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LADYBIRD: The Animal-Friendly Robot Vacuum Cleaner

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Abstract

More and more autonomous and semi-autonomous machines make decisions that have moral implications. Machine ethics as a discipline examines the possibilities and limits of moral machines. In this context, the author developed various design studies and thus submitted proposals for their appearance and functions. He focused on animal-friendly machines which make morally sound decisions, and chatbots with specific skills. For the design of moral machines decision trees are still little used. This article focuses on a service robot which shall spare beneficial insects – a vacuum cleaner called LADYBIRD – and an annotated decision tree modelled for this objective will be presented. The outlined work leads to a practice project that was proposed in spring 2017 at the School of Business FHNW.

Introduction

The subject of machine ethics is the morality of machines, in particular of autonomous and semi-autonomous systems such as certain agents, robots, drones and self-driving cars (Anderson and Anderson 2011; Gelding et al. 2009; Bendel 2012; Bendel 2014d). There are various discussions and great disputes, e.g., about the term "machine morality". According to a proposal it can be used like one uses the word "artificial intelligence" (Bendel 2016). This is not saying that mechanical and human morality are identical; rather, it is an approach or a comparison. Widely accepted, however, is that the decisions of the machines can have moral implications and that simple moral machines are possible which make proper or adequate decisions in not very complex situations (Bendel 2013).

Service robots are robots that provide a service, that is to say explain something to the users, advise them, guide and support them. This makes it already clear that they can be active linguistically as well as physically (if they are implemented not only electronically). Household and garden robots such as suction, mowing, swimming pool and window cleaning robots can be called service robots and thus differentiated from industrial robots, motion machines that are at work in a factory. Also surgery, care and therapy robots can be associated with those, or monitoring and surveillance robots like Knightscope's K5 that patrols in shopping malls or on factory grounds. Depending on the language, the term "service" in some areas and for some types of robots may seem strange.

An ordinary robot vacuum cleaner devours everything it encounters on its way, not just fluff, bread crumbs and confetti, but also spiders and beetles. According to many people's opinion, one should not hurt animals or kill them, above all not the harmless and useful ones. It is possible to equip the robot with pattern and image recognition as well as motion sensors, and thus to teach it to spare certain living things. Mowing robots can be improved in this way as well whereby a lawn – not to mention a meadow – is a relatively complex environment.

From the basis of machine ethics, this article focuses on the conception of an animal-friendly robot vacuum cleaner called LADYBIRD. On this subject there are a design study (Bendel 2014a) and an annotated decision tree (Bendel 2016). At the beginning of 2017, a project on LADYBIRD was proposed at the University of Applied Sciences and Arts Northwestern Switzerland FHNW. Within a practical work, students under the supervision of the author were to implement the machine prototype.

The Rise of Robot Vacuum Cleaners

Robot vacuum cleaners, also called robotic vacuum cleaners, robot vacuums and vacuuming robots, are in use in many households and office buildings. Most of the major relevant manufacturers such as Dyson, Vorwerk, Bosch and Kärcher have the devices on sale in various types and price categories. Electronics companies and conglomerates such as Sony, Samsung and Philips are engaged in this segment as well. The vacuuming robots can work for hours independently, in replacement of human physical work, which makes them typical moving machines.

The robot vacuum cleaners have a pleasing appearance, are relatively small and mostly flat and round and fitted with a soft edge. More and more sensors are being used in the systems, and the robots continuously learn to make intelligent and autonomous decisions. Vacuuming robots have often auditory and visual interfaces in addition to cameras and other sensors in order to report errors and needs or fulfil wishes. For example, if they need power or the container or bag must be emptied they speak to the user or provide information via display.

Animal Welfare at Home

In connection with wild and domestic animals some attention has been given to partially autonomous and autonomous systems. Advanced driver assistance systems have been designed that are able to recognize wild boars, deer and hedgehogs on the road and make braking or evasive maneuvers, if the traffic allows it (Bendel 2014c). Prototypically also available are mowing machines which in cooperation with drones spare the fawn in the field, as well as wind turbines which stop at the approach of flocks of birds (Federle 2014).

Some robots shall take over a function in flocks and herds or tasks of animals as social beings or interacting organisms. It is the intent that they examine the appropriate animal groups, influence them, try to guide and direct them, and bring them to adopt a certain course of action. The interactions here are of various kinds (Mondada 2013) going from mutual interference up to learning through observation and imitation.

Animal welfare at home seems something absurd, especially when it comes to very small and tiny animals. Some people undertake a lot to banish any creatures from their apartment, and some purposefully use their vacuum cleaner to suck up spiders or isopods. In the case of certain cockroach species wider action must be taken, because they can be a veritable infestation, and even pests like moths are fought, especially since they can cause damage to clothing and furniture.

Nevertheless, there are good reasons not to kill certain animals, and to give the human residents the opportunity to carry them outside. Ladybirds, as known as ladybugs, are liked by many people. In some countries they are even considered good-luck charms. They relatively slowly scramble across the ground and tend not to fast and repeated fly ups. Other rather cozy beetles as well as caterpillars that get into the apartment from the garden are often liked and spared in the direct encounter. Some of these insects are beneficial and help to decimate certain pests. So ladybirds are used against aphids and can thus save infested plants. Of course, plagues can occur sporadically, so that action has to be taken against beneficial insects.

The following can be said: Small animals can get lost in the house and are not able to flee fast enough and, for personal and moral reasons, they should not be sucked up. In individual cases, there may be tiny animals that have their place in the apartment, e.g., snakes or lizards, which fled their terrarium (and are possibly injured and are therefore unable to get away). The robot vacuum cleaner must stop in front of them and – if necessary – inform the user (when he or she is present) of a possible problem. The robot can also try to scare away the animals, and in some species this can be achieved.

Even if one is not prepared to accept these assumptions, one must acknowledge that in this context the principle of simple moral machines can be clarified (Bendel 2016). The findings are meaningful also in other contexts; so the intended actions and interactions can help imprisoned and free-range farm animals and larger wild animals and be of general interest in animal-computer and animal-machine interaction (Mancini 2011). Last but not least, vacuuming robots that are able to identify and classify that what they suck up are useful also in case of fallen jewelry or dropped money. So, animal welfare could help also with the protection of valuables.

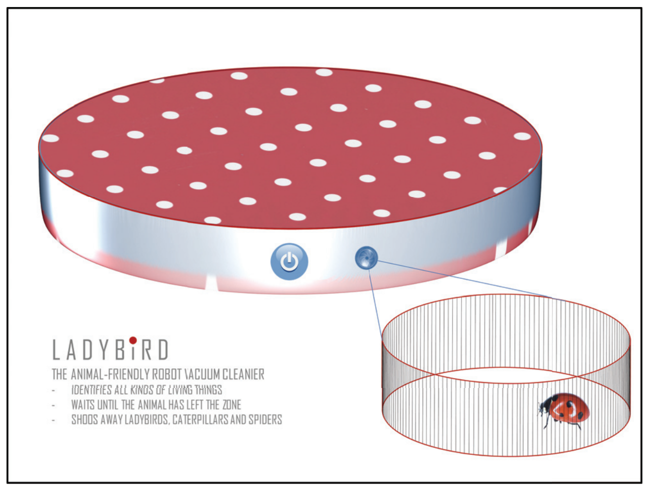

Figure 1: Design study LADYBIRD, according to (Bendel 2014a)

The LADYBIRD Project

Elaborated already in the year 2014, the LADYBIRD design study (Figure 1) roughly informed about the desired look and the planned functions of the device, and was published on the website maschinenethik.net and in (Bendel 2014a). The idea of the animal-friendly robot vacuum cleaner was again mentioned in lectures, publications and interviews. On the one hand, it was well received by listeners and readers, on the other hand, it attracted the attention of the media and the interest of science, because sense and purpose of a simple moral machine were made visible and comprehensible, and the concern of machine ethics was made understandable.

In January 2017, a project on LADYBIRD was advertised at the author's university in Switzerland (School of Business FHNW). Under his supervision, students should select, adapt or develop an appropriate sensor system and improve and implement the annotated decision tree, as it is presented in this article. At the end of the project, LADYBIRD should exist as a prototype and serve as a model for further developments in science and industry.

Technologies and Sensor System

As indicated, robot vacuum cleaners have a whole bunch of technologies and sensors, and there is the tendency that they must be supported less and less by accompanying measures, and can act more and more autonomously. So, barricades and crash barriers are often no longer needed, obstacles of all kinds are detected, and some devices return to their charging stations independently. Ambitious devices scan the room, even the whole apartment, so that each area will be vacuumed, and at the same time they take care that no room is strained too much and recognize the individual degree of pollution. Also a linking with the user's smartphone will be tried out, so he or she can give a command to clean or check the operability while being out of the house. Cameras and ultrasound sensors are more or less standard. In some models infrared LED are incorporated for a better visibility in the dark.

So that the robot vacuum cleaner can recognize a ladybird, sensory and analytical methods are needed. Firstly, the device may try to detect by means of color sensors the red, reddish or yellowish color of the animals. Digital color measurement systems clearly distinguish between red, yellow, green and blue according to the reflection spectrum (Harding 2013). Secondly, the typical pattern, the points on both wings, can be analyzed by a system with pattern recognition. The distances and the size of the points will be measured, if possible. Thirdly, using image recognition, the whole animal or the animal species can be identified. In this area several apps like "Map of Life" or "Project Noah" exist already, and are suitable for mass production.

The above procedures can and should be combined, because also a piece of pizza can be red and have points for whatever reason and should usually just be eliminated if it is not too big. Therefore, the machine should throw – so to speak – a final look at the whole thing. This can be equally important in order to avoid an unnecessary harassing of larger animals such as cats and dogs.

Annotated Decision Trees

In machine ethics different models and methods were developed to implement moral machines (Anderson and Anderson 2011; Pereira and Saptawijaya 2016; Deghani et al. 2011). Currently, decision trees play only a minor role in this context (Azad-Manjiri 2014; Bendel 2016). They are conceivable for the mapping of various procedures.

What is being proposed here are annotated decision trees. The nodes with their ramifications are commented on, so to speak. Both are given: moral justifications as well as reasons pertaining to economic efficiency and operational safety. At each node, several comments can be present, and, in order to keep the overview, the annotations can be numbered. It is important to make considerations, also moral ones, in an explicit way; therefrom, in a certain sense, the moral machine results.

A vacuuming robot's main task is clearly defined: dealing with the vacuuming, the removal of debris and remains on the floor (Bendel 2015). As shown, other activities are interesting, in particular in regard to navigation and control. There are also approaches to employ the robot vacuum cleaner for the monitoring of the living quarters; via smartphone the user can access the integrated camera and align the device in a targeted way. In the following the author is focusing on suction.

The starting point in the modelling (Figure 2) is the activity suction (Bendel 2015). It is checked whether there is something in the path of the vacuuming robot. If this is the case and it is an animal, it is clarified what size it has. Given the size of the suction equipment, a cat is not a problem, a ladybird, however, is. The moral assumptions are crude and simple. They must not be shared by everybody. In fact, this is not even necessary since different devices can be offered. When the customer is purchasing the device the extensions and restrictions, the product information, labels and certificates can be pointed out to her or to him and she or he can be offered to have the machine modified according to her or his needs. So, some people fetch the vacuum cleaner to suck in spiders, isopods, or flies. They would be helped by LADYBIRD since it makes an exception for these animals. However, this contradicts the animal-friendly approach. If it is not a living being, other possible factors are included in the modelling.

As suggested, the annotations in the decision tree were systematized and numbered (Bendel 2015; Bendel 2016). They help the developer and the programmer to justify the options from an ethical and engineering-oriented point of view – as well as from the perspectives of life and science management. Also they can be listed in the operating instructions or in the manual. The modelling showed that a simple moral machine of this type with corresponding sensor combinations and analysis programs is possible without further ado.

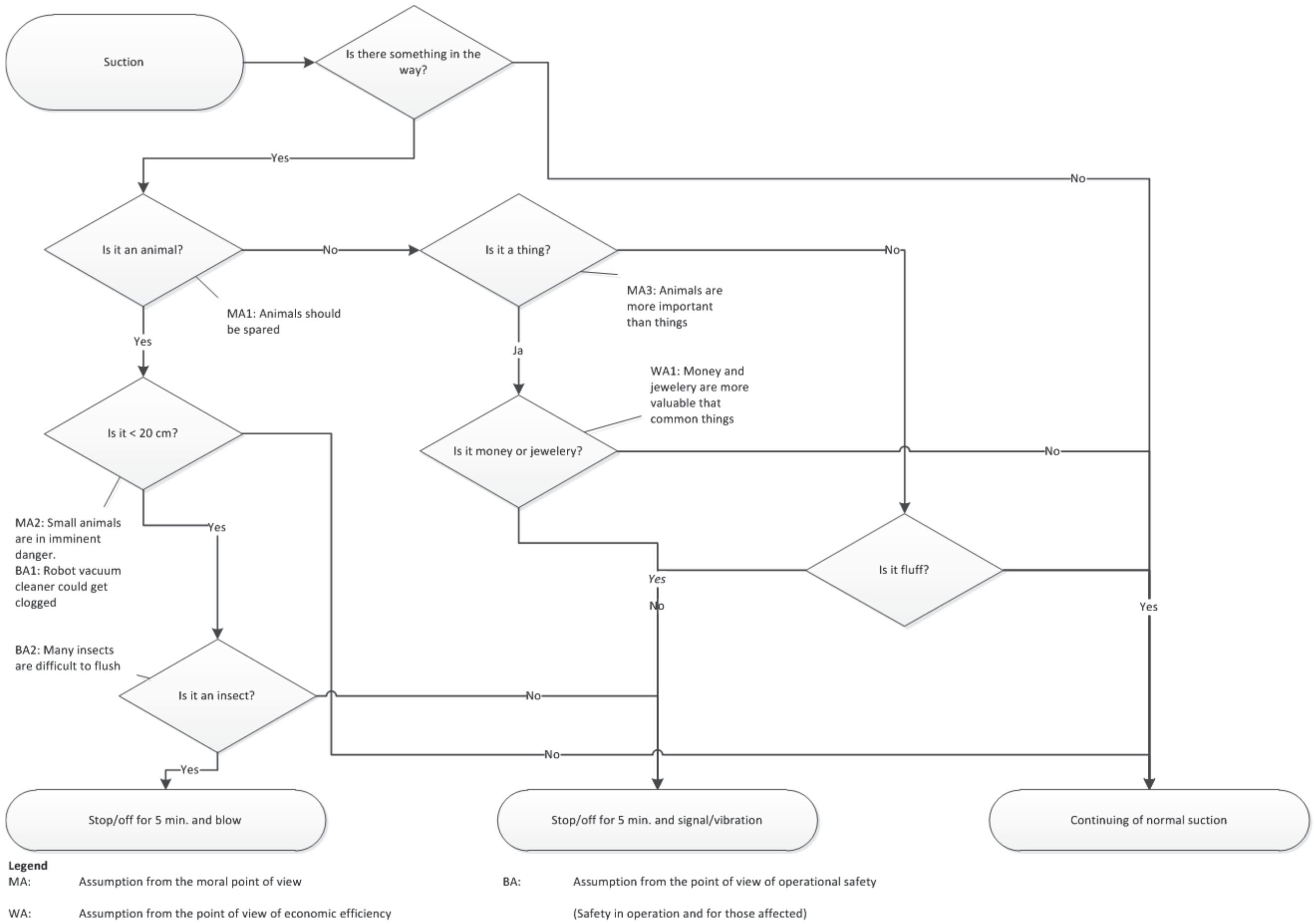

Figure 2: Annotated decision tree for LADYBIRD, according to (Bendel 2015)

Summary and Outlook

Machine ethics is a young discipline which is currently faced with demands that it can solve technically and ethically only with difficulty – just think of self-driving cars and autonomous combat robots. Many other development and application areas are interesting as well. While in the case of a robot car qualification of human beings as well as quantification cause practical and moral problems, such are hardly seen in the case of a robot vacuum cleaner which focuses on animal beings.

In the discussed example, animals were qualified and evaluated with regard to size, appearance, species, etc. In relation to animals, this is much less problematic than in relation to humans, especially when you can protect and save certain species on a rational and ethical basis. This principle can be transferred to different areas, some of which have been addressed already. Advanced driver assistance systems and robot cars can slow down for hedgehogs and toads, if the traffic situation allows (Bendel 2014b), mowers and wind turbines can stop in time. It is also generally possible and sometimes even useful to quantify animals, this has been ignored, however, in the present article. Furthermore, other approaches may be taken into account, e.g., the collection of the ladybugs in an extra reservoir so that the owner would have the option to release them into the nature. An advantage beside the liberation would be that the machine does not have to stop, a disadvantage that the insects could be violated. However, machine ethics can confront the moral choices of semi-autonomous and autonomous machines, which relate to animals of all kinds – and thus acquires a multifaceted and fertile field of application.

Decision trees are suitable for the representation of moral decisions. In this contribution, they were modelled for an autonomous system (and its main task, the suction). No emphasis was placed on completeness. Rather, the aim was to clarify the principle (Bendel 2015). The moral assumptions (that can act as justifications) were made visible in the annotations. Here, it was not essential that they were particularly sound or shared by a wide majority. Instead, it was again a matter of principle. It emerged clearly that in addition to moral arguments other arguments were possible and meaningful, which are related to profit and operation. These too may appear in the annotations.

To conclude, a realization that manifested itself marginally should be pronounced even more explicitly. Again and again it is claimed that moral machines need a global ethics, and therefore their implementations are condemned to fail. This is not the case – in the household and in the garden there are numerous situations in which simply the individual morality of residents and owners counts. The vacuuming robot does what its owner would do too, who has purchased it for precisely this purpose. The market plays, so to speak, exactly like with fair trade and organic products. Also the basic renouncing of responsibility seems not problematic. Machine ethics can look specifically for such situations and will continue to strengthen its foundation, unless it is crushed between exaggerated claims and arrogant attacks.

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