DoBots B.V.
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Auto inspection

“Make your inspection autonomous”

Introduction

Modern business is about continuity. Checks at regular intervals lower the risks of unplanned interruptions to your business. However, executing daily inspections and processing the results drives up your costs. At Dobots we have created advanced solutions based on Open Source software that make executing an inspection and processing the results a cost effective exercise. Our experiences range from drone inspection of bridges through water based inspections of harbor installations to cleaning of cow stables and warehouses.

A project starts with a short one day workshop to understand your inspection approach and your current inspection deliverables. We can then deliver a clear plan on how to process your inspection results.

What is in an inspection?

The use of AGV’s (automated guided vehicles) to execute inspections (or drones for that matter) has taken off in recent years. This popularity is driven by the lower costs of robotic tools such as AGVs and the higher demands that regulatory bodies put on regular inspections. The advantages to human inspection are legion and can easily be put in the replacement of dirty, dull and dangerous work. But there is one thing that humans are good at that are harder to replace: “judgment”. AI can help here and here is how we can help you!

What does a project look like?

The starting point for automatic processing of your inspection results is are the current digital results that come out of your inspection. Typically these are image results although other sensor readings (e.g.gas levels, sound, heat) can be used or fused into the analysis as well. Since processing graphical information is easiest, some form of image analysis always seems to be included.

The project kicks off with a one day workshop in which the current and preferred inspection process are discussed. What is the current best practice in pre, on-site, and post inspection.

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What are the main risks that are being covered and what are the areas for improvement that separate the current practice from the preferred practice. The gaps between the two states are divided in internal and external improvement points.

Typical problems that relate to auto inspection that we have solved in previous projects are:

- **Automatic inspection**
  Business sites change continuously and the inspection robot is not alone. How can you keep the map up to date and how do you avoid collisions or other dangerous situations? Questions like these come up quite often but are a bit outside the scope of this work. For these kinds of questions consider the white paper on Rossification.
- **Planning the right route**
  When you do not have the time to inspect all of your facilities or if two or more robots cooperate, what is then the right route to reduce the risk of an incident to a minimum. Within DoBots we know how to create the right routes based on maximum reduction of risk. We also know how to make robots cooperate effectively. Based on the description of the risks that need to be reduced we can adapt the route planning to aim for a minimal risk approach.
- **How to process the inspection results**
  Typical video speeds of 60 frames per second that are used on an inspection robot create over 200.000 images per hour, compared to perhaps 60 images of a human inspector in the same time frame. For almost any inspection application processing of over 200.000 images is not needed to get a clear picture. But how do you choose what image to process and what image to ignore? At Dobots we have worked on a number of solutions for exactly this problem.
  - **Quality selection**
    The easiest way to avoid processing is to discard images that don't meet the quality requirements. Pictures that are too vague, don't have enough contrast or are too dark can be discarded during the process and are never offered for processing.
  - **Enough is enough**
    If you have a couple of hundred photos of the same area then it is quite clear that these are too many. But how do you know the number of pictures you have and how do you know that you have selected high quality ones? The approach we have finetuned is to combine the navigation approach with the inspection mission. Navigation of a robot is typically based on camera images. These images are processed and the points of interest are "extracted" acting as the "fingerprint" of that location. In our approach we pre-process each photo to be

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linked to each fingerprinted point. Once we have reached the number of photos per point that is needed we keep storing the later images but we don't process them again. This approach assures that every point of interest is covered by enough photos but never too many. In a typical scenario this drops that number of images from over 200.000 to 3.000 to 4.000.

- **On-board preprocessing**
  The reason that most inspection results are processed in the cloud is both the number of inspection results and the heavy demands that running an AI application such as a neural network can put on the hardware. With higher performing hardware comes higher energy use and that limits the reach of the robot.
  However, some initial processing can still be done on the robot. A simplified (pruned) version of the neural network that runs in the cloud can be constructed and can act as a first filter. When the filter "fires" the limit for the points of interest in the previous point can be put higher so that more images are available. Similar approaches can be applied to areas of higher risk (Planning the right route) or areas that stood out in previous inspections.
- **Automatic classification**
  The inspection images that are marked for further processing are now analyzed by a neural network that is trained for the type of inspection needed. Examples that we have worked with are for example crack detection, corrosion detection and missing concrete. These anomalies are marked on a layer above the photo so that the customer can easily schedule followup actions.
- **Customer analysis**
  Customers have moved from the use of written inspection reports to the use of online tools. These include the use of 3D representations and intuitive dashboards, often combined. The use of these tools makes it easier to develop a plan of action based on the results of the inspection.

- **Comparing results**
  An additional advantage of automated analysis is that all reports can be easily compared to each other. This makes it possible to follow a structure over time and focus remedial actions even more on the areas that require most attention.

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Is it worth it?

Part of every project is to create a business case. The business case for automatic inspection is simple. The comparison of the costs of human execution and processing of the results against automated execution will show a business in a very short timeframe. On top of clear costs benefits the repeatability of the process and the much higher quality make automatic inspections also the technically superior solution.

Can you show me?

A white paper like this is meant to offer insight into what you can expect from a technology in this case automatic inspection. At Dobots we can show you working examples of all of these technologies. Also, we do not use commercial licenses in our software, we develop everything in Open Source. This way we know what we are doing and we don’t have to charge you for the software itself.