

Robot Learning Technology for Multi-Task Service Robots

This article discusses the benefits which the robot learning technology brings to the field of multi-task service robotics.

1 The Problem

For a long time, the use of robots was limited to manufacturing automation and space exploration. Only large corporations and government agencies could afford the systems integration costs associated with the robotics automation projects. Underdeveloped artificial intelligence technology, safety issues and high costs of systems integration were the main limiting factors preventing the use of robotics by small businesses and households.

According to the industry statistics, for every dollar spent on an industrial robot, four extra dollars are spent on getting the robot to work properly. The robots required much technical expertise to make them work properly. This complexity created a roadblock for applications of the robotic technology in small manufacturing, service-related businesses and in households.

Military and law enforcement agencies have been using the robotic technology in the form of bomb-disposal robots, autonomous logistics/patrol vehicles (UGV), robotic aircrafts (UAV), cruise missiles and robotic mini-submarines (AUV). Recently, the US DoD has started a major program to introduce more autonomous robots into all branches of the service. The US Congress issued a law demanding that by the year 2015, one third of all acquired military vehicles must be autonomous. If we look at the reality, most of

the military robots are either remotely-controlled or single-function self-navigating machines, capable of autonomously navigating from point A to point B. Although the remotely controlled robots do their job well, today's military robots can hardly be considered multi-mission due to their pre-programmed behavior. To be easily adaptable to new environments and missions, the military robots should be able to learn directly from soldiers, acquire new skills and be trainable, not remotely controlled or programmable.

If we look at the consumer market, service robots have penetrated households in the form of single-function appliances such as robotic vacuum cleaners, robotic lawn mowers and robotic toys. Those robots perform their functions well and at a reasonable price, but once again can hardly be considered multi-task due to their fixed utility. Those robots cannot be used for anything other than a specific task which they were designed and pre-programmed to perform (e.g. vacuum cleaning).

Common sense tells us that a home service robot needs to be able to perform a wide range of tasks and be multifunctional. Otherwise, the home would be occupied by many single-function robots, instead of humans. This means that the service robots should be able to learn how to perform new

assignments while still being easy to operate by non-professional users.

Building the multi-functional service robot requires solving several fundamental problems such as making it adaptable to new environments, reducing the complexity of operation, introducing the robot learning technology, improving perception capabilities, and building flexible and reconfigurable robotic hardware.

The Skilligent product makes such multifunctional trainable service robots possible by enabling the robots to learn new skills and procedures directly from their users.

2 The Skilligent Solution

Skilligent has developed its robot learning technology to solve one of the key problems facing a designer of a multifunctional service robot – how to make the robot adaptable to new tasks and environments while still preserving the ease of use by non-professional users.

The Skilligent technology allows a non-professional user to train a service robot to perform a new task in a particular environment. For example:

- A restaurant owner can train a team of service robots to deliver orders in the restaurant.
- A floor manager at an assisted living facility can train a team of service robots to automatically scan the health of patients, remind them of the need to

take the medications and entertain the patients¹.

- An owner of a budget-priced motel can train a team of service robots to guide guests to their rooms, carry baggage, make deliveries, and patrol the area.

The examples highlight the key advantage of the technology – a user who is not an educated robotics professional, uses the off-the-shelf trainable robots for *service automation* tasks.

The videos published on the Skilligent web site demonstrate that the robot training process is simple and doesn't require technical expertise². During training, the robot is directed via gestures, object manipulations, simple words and sounds; in other words, the robot is trained in the same way as a home pet.

¹ Read an application study describing the use of product in the health-care domain at <http://www.skilligent.com/products/documents/docs/Skilligent-Health-Elder-Care-Robot-Study.pdf>

² The robot learning videos are published at <http://www.skilligent.com/products/robot-learning.shtml>

3 About Skilligent

Skilligent's flagship product is a trainable control system for autonomous robots such as mobile service robots, UGV, UAV or AUV. The software enables the robots to learn new behaviors, tasks and skills by observing how human operators accomplish the same tasks. A robot vision system, a part of the package, reliably recognizes objects, landmarks and gestures under real life conditions. The vision system enables the robots to visually navigate, control a manipulator and socially interact with the users.

<http://www.skilligent.com>