Robotics for Professionals

Course Content

● **Course Title**: ***ROS 1 with Raspberry Pi***
Course Duration: 15 weeks (adjustable)

Week 1: Introduction to Robotics and ROS

- Overview of robotics and its applications
- Introduction to ROS and its key concepts
- Setting up Raspberry Pi for ROS development
- Installation of ROS on Ubuntu and Raspberry Pi
- Basic ROS commands and tools
- Version Control using Git

Week 2: Introduction to Linux

Session 1 Objective: Introduce students to the Linux operating system and its core concepts.

- What is Linux?
- History of Linux and its distributions
- Linux as an open-source operating system
- Introduction to the Linux terminal
- Basic terminal commands (ls, cd, pwd, mkdir, rmdir)
- File and directory structure in Linux
- Navigating the file system

Session 2: Users and Permissions
Objective: Teach users and permissions management in Linux.

- User accounts in Linux
- Creating and deleting user accounts
- User groups and group management
- File and directory permissions (chmod, chown)

- Understanding permission modes (rwx)
- Changing ownership and permissions
- Managing files and directories as a regular user and superuser (sudo)

Week 3: File Operations, Processes and System Management

Session 3: File Operations and Processes
Objective: Cover file operations, text processing, and managing processes in Linux.

- Working with files (touch, cp, mv, rm)
- File archiving and compression (tar, gzip)
- Text editors in Linux (nano, vim)
- Basic text manipulation (grep, cat, less)
- Processes and process management (ps, top, kill)
- Running and managing background processes
- Redirecting input and output (>, >>, <, |)

Session 4: System Management and Basic Scripting
Objective: Explore system management tasks and introduce basic scripting concepts.

- System information commands (uname, df, du)
- Managing services and daemons (systemctl)
- Package management (apt or yum)
- Basic shell scripting concepts
- Writing and running simple shell scripts
- Script execution permissions
- Automating repetitive tasks with scripts
- Examples of common scripting tasks (e.g., file backups)

Week 4: Basics of CPP Language

- Introduction to Programming using C++
- Data Types.
- Variables.
- Operators.
- Control Flow and repetitions.

week 5: Modular programming in practice

- Functions
- Pointers (pointer to every data type, pointer to functions).
- Callback.
- Reference.
- Arrays and vectors.

Week 6: Object Oriented Programming

- Object Oriented Programming
- Classes and Objects
- Advanced class features
- Inheritance
- Compile time Polymorphism
- Run-time Polymorphism and abstraction

Week 7: OOP Relationships and Templates

- UML and design concepts
- OOP Relationships
- C++ Templates
- Strategy design pattern

Week 8: ROS Architecture

- Understanding Message passing architecture
- Understanding the ROS architecture (nodes, topics, services, parameters)
- Creating and running ROS nodes on Raspberry Pi
- Using the ROS master and roscore
- Working with ROS packages and workspaces

Week 9: ROS Topics and Messages

- Understanding ROS topics and messages
- Creating custom ROS messages
- Publishing and subscribing to ROS topics on Raspberry Pi
- Practical exercises with sensor data (e.g.,MPU, Laser scanner, GPS, ultrasonic sensor)

Week 10: ROS Services and Actions

- Introduction to ROS services and actions
- Creating custom ROS services and actions
- Implementing and using services on Raspberry Pi
- Practical exercises with servo control

Week 11: Robot Modeling with URDF

- Introduction to URDF (Unified Robot Description Format)
- Creating a simple robot model with URDF
- Visualizing the robot in RViz
- Simulating the robot's motion

Week 12: Robot Control with ROS Controllers

- Understanding ROS controllers
- Implementing joint controllers for robot movement
- Controlling robot motion with ROS controllers
- Testing and tuning robot movements on Raspberry Pi

Week 13: Robot Navigation with ROS

- Introduction to robot navigation stack in ROS
- Setting up a 2D navigation environment
- Creating a map with Raspberry Pi and a Lidar sensor
- Implementing robot navigation and path planning

Week 14: Computer Vision and ROS

- Introduction to computer vision in robotics
- Setting up a USB camera with Raspberry Pi
- Implementing basic computer vision tasks (e.g., object detection)
- Integrating computer vision with ROS

Week 15: ROS and IoT Integration

- Introduction to IoT (Internet of Things) in robotics
- Setting up sensors (e.g., temperature and humidity) with Raspberry Pi
- Sending sensor data to ROS using MQTT or ROSBridge

- Implementing remote control and monitoring via the web

Week 16: Final Project and Advanced Topics

- Students work on individual or group projects involving ROS and Raspberry Pi
- Advanced topics based on student interest (e.g., SLAM, robot arm control, ROS2)
- Project presentations and demonstrations
- Course review and discussion of further learning resources

Assessment:

- Weekly quizzes or assignments
- Midterm project (e.g., building and controlling a robot)
- Final project (e.g., implementing a robot with navigation and computer vision)

Thank You