COBOTTA - a ROS-Enabled Collaborative Robot

@ ROS-INDUSTRIAL CONFERENCE 2018

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DENSO Robotics Europe
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Ort: Stuttgart
**DENSO Corporation**

- **1949** – DENSO established as a separate entity of TOYOTA Motor Co. Ltd.
- **1967** – Start development of robots
- **2018** – One of the 500 world’s biggest companies
  - Market leader in small industrial robots
  - One of TOP 3 auto parts suppliers worldwide

<table>
<thead>
<tr>
<th>1) Automotive Industry</th>
<th>2) Consumer Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>One of TOP3 auto parts suppliers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>3) New Business Fields</th>
<th>4) Industrial Products</th>
</tr>
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</table>

- US $48.1 billion in annual revenue
- 170,000 employees in 200 group companies
- 9% of revenue invested in R&D
- 38,000 active patents worldwide

**DENSO**
Inventor of QR Code
DENSO Robotics

Robotics Pioneer

50 Years
Over 50 Years (since 1967) of Industrial Robots Development for Industries.

100,000 Robots
Worldwide Market Leader in Small Segment Assembly Robots

OEM Supplier
Trusted OEM Supplier with world wide Trust to our Products even as OEM Supplier

20,000 Own Use
One of the World's Largest Robot Users and has Over 20,000 DENSO robots work in our own manufacturing facilities

Assembly
Packaging
Measurement

Pharma
Medical
Automotive parts

DENSO Crafting the Core
Cobotta Overview - a ROS Enabled Collaborative Robot

COBOTTA

- Arm: 6 axis (+1 for electric Gripper)
- Reach: 342,5 mm
- Repeatability: 0,05 mm
- Payload: 500g (700g)
- Extended-joint motors

COBOTTA = COllaboration roBOT Technology for Arm
Cobotta Key features & concepts

1. Safe Design

Inherently safe design
• No sharp parts
• Designs to prevent pinching and rolling-in.

Safety Standards
• ISO 10218-1:2011
• ISO/TS 15066
• ISO 13849-1:2015
  PL d/Cat 3

Compliance with functional safety
• Safety-rated monitored function (all axis)

2. Easy to use

Easy to set-up & Use
• 1st set up takes only few minutes
• Few minutes Start-up time for a new application
3. Portability

Efficiency & Flexibility through Easy Portability of Cobotta

Pick & place on trolley or **ROS Enabled** - Mobile Plattforms (AGV)
4. Open Platform – Advantages of COBOTTA

Wide possibilities to use COBOTTA - *from first time user to robot expert*

### Programming Advantages

1. RC8A compatible (PacScript)
2. PC Control (ORiN / b-CAP)
3. COBOTTA (OSS type)

### Vision Connectivity

1. Vision via COBOTTA World
2. EVP Easy Vision Picking
3. CANON Vision Edition
4. External Vision Systems

### External Control possibilities
Use of ROS with DENSO Industrial Robots

- DENSO has initiated the use of ROS internally and develop ROS packages and libraries actively from 2012 onwards.
- First Demonstration was made at IREX Fair 2013
- Steady development w.r.t additional functions, improvement of our Controllers focussing ROS usage
Open Platform – Control Methodologies & Functional Overview

Control Structure (Application Layer Perspective)

OS: Windows

Functional Flow

Open Platform - ROS based control of COBOTTA

1st Method - Using DENSO basic OS version

Download from GitHub

ROS package (ROS node source)

Linux + ROS

Robot program

ROS

PLC

PacScript

bCapService

VRC

RobotMotion

Device driver

FPGA

Basic OS: Control from external PC which has installed ROS (same as RC8A)

- Utilising the existing facilities - PC control.

: Customer Development

: offered by DENSO
COBOTTA with ‘drag&bot’ Software

drag&bot adds options to control DENSO Robots

drag&bot is a software developed over ROS platform for a simple, graphical setup and programming of robotic applications. drag&bot works perfect with COBOTTA and other Denso robots.

Benefits:

• Everyone can operate and program robots
• No IT/robot skills or expensive training required
• 5x faster programming of robots in comparison to normal robot programming
• Enables cost-efficient automation by flexible change of robot tasks

www.dragandbot.com
Open Platform - ROS based control of COBOTTA

2nd Method – OSS Type (Open Source Software)

OSS: Control of COBOTTA with ROS

Built-in controller and API for controls

- Individual development environment (Linux + ROS)
- Suitable for Development, Investigation and education (Linux + ROS)

The functions which is not set on OSS ver., Please make it by customer.

ROS
Original user software

Device driver (open to API)

FPGA

Especially thought for ROS Enthusiasts !!!

ROS
(Installed by the customer)

(1) DENSO ROS package For COBOTTA (ROS Node, source)

OS: Linux Ubuntu
(Installed by the customer)

(2) Dedicated driver for COBOTTA (Source)

Provided as open source software
(1) DENSO ROS package
(2) Dedicated driver for COBOTTA
Open Platform - ROS Access Links for COBOTTA

Supporting ROS with Cobotta
- Links to access the ROS Packages for DENSO -


https://github.com/DENSORobot/denso_robot_ros
http://wiki.ros.org/denso_robot_ros
ROS packages for DENSO Robots

We provide 7 ROS Packages as DENSO ROBOT ROS

- 2 Packages for Simulation of DENSO Robot
- 4 Packages for Controlling Real DENSO Robot
- 1 Package for creating Path Trajectory easily

**Packages for Simulation:**

<table>
<thead>
<tr>
<th>Package</th>
<th>Description</th>
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<tr>
<td>denso_robot_gazebo</td>
<td>ROS package for starting DENSO robot simulation by Gazebo.</td>
</tr>
<tr>
<td>denso_robot_descriptions</td>
<td>ROS package containing some DENSO robot’s URDF files.</td>
</tr>
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**Packages to control Real Robot:**

<table>
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<tr>
<th>Package</th>
<th>Build Output</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>bcap_core</td>
<td>Lib: libbCAPClient.so</td>
<td>ANSI-C library for sending and receiving b-CAP packets.</td>
</tr>
<tr>
<td>bcap_service</td>
<td>Lib: libbcap_service.so Node: bcap_service_exec</td>
<td>ROS node containing all of b-CAP methods. Provide 1 ROS service for sending and receiving b-CAP packets.</td>
</tr>
<tr>
<td>denso_robot_core</td>
<td>Lib: libdenso_robot_core.so Node: denso_robot_core_exec</td>
<td>ROS node containing general DENSO robot’s functions, such as move or variable read and write. Provide some ROS action and message.</td>
</tr>
<tr>
<td>denso_robot_control</td>
<td>Node: denso_robot_control</td>
<td>ROS node for controlling DENSO robot by your original motion planning.</td>
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**Packages for Path Generation:**

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<td>denso_robot_moveit_config</td>
<td>ROS package for starting MoveIT! with DENSO robot.</td>
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ROS Integration with 6-Axis Industrial Robot

Steps to use DENSO Robot in ROS => MoveIT!'s ROS Plugin

Install DENSO ROS Package as Pre-requisite

$ rosdep install vs060
$ ros-$YOUR_ROSDISTRO$-moveit-ros-visualization

Execute MoveIT! Launch => Rviz Plugin

$ roslaunch denso_launch denso_vs060_moveit_demo_simulation.launch

ROS Converter - Tool for any further DENSO Robots

Easily generate DENSO Robot URDF Model from WINCAPS Software !!

Create WINCAPS III Project  ➔  Convert WPJ to URDF  ➔  Copy URDF to Linux, and Start Simulation
DENSO VS-060 with ROS
DENSO VS-060 with ROS – Practical Example

Main software:
- ROS (system integration)
- OpenRAVE (motion planning)
- OpenCV & PCL (perception)
- Denso SDK
- Ensenso SDK
DENSO VS-060 with ROS – Practical Example

Viewpoint exploration

The camera is placed at multiple viewpoints to locate the panel

Courtesy: NTU, Singapore
ORiN2 – IDE for Applications and Industry 4.0

ORiN2 - Integrated Development Environment Structure

ROS

Java
Labview
Delphi

Visual Basic
Visual C++
C++ Builder

Missing Link
A ROS Provider

Open Resource Interface for the Network

APPLICATION

Device

Development tools

Device interface

Application interface

Robot
PLC
Sensor
Monitor
Camera

ORiN/DENSO – IIoT Solution Overview
Summary

✓ DENSO Robots and Cobotta provides wide possibilities to ROS users

✓ Cobotta laying special focus on ROS Users, has an option of OSS Version for customers to install the OS and User software directly

✓ DENSO is steadily supporting development of ROS drivers and Libraries
Thank You