DoBots B.V.
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Rossification

"Transforming Existing Vehicles into Autonomous Robots with ROS"

Introduction

ROS, the Robot Operating System, has seen a strong growth in the latest years and has become the default operating system for especially autonomous and semi-autonomous vehicles. This document explores some of the reasons and how your existing vehicle can be transformed into an autonomous vehicle with a high possibility for success.

The market

Everybody with some technical interests has followed the development of autonomous cars. And although these have not arrived at the level and numbers previously expected they have served as the flagship example. Business executives have taken note of the fact that "reading a book while driving a car is possible" and have wondered: "Why does my internal transport, cleaning machine, inspection cart, etc etc still need a driver" This has led to a surge in interest in (sem) autonomous vehicles (a.k.a robot carts)

In the past building a robot was a huge effort since the number of choices for sensors (e.g. vision, sound, location), actuators (e.g. motors) and development boards was limited and the prices were high but these choices have exploded and the prices have dropped. This has made the development of a robot cart a lot more feasible. Robotics is not the only market that sensors are used in, also the market for Internet of Things (IoT) has grown fast fueling the same demand.

A third development that has made robotics more accessible is the fast growing maturity of ROS. The Robot Operating System is the glue that connects a collection of interesting open source tools that allow for modular design of components, improved code reusability, use simulation for testing and certification and increasingly distributed development. The use of these tools makes it possible to focus the development of a specific solution on the few parts that are specific, not the many parts that are generic. Those generic parts are already handled by ROS. It's modular internal structure makes it relatively easy to include new sensors, functionality and actuators.

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What benefits can you expect?

The benefits for any type of robot lie in the replacement of dull, dirty and dangerous work. Typically for internal transport the advantages are related to replacing dull work. This leaves the human staff for the more interesting tasks. With labor shortages being what they are any employee that is not doing dull and repetitive tasks is a gain.

What does a project look like?

The starting point of making your vehicle (cart, lorry, machine etc.) a robot is your current machine. If it is already running on an electric motor then that is a big plus. A further plus is, if it already has some form of electric steering e.g. with a joystick or an electric steering wheel. The more electric your current vehicle is, the smaller is the number of changes that are needed. If these electric features are missing then some redesign is needed.

The next step is to create a first simulation of the robot and the environment it will operate in. This sounds more advanced than it is. Your current vehicle most likely has some design documents that can be quickly converted into a digital model and with the help of a graphics designer it is not very difficult to build a digital version of the operational environment of the robot. The Internet is literally filled with, free or low cost examples. These items are brought together in an environment such as Gazebo or an hosted environment such as Asimovo.
[estimated number of consulting days: 5]

The new robot can now be seen but it can not see itself. It can move you, but it can not move itself. So the next step is to choose some sensors and actuators for the robot. The great news is that a simulated robot does not need a control board with all the wiring that comes with it. This exercise is left for later. Also you can quickly try out different sensors since installing a different option is literally similar to clicking a few times with your mouse. Actuators require some more background knowledge but are more or less a similar exercise.
[estimated number of consulting days: 4]

With these choices in place you can control your new robot in its virtual environment by keyboard or mouse. Now it is time to create a list of requirements. For these requirements it helps to have a broad base of future *stakeholders*. You qualify for example as a stakeholder if you are the robot's owner, customer, colleague or operator. And creating a list of requirements for both the hardware (needs to charge quickly) and its behavior (safety first) goes quick if you concentrate on the function a robot is good at. Think about replacing dull, dirty and dangerous

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work and the requirements pop up quickly. With the help of DoBots these requirements are quickly prioritized so that a budget and a high level design can be created.
[estimated number of consulting days: 15]

Moving from here building the robot becomes an iterative process that closely mimics the development of software. The choice of the components for hardware and software become clearer and the control system for the robot including the AI for video processing and the autonomous navigation system are developed. Next to the development of the software the electronic components for the cart need to be bought and integrated. Special attention goes to the cabling of all the components since that is always more work than expected and to the choice of the control board. For these efforts the budget depends on the requirements and the division of labor and this is different per robot. A detailed estimate is part of the design but an initial estimate can already be given after understanding your expectations of the new robot.