/C++ 6.0
- MP Lab IDE
- Proteus
- PIC Programmer
- Adobe Photoshop
- 3D Max

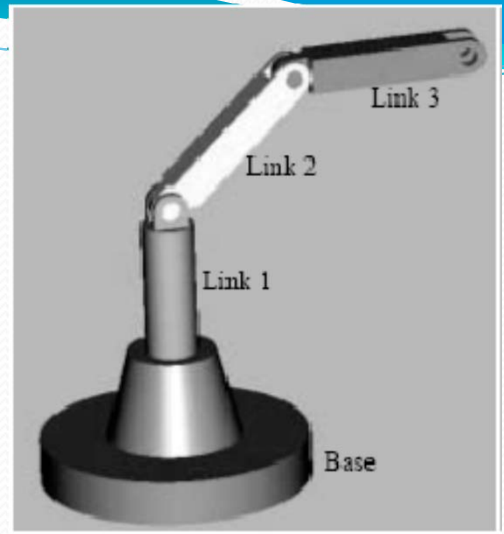
• Programming Language:	C Language
• Libraries:	Stdlib.h Stdio.h Windows.h OpenCV.h





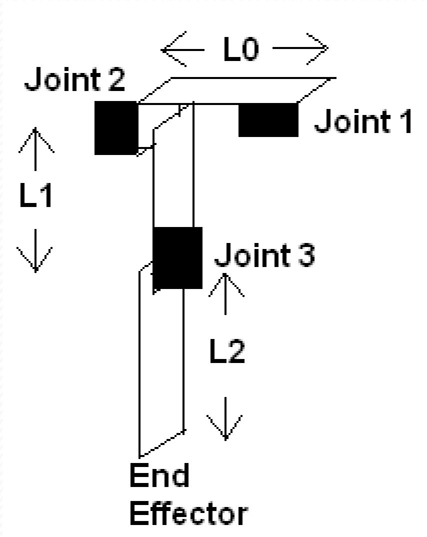


Kinematics



- At joint 1 => $x1 = 0$
  $y1 = 0$
  $z1 = 0$

- At joint 2 => $x2 = L0*\sin\alpha$
  $y2 = -L0*\cos\alpha$
  $z2 = 0$



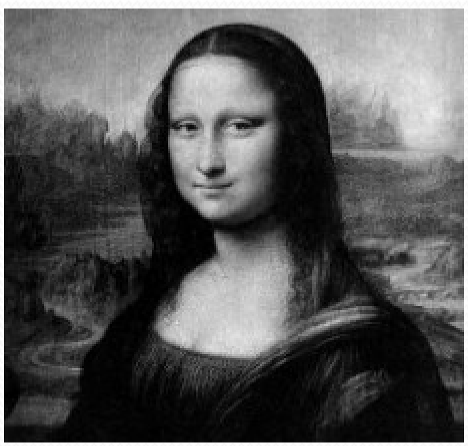
- At joint 3 => $x3 = L0*\sin\alpha + L1*\sin\beta*\cos\alpha$
  $y3 = -L0*\cos\alpha + L1*\sin\beta*\sin\alpha$
  $z3 = -L1*\cos\beta$

- At end effector => $x = L0*\sin\alpha + L1*\sin\beta*\cos\alpha$
  $y = -L0*\cos\alpha + L1*\sin\beta*\sin\alpha - L2*\sin\alpha*\sin(\beta+\gamma)$
  $z = -L1*\cos\beta - L2*\cos(\beta+\gamma)$

IMAGE PROCESSING

- Computer vision is concerned with modeling and replicating human vision using computer software and hardware.

Grey Scale

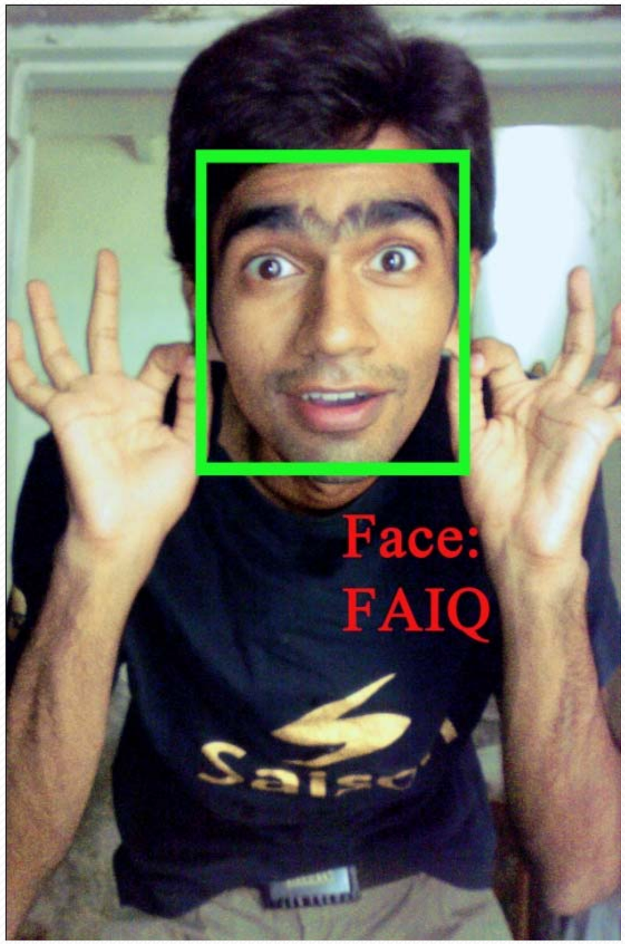


Pixel Rendering

RBG

Threshold

Face Recognition



SPEECH RECOGNITION

- Speech Vocabulary
- Microsoft Speech Engine
- Speech Recognition
- Comparison
- Speech Synthesizing
- One word at a time (isolated-word speech) Mode VS Continuous speech Mode

DRAW BACKS

- It is made for plain surface
- It is not functioned with gyroscope or accelerometer for stability
- It can lift maximum of 2.5 Kg weight from its hands
- It moves forward through gait of one leg

This project is dedicated to all those who think this project was impossible.