An Embedded Computing Platform for Robots

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Why A Robot Specific Platform?

- Abstract tasks specific to robotics
- Modularize tasks
- Separate device level control from higher level abstract control

Already Existing Platforms

- Microsoft Robotics Developer Studio
- iRobot Create
- ROS

Microsoft Robotics Developer Studio

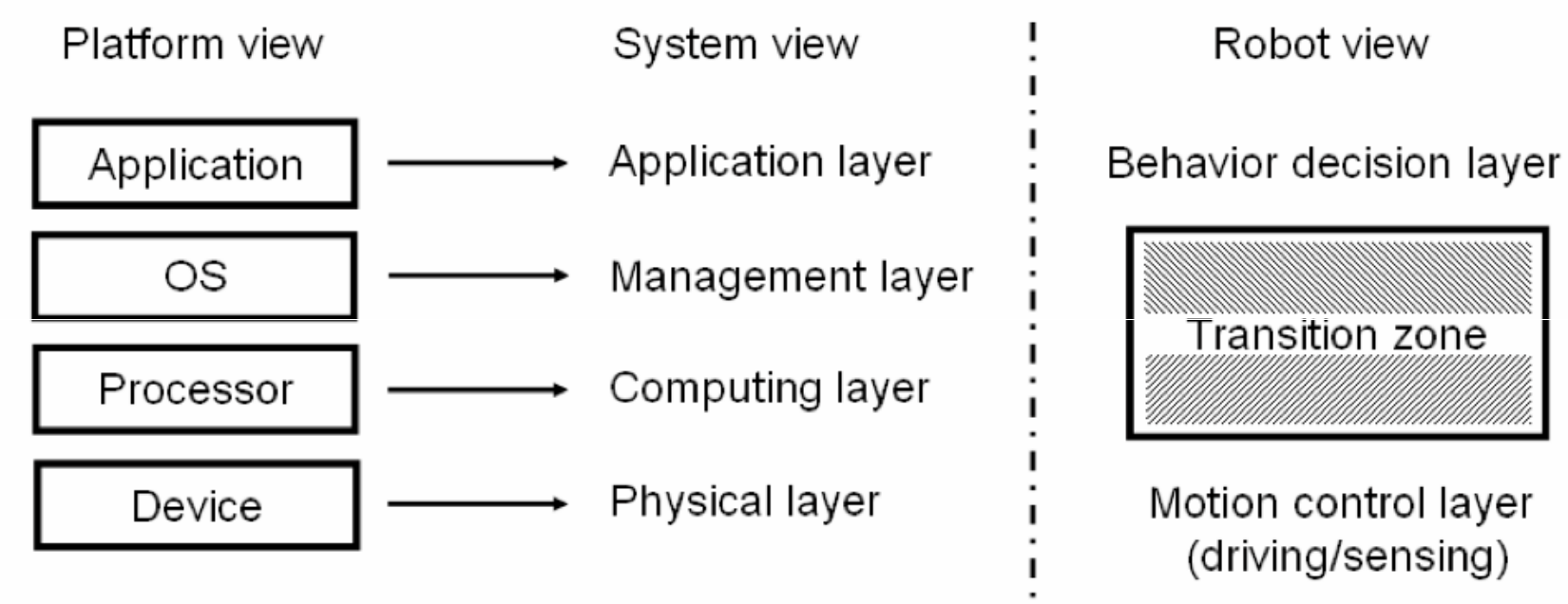
- Provides Visual Programming Language
- Supports C#, Visual Basic .NET, Jscript, and IronPython
- 3D Simulating Environment

Components

- CCR (Concurrency and Coordination Runtime)
- DSS (Decentralized Software Services)
- VPL (Visual Programming Language)
- VSE (Visual Simulation Environment)

iRobot Create

- Specifically for robotics development
- Centers around the iRoomba robot
- Interfaces through a serial port on the robot
- Often an external computing platform is used


Platform view
System view
Robot view
Application
Application layer
Behavior decision layer
OS
Management layer
Transition zone
Processor
Computing layer
Device
Physical layer
Motion control layer
(driving/sensing)

- Application Layer
  - High level layer where logic is written
  - API and drivers should be well encapsulated to allow
  - easy to understand flow at this level
- OS Layer
  - Handles management of data flow
  - coordinates tasks
- Processor
  - Handles processing of tasks
  - Provides hardware mechanisms for software
  - e.g. i2c, uart, pwm, procesing
- Device
  - Sensors, motors, communications interfaces

ROS (R.obot O.perating S.ystem)

- Open-Source meta-operating system
- Provides
  - hardware abstraction
  - low-level device control
  - implementation of commonly-used functionality
  - message-passing between processes
  - package management
- Also provides code libraries for writing code across multiple computers
- Not real-time, but can be integrated into real-time code

Goals of ROS

- Thin: Designed so that your main code can easily be ported to other projects
- Agnostic Libraries
- Language Independence
- Easy Testing: built-in unit/integration test framework ‘rostest’

Three Levels of Concepts

- File-system Level
- Computational Graph Level
- Community Level
  - Distributions
  - Repositories
  - Wiki

Computational Graph Level

- Nodes
    - Processes that perform computation
- Master
    - Provides name registration and lookup
- Parameter Server
    - Allows data to be stored at a central location
- Messages
    - Allows nodes to communicate
- Topics
    - Messages are sent via a transport system with publish/subscripe semantics

Community Level

- Distributions
  - Similar to Linux distributions
- Repositories
  - Different institutions can develop their own software components
- Wiki
  - Community wide documentation

Higher Level Concepts

- Coordinate Frames/Transforms
- Actions/Tasks
  - Topic based interface for preemptive tasks in ROS
- Message Ontology
- Plugins
  - Dynamically loading libraries in C++ code
- Filters
  - C++ library for processing data using filters
- Robot Model
  - Provides an xml format for representing a robot model

Currently Available Stacks

- 3d pipeline
  - Algorithms and tools for dealing with 3D point cloud data from a variety of sensing devices
- arm navigation
  - Contains action/behavior used to execute collision free motion planning and control for a robot arm manipulator

Example Libraries

- Roscpp
  - C++ library
- Rospy
  - Python Library
- Rosoct
  - Library for Octave, an open source Matlab alternative
- OpenCV2
  - Open source computer vision library 2