https://doi.org/10.48047/AFJBS.6.14.2024.5998-6023

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

A Comprehensive Survey on Regulating Robot Behavior: From Asimov's Laws to Value-Sensitive Design in Modern Robotics

Lavanya Paruchuri[1], Dr. K. Manigandhan[2], Dr. M. Ravichand[3], M. Sandhyasree[4]

1. Research Scholar, Department of English, School of Liberal Arts and Sciences, Mohan Babu University, Tirupati, AP, and Assistant Professor, Dept. of English, Santhiram Engineering College, Nandyal, Lavanyaparuchuri2207@gmail.com, 8309804964.

2. Associate Professor, Department of English, School of Liberal Arts and Sciences, Mohan Babu University, Tirupati, AP, manigandan.k@mbu.asia.

3. Professor of English, Velagapudi Ramakrishna School of Engineering - Siddhartha Academy of Higher Education; Vijayawada, Andhra Pradesh, ravichandenglish@gmail.com
Orcid Id: 0000-0002-9003-5359.

4. Research Scholar, Department of English, School of Liberal Arts and Sciences, Mohan Babu University, Tirupati, AP, sandhyasreemurari@gmail.com.

Volume 6, Issue 14, Aug 2024

Received: 15 June 2024

Accepted: 25 July 2024

Published: 15 Aug 2024

doi: 10.48047/AFJBS.6.14.2024.5998-6023

Abstract

From the play "RUR" by Karel Čapek in 1920, the idea of robots taking the place of humans has fascinated people. This curiosity is summed up in Isaac Asimov's three rules of robotics, along with worries about the morality and civility of robot behavior toward humans. These regulations give a high priority on human safety and demand adherence from the public, portraying robots as human property and as long as a wealth of material for science fiction stories. On the other hand, up-to-date robotics is less concerned with stopping rogue behavior and more with solving real-world problems like object manipulation and navigation. Despite this, debates in ethics and philosophy highlight the significance of value-sensitive enterprise, which calls for robots to both represent particular values and conform to societal and legal norms. This work reports the difficult challenge of coordinating sensor inputs and actuator outputs with legal and societal standards, and investigates how to train robots to adhere to these norms. Different methods to technology regulation are explored, using self-driving cars as an example to show how design has changed the focus from controlling human conduct to controlling robot behavior. This study explores the philosophical, technological, and normative issues involved in this attempt, emphasizing the need of value-sensitive design and techno regulation in influencing robotic behavior in the future.

Keywords: Robotics, Ethics, Value-sensitive design, Norm compliance, Techno-regulation and Social norms

I. INTRODUCTION

People's fascination with the notion of robots replacing humans is still present. This could be partly explained by the fact that robots have frequently been portrayed as humanoids since their introduction in Karel Čapek's RUR (Rossum's Universal Robots) in 1920. Concerns have been expressed about robots' capacity to behave morally and politely toward humans in light of this humanoid portrayal. The most well-known response to these queries is arguably Isaac Asimov's three rules of robotics, which were initially presented in the novella "Runaround". In line with these laws:

- A robot is not allowed to intentionally damage people or, by remaining still, permit people to suffer injury.
- A robot is required to comply with human commands, unless they are in opposition to the First Law.
- A robot has an obligation to defend itself, provided that doing so does not violate the First or Second Laws.

Asimov's guidelines are persuasive because they distinctly establish humans as the superior race above machines. Robots are not supposed to hurt people; instead, they are supposed to obey human commands and consider their own safety only as a third priority. These laws are perfect in the eyes of Science Fiction (Sci-Fi) writers. They explain the relationship between humans and robots in detail. Additionally, they are easily broken (particularly rule number one), which leads to circumstances that set off rule conflicts, which are a great source material for science fiction stories.

The debate in ethics and philosophy has focused on the morality of robots and the implications of moral laws governing their actions. These issues raise important questions about what it means to be human in the context of developing technology and vice versa.3. The three laws of robotics have shaped ideas of future robo-dense worlds in philosophy and science fiction, and yet hands-on roboticists have mostly ignored them despite their broad influence. In fact, the robotics state of the art is far different from the robots portrayed in books and movies. The C-3POs (and even R2D2), Wall-es, and Datas that we have grown to adore from the big screen are far superior to even the most sophisticated humanoid robots on the market today. Asking problems far more banal than how to stop robots from going rogue and assaulting people is what modern roboticists have to deal with. As an alternative, they struggle to figure out how to navigate through space, move around, avoid obstacles, learn by doing, and hold onto items like eggs without crushing them.

The distance between Asimov's rules and the everyday problems of task description and functional robot design is, however, far smaller than it first appears. In fact, a number of experts in the fields of philosophy, ethics, and technological sociology have emphasized how ethically significant design decisions. Six One way to distribute roles and responsibilities among social actors regarding who is authorized to remedy a problem is to decide not to provide users access to a machine's control panel. Technology is never neutral; in the process of mutually constructing the "moral landscape" of society, it elevates certain ideals and denigrates others. If "value-sensitive" design is possible, then engineers' decisions while creating robots must take normative and ethical considerations into account regarding the kinds of values that will be ingrained in them.

If we take into account that robots operate in highly regulated normative situations, the difference between them and norms becomes increasingly smaller. Robots will therefore need to respect and conform to the current normative environment in addition to creating a moral landscape by exhibiting, enacting, and supporting certain values while demeaning others. Robots that work with people must abide by social and legal conventions. Robots used in public areas, such pavements and roadways, ought to abide by traffic laws and not just cross the street whenever it's convenient for them. Companion robots ought to adhere to the socially acceptable standard that it is improper for them to just barge in and start a conversation at a higher degree of sophistication. Social and legal norms are an integral part of human life, thus it seems to reason that robots should also adhere to a minimal set of these standards. Even while these guidelines are far more commonplace and tangible than Asimov's moral imperative, they nonetheless offer a normative framework that the robot must recognize as relevant in a given circumstance in order to comply.

These rules will need to be built into the system because present robots are not very good at learning new things. Typically, adhering to norms necessitates connecting specific (intended) actions to comparatively vague standards. For example, criminal rules that penalize stealing typically involve abstract concepts, such "any good," rather than specific items that can be stolen. Concrete acts that fall under the purview of the stealing clause, such as stuffing a bag of candy into one's pocket and walking out of the candy store without paying, must be defined as instances of appropriating a good without the owner's permission. These rather abstract legal and social standards are generally well-understood by humans; disagreements over the interpretation of norms and the legal qualification of facts are the exception rather than the rule. Contrarily, computers struggle to comply with legal requirements even though they currently spend most of their time processing data and information rather than doing mathematical calculations. Compared to areas like image processing and search, artificial intelligence, which has been around for around 50 years, has made relatively little development. There are legal expert systems that use codified legal knowledge in cases, but they are typically restricted to narrow, well-defined domains and designed to address particular tasks within them. In the case of robots, sensor input and actuator output must be mapped onto legal and social knowledge in order for them to generate norm-compliant behavior, which increases the already difficult task of coping with symbolic information under the garb of rules and "facts."

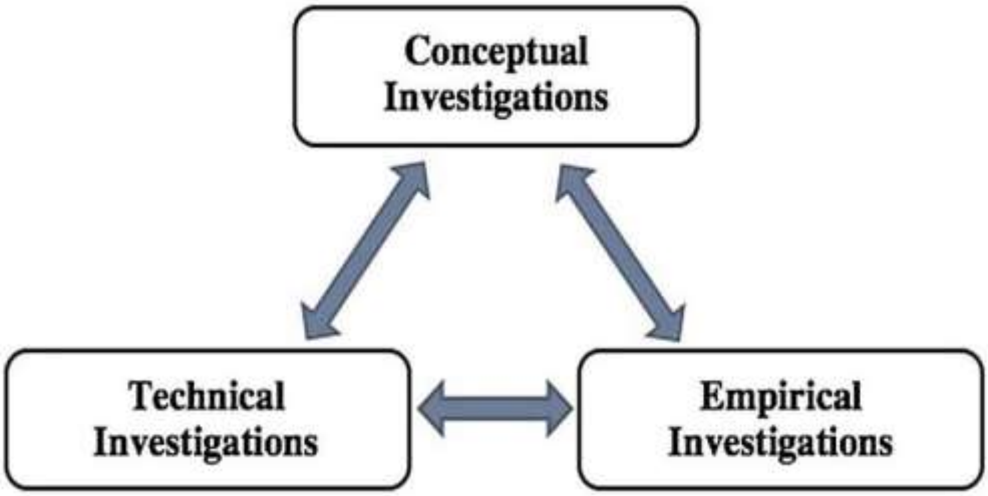

Figure 1: Aspects of the proposed study

The dilemma of how to program robots to behave in a way that complies with specific legal and social norms emerges. This question is investigated in the current paper. In section II, we will first discuss the many forms of regulation that can be applied to technology and introduce four of them. Subsequently, in Section IV, we will explain the four forms of robot regulation using the example of self-driving automobiles (Section III). By doing this, we will highlight how crucial it is to shift the focus from regulating human behavior to regulating robot behavior through design (technoregulation and value-sensitive design) (section V). A variety of conceptual, technical, and normative challenges pertaining to the endeavor to control robot behavior through design are covered in Section VI then VII I the discussion section followed by conclusion section VIII.

II. REGULATING ROBOTS

In his latest research on the "laws of robots," Ugo Pagallo13 notes that when academics tackle the subject of the laws of robotics, they typically either (1) examine how robots impact legal concepts and principles, as in the case of the concept of "legal personhood"; (2) examine how they generate new principles and concepts, as in the case of liability for transactions carried out by autonomous agents; or (3) deny their specificity and reframe the problems posed by robots as issues that can be resolved within the confines of the existing framework.

Similarly, Bibi Van den Berg notes that most legal and robotics academics focus on issues related to the regulation of robotics, elaborating on the difference made by Roger Brownsword and Karen Yeung between regulation of and through technology. Their main concerns are whether or not robots create legal issues and whether or not these issues can be resolved within the current legal system. These legal assessments typically tackle issues related to liability, robots' legal standing, and their rights. Van den Berg claims that the way robots is used to control human behavior is something that is generally ignored. She contends that technology will increasingly be used to control human behavior and that more research should be done on the effects of this covert kind of control.

It's not a novel concept that technology can control how people behave. More than thirty years ago, Langdon Winner made this point in a ground-breaking work. Winner made the well-known claim that the low height of the fly-overs on Long Island was purposefully designed to impede public busses from traveling under them. This had the strong normative connotation of deterring or outright prohibiting low-income individuals from accessing the beaches on Long Island. However, Lawrence Lessig's theory of "code as law," which holds that the purposeful use of technical artifacts' code (architecture or design) to impose legal norms, popularized the notion of technology regulation among legal scholars. "Techno-regulation" is another term for this idea of technology regulating itself. Such regulations include those imposed by speed ramps, which force drivers to obey speed limits by threatening to destroy their vehicle if they attempt to break the law, and technological ones like "region codes" that are installed in DVD players to divide markets and control what content is available for viewing on the format. Van den Berg makes the case for expanding the field of law and robotics studies by taking a critical look at the ways in which robot design and functionality might influence human behavior.

There is another facet of robot regulation that may be mentioned if the distinction between regulating robots and regulating through robots is useful in highlighting how robots can be both the regulated entity and the regulating method. Regulation specialists have traditionally concentrated on the use of law to regulate human behavior. Humans are still susceptible to regulation in Lawrence Lessig's perspective, despite the fact that he broadens the definition of regulation to include architecture (code). Nevertheless, when robots enter the picture, human and robot behavior are (or may be) subject to regulations. This implies that laws and codes can control not only human behavior but also that of robots. Given that humans and robots coexist in a systematic manner, the following types can be distinguished:

- Using legislation to control robot design and manufacture.
- Controlling user behavior by means of the robot's design.
- Controlling robot behavior by means of legislation.
- Controlling the actions of robots using code.

Whereas in 1 the human producers, designers, and users (e.g., through ISO standards) and liability rules are the regulatees, in 3 we speak of (the legal consequences of) robot behavior that is regulated, or rather legally formed. For example, legislation must specify whether robots are capable of entering into contracts. While 2 deals with controlling human behavior through the creation of robots that forbid illegal activity (by humans), 4 deals with controlling robot behavior through the incorporation of code that restricts the robot to only doing specific (legal) tasks. Prior to delving more into these four categories of robo-regulation, allow us to present an example of a particular kind of robot that falls into each of the following four categories: automated automobiles.

III. REGULATING ROBOTS: THE EXAMPLE OF SELF-DRIVING CARS

Globally, automakers and academic institutions are testing automobiles with varying levels of autonomy, including high, partial, and total automation. Google has previously driven fully autonomous cars thousands of kilometers on public roads. There is a noticeable public investment in automated vehicles. The European Union has made significant investments in automated systems with the expectation that they will tackle a number of issues that the Directorate General of Transport and Mobility has identified as strategic objectives. Automated cars have the potential to improve traffic safety by lowering the number of accidents caused by human error, such as distracted or inattentive drivers. By optimizing driving techniques, they should help lower fuel use and ease traffic congestion.Indeed, the European Commission has made accessibility to transportation, road safety, and sustainable energy usage top goals.

Positive results from scientific study on automatic autos are also anticipated by the US Defense Advanced study Projects Agency (DARPA). To encourage it, DARPA held two "Grand Challenge" competitions in 2004 and 2005, where academic research groups were tasked with creating automated cars that could compete on a desert course.The Urban Challenge is a new tournament that was introduced in 2007."Capable of driving in traffic, performing complex manoeuvres such as merging, passing, parking, and negotiating intersections" was the need for autonomous vehicles in this instance.The 50 manned and unmanned vehicles that were added to the circuit to boost traffic congestion interacted with the 11 vehicles that made it through the National Qualification Event throughout their 97 km of driving through an urban setting.

Automated cars are capable of executing the three primary tasks for which they are intended: perception, planning, and control, as demonstrated by DARPA challenges and other trials conducted in experimental sites that range in complexity. According to Sebastian Thrun, a Google employee and former Stanford artificial intelligence researcher who led the team that created Stanley, the winning robot in the 2005 DARPA Grand Challenge.

The challenge of translating sensor input into internal thoughts and environmental predictions is addressed by perception. Making snap decisions is a problem that planning tackles. The steering wheel, throttle, brake, and other vehicle controls are then activated via control.

The path to public roadways remains lengthy despite the rapid development of these functionalities in software design; nevertheless, governments are acting to expedite improvements by permitting testing on public roads and considering modifications to traffic laws. The automated vehicle market is now dealing with a number of issues. In addition to technical challenges (particularly those related to sensing and reliable control) and traffic management challenges (pertaining to vehicle-to-vehicle and vehicle-to-infrastructure communication, platooning, and lane-specific controls), the Dutch Automated Vehicle Initiative (DAVI), which is creating tools to study automated driving on public roads (in real environments), has highlighted the need to address legal and human factors challenges.

The DAVI team defines "human factors" as the responses of human users to automated driving and the expected driving behavior.The authors stress the importance of obtaining actual data regarding how driving automation alters the driver's role—the driver will no longer be the vehicle's manual controller.There are three different categories of legal difficulties.The first is related to the kind of approval that automated cars need in order to be sold in European markets and operate on European roads; the second is the legalization of the driver-vehicle shared driving responsibility; and the third is the need to reevaluate the current laws regarding liability for material and immaterial damage in the event of partial or high automation.

Similarly, the UK's Royal Academy of Engineering comes to the following conclusion in a paper on the social, ethical, and legal challenges surrounding autonomous systems:

> To prevent a technology that could have major benefits from being delayed, the government should think through regulatory policy early on so that these systems can be implemented. It is necessary to contemplate modifying the legal structures that determine accountability for vehicular mishaps. A driver also relinquishes some responsibility when they allow their car's navigation or driving systems, or a centralized system that regulates the speed and spacing between vehicles, to take over. If there was an accident, where would that responsibility lie? How will the technology be verified, and by whom will it be regulated? Will insurance providers take the chance?

The many issues raised by these reports fit into the several categories that were presented in the preceding section and will be discussed in more detail below. As we'll see, these regulatory challenges actually call for responses like legal guidelines governing the manufacture of self-driving cars (approval types), behavioral guidelines for users (shared responsibility), and legal guidelines governing the consequences of robot behavior (liability for damage). Here, something that seems to be lacking—and this relates to our fourth category—is an admission that robots ought to abide by current laws, like traffic laws. A crucial aspect surfaced in the DARPA Urban Challenge in 2007.

That time, the Stanford team's car, "Junior," was the first to cross the finish line. Carnegie Mellon's entry, "Boss," came in one minute later. DARPA emphasizes that the competition's objectives went beyond simply giving out a speed award, though, and included determining if the vehicles could adhere to California's traffic laws. Following an analysis of each team's violations of the California Driver Handbook by DARPA officials, "Boss" was given the $2 million top prize.35 In section 4.4, this fourth category of regulations will be covered in more detail.

IV. TYPES OF ROBO-REGULATION

4.1 Regulating the Design and Production of Robots through Law

In order to ensure that robots do not pose a risk to users, regulations and safety standards governing their design are enforced. Robotics construction is governed by norms and rules in the manufacturing context. Since industrial robots are categorized as "machinery," they are governed by machinery regulations, such as the European Machinery Directive 2006/42/EC. This directive's goal is to give workers in industrial settings a safe and healthy working environment. These settings have a fair amount of organization. For example, machines may have cages surrounding them and be attached to the floor, which would limit their mobility. In such controlled conditions, machine-induced risks can be handled rather easily.

These settings have a fair amount of organization. For example, machines may have cages surrounding them and be attached to the floor, which would limit their mobility. In such controlled conditions, machine-induced risks can be handled rather easily. Industrial robot behavior toward human coworkers and other individuals needs to be controlled, and it can be. Both passive measures, like fences and emergency stop buttons, and active ones, like sensors that alert the robot when people are near moving parts and cause it to stop or at least not move dangerously in the direction of people, can be used to accomplish this. Guidelines for designing and implementing robots that comply with health and safety regulations are provided by the Machinery Directive and ISO standards, particularly ISO 10218 on industrial robots.

However, the robots industry is evolving quickly. A range of (personal) service robots (non-industrial robots) are being added to the army of industrial robots that already exists. They include everything from basic cleaning robots like the Roomba to care and companion robots to help and keep the elderly company. The development of functions and the operating surroundings of service robots have resulted in complex and altered safety requirements. Health and safety regulations will need to take into account the fact that the surroundings in which service robots work are significantly less structured than those in which industrial robots operate. Service robots are designed to be close to, if not directly touch, human beings. They also need to be able to deal with human movement and unforeseen situations rather than not having to "worry" about people because they will (must) maintain a safe distance.36 Although there are a number of specific areas and types of robots covered by regulations at the EU and Member State levels, such as the General Product Safety Directive 2001/95/EC and the Consumer Protection Directive 1999/44/EC, regulation pertaining to non-industrial robots lags behind regulation for industrial robots. For non-medical care robots, an ISO standard (ISO 13482) is being developed.

The fact that user behavior—that is, consumer behavior—influences machine behavior as well as that of the machine further complicates matters. Both robots and human users contribute to risk reduction, and as humans are more adaptable than robots in the face of unforeseen circumstances and environmental shifts, their contribution is probably going to be significant for some time to come. The user must be technically and legally safeguarded against any potentially detrimental consequences of the robot in addition to being aware of the dangers associated with utilizing it in order for them to do their function effectively. Other forms of robot regulation, such as regulating the impacts of robot behavior (section 4.3) and coding embedded in robots (section 4.4), will be necessary to govern and apply these technical and legal protective measures.

Law regulating the design and manufacture of automated vehicles is undoubtedly another topic on the table. The road authorities have to test cars, even for road tests, but most definitely for production vehicles. Here two types of problems surface. Prior to quantifying the safety of these systems, a statistically significant number of on-road automated vehicle tests must be conducted. Right now, this isn't the case. Second, it's unclear how to evaluate automated vehicles for safety under current regulations.

For instance, in light of Article 8 of the Vienna Convention, which mandates that a vehicle must always have a driver in control, how should the safety of autonomous cars be tested? A framework for the licensing of motor vehicles is established by Directive 2007/46/EC, which lists 47 different forms of testing for active safety (such as airbags) and passive safety (for the purpose of preventing accidents). Article 20 permits Member States to give provisional approval for new technologies that are incompatible with one or more regulatory acts; this approval is only effective inside the Member State's borders.In the instance of the DAVI initiative, the RDW (the Dutch type-approval authority) had to come up with an ad hoc method for testing the vehicle, which resulted in the first automated vehicle being driven on a Dutch highway on November 12, 2013, with the Dutch Minister of Transport acting as the "driver." In this instance, a deviation from the traffic and vehicle safety regulations was approved.

4.2 Regulating User Behaviour through the Design of Robots

Individuals' behavior (as robot users) is governed by technology's capabilities and limitations in addition to laws and societal standards. A robot's specific design can restrict what the operator can accomplish with it as well as potential risks. A basic illustration of the latter would be a household (cleaning) robot that, upon being lifted, cuts off all motors, thereby reducing the possibility of the user's fingers becoming entangled in undesirable areas. A wide range of events, such as the degree of freedom a human has to defy the technology's mandated behavior, are examples of how design can elicit behavior. We transition from nearly complete freedom to persuasive technologies via affordances and "nudging," and then to techno-regulation.

Persuasion plays a major role in "captology," as defined by BJ Fogg. ICTs frequently employ persuasive strategies to alter users' attitudes and behaviors. A Speed Monitoring Awareness Radar Trailer (SMART) is an example of suggestive technology, which is defined as "an interactive computing product that suggests a behavior at the most appropriate time." A portable speed detector called SMART can be positioned outside of locations like playgrounds to have drivers stop and consider their present speed and whether it is reasonable given the nearby playing children. Although the user is free to disregard the speed limit, they are unlikely to avoid second-guessing their decision. The lane assist/lane departure feature found in certain cars, including the Volvo V40, is an illustration of persuasion in autonomous vehicles. Under some circumstances, the car can stay in its lane. It can also vibrate the steering wheel to warn the driver when it is about to leave its lane.

Though it is connected to captology, nudging was first proposed by Richard Thaler and Cass Sunstein46 and has a marginally stronger normative meaning. Every technology has an impact on behavior, and as every design involves choices, they are also known as "choice architectures." Designers, according to Thaler and Sunstein, have a "responsibility for organizing the context in which people make decisions." They contend that some decisions are better than others and that better decisions will be made if people are gently prodded in the right direction, whether it be morally, environmentally, or health-wise. They take a "libertarian paternalism" stance. Pre-selecting the "correct" option or putting the desired option at the top of a list are two examples of nudging. Although people are free to act in any way they choose, cognitive psychology and behavioural economics show us that people are biased by their cognitive processes and heuristics rather than being the rational agents that economic theory presumes them to be. By using decision architectures, nudging can take advantage of these behavioral biases. One example of nudging in the context of autonomous vehicles could be to activate the "lane departure warning" setting by default. If turning it off requires action, many individuals are probably not going to do it.

One way to even more effectively hardcode planned behavior is to use the concept of "affordance." Donald Norman popularized this idea, which has its roots in animal psychology, to explain how objects affect people's behavior. When a glass door opens just one way, designers can quickly indicate to users how to open it by installing a plate on one side and a handle on the other. While the technical design permits some tasks, it hinders or makes other acts more difficult. A robot that has no controls would provide the operator the clear indication that they shouldn't tamper with it. And lastly, technological regulation. Techno-regulation is unique in that it deals with standards that are purposefully built into the technology.

The glass door's designer may have chosen the push plate solely because it looked better on the outside, which just so happens to be the side that can be pushed, rather than because it was intended to have an affordable impact. Truck speed limiters are an example of a competent technological regulation. A truck's system may be hardcoded with the current speed restriction to prohibit speeding by the driver. It is crucial to understand that regulation by design encompasses all of the methods mentioned above. It addresses both the inadvertent ways that artifacts influence human behavior as well as deliberate decisions made to control users' behavior. This could result in a complex interaction between technology users' purposeful and inadvertently evoked behavior, where people are both actors and recipients. When discussing the law of robots, it is important to keep in mind that it cannot be understood by looking only at the interactions between people and robots.

Because human-machine interaction is so important, technology regulation ought to address both the interaction's environment and the actors involved in the legal system. Therefore, regulation by design should consider that creating the world through design include shaping environments (space) as well as products. Thus, Pagallo refocuses attention on how social behavior can be influenced and changed by the architecture of the human-robot interaction environment. Similar to this, Van den Berg claims that users' ability to communicate and form an emotional bond with carebots is influenced by design. ‘The main goal is to start a conversation about the values we instill in machines and the potential consequences of doing so for the environments in which they are used.

In automated vehicles, user behavior regulation is essential. The creators of automated cars recognize that operating one of these cars places the human driver in an extremely unique position, changing their function from "manual controller" to "supervisor." This necessitates a change in driving behavior, which is crucial to track and ultimately regulate (or prod) in order to foresee potential outcomes from the driver's inattention or lack of awareness. Human–machine interfaces (HMIs) are a problem that manufacturers and projects have approached in various ways.In certain instances, a haptic feedback-activated display offers information and warning (BMW); in other instances, an LED matrix placed beneath the windshield combines an auditory alert and feedback on the steering wheel (Daimler). The goal of these various designs is to strike a compromise between providing the driver with enough information to keep them informed about the driving process and preventing information overload, which could make driving stressful and unpleasant. But functionality and technical specs vary, which in turn gives the driver varying sensations.

The choice of HMI is crucial because drivers' perceptions and actions in the automobile are influenced by the information accessible to them, including whether they choose to take control of the system or defer to it. Clearly defined regulations could be incorporated into HMI design decisions. For example, HMI interfaces will need to include features that track the user's attention to the road and take action if they are thought to be distracted. This is because Article 8.5 of the Vienna Convention states that "Every driver shall at all times be able to control his vehicle or to guide his animals." The robot user's behavior is governed by this type of techno-regulation.

4.3 Regulating the Behaviour of Robots through Law

The consequences of robot behavior are the subject of the third category of regulations. Here, the legal distinction between actions that are lawful and those that have legal ramifications is significant. A legal act, like a contract or marriage, aims to have a certain legal impact. Without laws that establish the institution of marriage, marriage cannot exist. Comparably, the rules of contracts define what or who is able to enter into agreements as well as the types and outcomes of those agreements. The goal of legal acts is to create a legal state. In other words, they modify the law. Legally significant actions seek to bring about a change in the world, and the law also occurs to link these changes to legal ramifications.

For instance, a tort is typically the result of someone acting inadvertently. People who steal another person's property don't want to be called thieves—that is just the result of the law—they just want to get new things for free. This divide also emerges in the domain of robots and law. The question of whether autonomous agents should have legal personality or, at the very least, if they can join into contracts in another way, has long been debated in relation to legal acts. However, since robots are not considered legal entities, they are not endowed with legal rights or obligations, and thus are unable to carry out legal actions. Legally speaking, robots are seen as tools, and as humans are always legally accountable for the conduct of their creations, it is their duty to ensure that they comply with the law. Regarding actions having legal ramifications, debates center on whether tort law—particularly liability for objects—is capable of handling highly autonomous robots. Robotic actions could have consequences that the law needs to address. When a robot causes harm, the plaintiff will want to be compensated; the question then becomes, what or who is at fault for the harm? Currently, robots are seen like tools, just like hammers and refrigerators, and as such, the owner is typically responsible.

This is not to argue that the current regulation is perfect; for example, it might impose liability on the incorrect party. The development of such robots may be hampered if makers are held accountable for any harm done by properly operating robots that choose to inflict certain harm in order to avert more serious harm (such as crashing into the cupboard to catch a falling baby). Robots operating at higher levels of autonomy could put existing legal domains' underlying presumptions to the test. In certain situations, the law must and will change, just as it did in the past for women, companies, and slaves.

Actors in this space do understand the necessity of readjusting the current liability framework to take automated vehicles' unique characteristics into consideration. Because some or all of the controlling and sensing activities are outsourced to the system in automated vehicles, depending on the level of automation, the driver is not solely responsible for accidents or damage. Therefore, the car's maker is probably liable if something goes wrong. The automated car industry has been said to experience a "chilling effect" that could postpone the release of these systems due to manufacturers' heightened litigation risk and the ensuing costs and reputational harm.

Automated vehicles may introduce additional hazards for harm and/or damage, for instance because of inaccurate sensing or control. But they also make things safer by removing the possibility of mistakes made by people (such being fatigued or distracted, for example). Schellekens contends that the current liability laws need to be revised and harmonized throughout nations in order to foster innovation and enable society to reap the benefits of automated vehicles. In the event of driverless automobiles, traffic liability models that assign blame to the driver after an accident (as in Germany) might not be the best choices. The Swedish model, in which a person's own insurance firm covers their own losses, presents a viable substitute and helps to reduce the quantity of tort responsibility cases. However, in order to control the interests of insurance firms, this model needs to be combined with certain policies.

4.4 Regulating the Behaviour of Robots through Code/Design

Robot behavior can be shaped and controlled by technical and design tools to conform to social and legal norms that are pertinent to the context in which the robot operates. This is the fundamental law of Asimov. As ridiculous and sci-fi as Asimov's laws may seem to those who are knowledgeable about the state of the art in robotics today, they highlight a crucial point for researchers studying robotics and law: for robots to behave appropriately and in a way that is acceptable, they must adhere to certain norms.

Humans live in a society where social and legal standards are everywhere. If robots are to become a part of our daily lives and engage in sophisticated interactions with us, it could be appropriate to require them to adhere to at least a minimal set of these rules. These robots will be more than just tools that their owners can always manage and turn on and off; instead, they will be able to carry out a variety of activities independently, giving them a certain amount of autonomy.The benefits of outsourcing chores to robots are somewhat defeated since, if robots are exempt from the norms that govern our life, people would always need to pay attention anytime an autonomous robot approaches.

Therefore, it might be preferable if robots followed certain rules and acted like law-abiding citizens. For example, it should go without saying that autonomous cars must abide by traffic laws in order to coexist alongside human-driven automobiles. It may be vital for social robots to function silently rather than attracting attention with sirens and lighting. Hospital robot assistants may have to move aside in the center of the corridor to make room for people when they approach. Robotics design will need to incorporate the enforcement of adherence to these social and legal norms, often requiring very technical solutions. The issue here is that robots are supposed to behave in the world, interact with humans, and make decisions that have some bearing on the law as (semi-)autonomous agents. This may not be enough to give them moral agency, but it does present issues with their legal agency. Robots will act with a high degree of autonomy with little to no human intervention, so the question of regulating robot behavior and ensuring that it complies with legal norms is highly relevant—this is without getting into the debate over whether or not we should give robots legal personhood and legal responsibility.

Urban and social robots will need to have the rules ingrained in their "positronic brain," as Asimov put it, in order for them to follow pertinent regulations. In other words, the robot's behavior will need to be controlled by design, primarily through code. If Asimov is talking about laws that are unique to robots and are encoded in their positronic brains, then what we are talking about here is robots that are able to abide by the laws and customs that currently govern humans. For instance, it's understood that autonomous vehicles require awareness of their surroundings in order to comply with local traffic rules and safely interact with other vehicles and pedestrians. Respecting traffic laws is an important issue, but it seems that discussions on the legal issues surrounding automated automobiles barely touch on the subject in passing. Technological designers appear to rely on implicit models of pertinent traffic control, while using precise and explicit models of physics.

This tendency to abstract from a complex model of the target socio-legal context is a prevalent and systemic feature of technology design processes, which emphasize the technological aspects of creating artifacts intended for everyday use.Given the technical difficulties, this makes sense as well. After all, what good is it to figure out how a car should act in city traffic if it can't even stay on the road?Researchers are focusing on a number of functions when designing autonomous vehicles that can navigate urban environments. These include "structured driving" on a road, which calls for the vehicle to "robustly follow the desired lane," "avoid static and dynamic obstacles," and "unstructured driving" in a parking lot, which has less navigational restrictions but still requires the vehicle to perceive other vehicles and obstacles. Other crucial features that autonomous vehicles require to navigate real-world surroundings include distance keeping, merge planning, localization, and intersection handling. The design procedures recognize that these vehicles will be used in complicated geographical and social situations, despite the necessity for abstraction.

Highly autonomous cars are often prepared for life on the road by going through "play books" that include scenarios that the vehicle has to be able to handle correctly. The Google Boss team used a master playbook with 250 of these "driving events" when they took part in the DARPA challenge. These events outline specific scenarios (such as passing a slowly moving car), their prerequisites (such as the vehicle to pass (V1) driving at less than half the test vehicle's speed), and the success criteria (such as figuring out V1's correct speed and passing without stopping). The driving events are a collection of commonplace (stopping at a stop sign appropriately) or difficult (managing a congested crossroads successfully) scenarios. Rather than assessing adherence to traffic laws, their purpose is to evaluate the intricate interactions between the many parts of the system. However, the scenarios do presuppose a functional traffic regulation mechanism. For example, the scenario about passing a slow-moving vehicle assumes that overtaking is done on the left and that a check is made to see if V1 may be overtaken. However, it is not made clear what the underlying (road law) rules are or how the system models/represents them. Therefore, it's unclear if the automobile genuinely functions based on a more abstract representation of the traffic law, or if it is programmed to detect the proper scenario and behave accordingly.

While it helps manage the challenge of developing complex systems like highly automated vehicles, mapping the complex socio-legal environment into a set of scenarios that can be used as a test suite and draft technical requirements also carries the inherent risks of modeling. It is challenging to determine if the situations really depict the desired behavior, and the models could wind up being overly simplistic. The dilemma of whether cases (scenarios) should be utilized as a transitional step to introduce the intended behavior into the system or if the legal rules themselves should be the basis arises in an environment where there are legal regulations. In the section that follows, we will address this issue once more. Regardless, the relationship between automation of cars and traffic flow efficiency is significantly more complex than envisaged in these theoretical considerations and modeling studies, as stated in the DAVI white paper. This demonstrates that the developers are conscious of the drawbacks of the strategy they are using now.

An early stage of technology development, rather than a later one, should take into account the automated vehicle's requirement to respect traffic laws. It is possible to take an incremental approach to development, moving from routine to complex and from regular to uncommon events. However, this may result in path dependencies that are particularly difficult to resolve in the future and may necessitate extensive software re-engineering.

The few laws that make up traffic regulation are primarily focused on encouraging road safety and, to a lesser extent, civilized behavior. The fundamental guidelines, such "stay within speed limits," "pass on the left," "don't block intersections," and so forth, appear to be somewhat simple, but there are a lot of subtle exceptions to the norms that call for situational awareness and sometimes even value judgments. Not only do suitable algorithms and reasoning systems need to be used, but suitable sensors must be incorporated into fully autonomous cars. We'll go over a few instances of the kinds of regulations—as well as their implications—that autonomous cars need to abide by below.

Take Article 16 of the Dutch Road Traffic Signs and Regulations Act 1990 (RVV1990), for instance, which states that "motorized funeral processions and military columns shall not be crossed by road users." This is not a complicated rule for humans. Regardless of whether they are flying the proper flags or not, the majority of people should have no trouble identifying one of these unique convoys when they encounter one (at least in the case of military columns). However, this rule would be difficult to apply to Boss, the autonomous car that took first place in the 2007 DARPA Urban Challenge, as there is "no explicit vehicle classification performed" in the system. The tracking system simply offers data regarding object hypotheses' current stage of movement. It would be impossible for Boss to identify even a single military car, much less an entire military convoy. Even though it might not have been required to finish the Urban Challenge tasks, classifying vehicles would have helped the system behave in a way that was more in line with current traffic regulations. Article 16 RVV 1990 compliance is not insurmountable, but it does involve sensors, software constructs, rules, algorithms, and other considerations when designing systems.

In addition to situational awareness, or the capacity to identify moving objects, people, and obstructions, adhering to traffic regulations also necessitates explicit or implicit understanding of the traffic code. For example, recognizing the different cars as they approach a crossroads is just one part of the situation. Finding out which is more important is another. The vehicle must be able to tell when it is its turn to cross the intersection because priority is established by traffic law.

Article 15 para 1 RVV 1990 states that drivers must give priority to traffic approaching from the right at road junctions. Other articles, such as Article 15 para 2, which states that drivers on paved roads must give priority to drivers on unpaved roads and that all drivers must give priority to tram drivers, specify the general rules that govern priority. Priority-giving at actual intersections needs to be integrated into the vehicle's system and based on traffic laws. This can be achieved by explicitly representing (traffic) rules in some way. A reasoning engine can then use this representation to identify the applicable rules, resolve potential conflicts between rules (see below), and make judgments based on the (hopefully) one remaining rule. It is also possible to implement the rules in other ways that do not need reasoning with rules, including hardcoding them so that any rule conflicts are handled during software design as opposed to being addressed on the fly.

Keeping in mind that different jurisdictions and laws change from time to time, it is imperative that early in the design process that the vehicle system be able to adjust to changing regulations. Cars need to be able to adapt to various rule sets in order to be able to cross borders. The behavioral disparities between countries with left-hand driving laws (such the UK and Japan) and those with right-hand driving laws amply demonstrate the need for some behavioral adaptation. It goes without saying that not all jurisdictions will allow cars to be programmed to behave as intended just by staying on the right side of anything that is identified as a road.

Conflicts between rules are another legal topic. The law is not a consistent, logical set of rules that can be carried out by a machine. In specific situations, the regulations may result in conflicting duties. Take into consideration, for example, Article 82 para. 1, which states that "road users are required to follow instructions given verbally or by means of gestures by: authorised officials who are identifiable as such," and Article 14 RVV 1990, which prohibits drivers from blocking road junctions. A car that reaches a junction and is then ordered to halt by a police officer may run afoul of these two rules.

The car cannot simultaneously abide by both regulations. One of the RVV 1990's conflict resolution rules, which stipulates that signals from authorized officials take precedence over other signals and rules, readily resolves the problem in this instance. However, less obvious duty conflicts could also occur. Different implicit/general (lex specialis derogat legi generali) and explicit conflict resolution rules are used in law to address rule disputes. While humans are often able to handle these rule conflicts somewhat effectively, computers have distinct needs.

Ordinary driving circumstances often necessitate thoughtful consideration and value judgments that are predicated on an interpretation of the intent and meaning of traffic regulations. A motorist "must at all times be able to bring his vehicle to a standstill within the distance that he can see to be clear," according to Article 19 RVV 1990. This clause, which states that drivers must always be able to stop their car without colliding with anything in front of them, obviously attempts to increase road safety. As a result, the clause lists visibility as a requirement that must be considered.

Drivers must to adjust their speed in accordance with the visibility. By doing this, you might be able to override the current speed limit in a certain area and set the maximum speed contingent on other elements, such visibility. It is not recommended for cars to operate at top speed when there is fog. However, there are numerous more circumstances in which a driver should reduce their speed. This rule must be operationalized in a way that allows sensors, actuators, and software to carry out its intended purpose in a highly autonomous vehicle.

Making decisions based on social cues could also be necessary. Managing lines of traffic is an obvious example. Although the guidelines for joining a queue are quite straightforward, in reality. Driving is a social activity in which there are a lot of subtle and not-so-subtle cues. By slightly altering their speed and the distance between them and other vehicles, drivers will show that they are willing to switch lanes. Other times, when the standard rules of the road are broken or must be broken in order for traffic to go smoothly and efficiently, it is important to interpret hand gestures and eye contact. Autonomous vehicles would need to be able to comprehend these gestures in order to blend in with civilization.

Perhaps here is where the fully autonomous vehicle approaches its limits in situations involving both driven and driverless cars. It might be quite challenging to get the fully driverless car to recognize these nuanced social signs. The statement "perhaps it will be sufficient and easier to assume that we humans will adapt to robotic conventions of driving rather than the other way around" made by Urmson et al. may have been influenced by this.85 That might not be desired, though. If the promise of automated vehicles is to be realized, we must be realistic and not assume that humans will simply become obedient to robots or that robots will behave as slaves.The human controller may assist in order to simplify the system when sensors and automation are not the most effective ways to direct robot behavior and rule compliance. This necessitates a comprehensive strategy in which designers envision collaborative human-robot systems in which shared responsibility for rule compliance is established.

V. LEARNING THE ROPES: NORMS AND LAWS THROUGH DESIGN

The aims of this analysis are to: (1) take the concept of the "law of robotics" seriously, demonstrating its practical and relevant aspects that cannot be written off as pure science fiction; (2) provide a methodical approach to addressing robot regulation issues without grouping them together; and (3) emphasize that normative rule compliance is essential to robots' ability to function in complex social environments and does not always require articulate moral reasoning.

The four categories of regulatory difficulties that we have identified are dealt with by the developers of automated cars, as seen in section IV. Key challenges that remain unresolved include observance of safety regulations, human-machine interaction and behavior regulation of drivers, and regulation of the consequences of robots in human transactions, including liability. The fourth category of robot regulation pertains to the technical design that governs a robot's behavior in accordance with many legal standards now in place.Technology developers have previously addressed this problem, albeit to a limited degree. Given the state of the art, it is not difficult to give an automobile the ability to recognize existing infrastructure or speed limits and to respect them. When lateral control systems are involved, as they are when merging, overtaking, and changing lanes, things get more complicated. Robot development frequently encounters challenges because to the growing complexity of human behavior, infrastructures, and social and legal standards in which the machine must function. How does the car know what comes first at a crossroads or roundabout? How can we "design in" the capacity to judge whether it is preferable to deviate from the norm (such as going over the speed limit) in a hazardous circumstance (such as a roadblock when passing)?

Technology developers find it difficult to design robots that adhere to current legal and normative frameworks; instead, they may choose to recreate experimental setups in real-world scenarios and place the onus on human users. In this regard, the DustBot case is instructive. The DustBot project88 featured an experimental phase that involved use in a real-world operational environment in a tiny medieval village in Tuscany. The project's goal was to produce an automated system for urban rubbish collecting. The real-world trial replicated the experimental laboratory setting. The residents of Peccioli were informed of the robot's presence and a priority lane was established for it.If the robot was approaching, they needed to look out and come to a stop.

However, no effort has been made to date to provide the robot the ability to respect the traffic code. Engineers working on proving the "general feasibility, scientific/technical effectiveness and social/legal plausibility and acceptability by end-users" of these robotic services do not address traffic rules, despite the fact that they should be a fixed and stable element of the environment in which the robot will operate. Engineers responded that issue should be handled in a later experimental phase when questioned. Additionally, they envision potential integrated sensor systems that may, for instance, enable the robot to interact with a smart traffic signal to receive instructions to stop when necessary. From an engineering perspective, however, integrating priority rules at a crossroads is more difficult since it necessitates some hierarchical rule reasoning on the part of the device.

In summary, the following issues have been brought up by our four-fold examination. First off, regulating robots involves more than just considering the legal and social norms that currently govern human behavior in the areas where the robots operate. It also entails investigating how the behavior of the robots can conform to these norms.

Second, as we've seen with autonomous cars, the kinds of legal obstacles that robots must overcome in daily life are frequently unanticipated and necessitate a careful examination of the legal system. To prevent having to implement significant design changes later on, it is especially crucial to consider the legal environment early in the development and design process of robots. A closer examination of the current legal provisions in traffic regulation offers researchers and manufacturers a much richer set of requirements that ultimately need to be met and that are frequently disregarded in scenario-based tests and simulations, as we saw in the case of embedding recognition of different kinds of vehicles.

Thirdly, not all legal codes' requirements may be simply converted into technical fixes. Legal requirements must be interpreted in light of their intended uses as well as additional considerations, such case law. As previously said, drivers ought to be permitted to stop their car, according to Dutch RVV 1990 Article 19. The definition of "safety" is vital for the purposes of this rule. Human drivers must define what is safe in a given situation based on their own assessment because they are not provided with a definition. They occasionally make mistakes, and a machine can naturally behave in a more predictable way. But how much better is it? It depends on how safety is interpreted—a concept that is ingrained in the design—in addition to contextual variables. It is necessary to engage in a discourse over varying interpretations of normative norms to ensure that robots exhibit desired behaviors. It goes without saying that certain legal requirements should also not be followed as they have no bearing on the robot. For example, Article 61a RVV 1990 prohibits "holding a mobile phone while driving by a person operating a motor vehicle, moped, motor-assisted bicycle, or disabled person's vehicle equipped with an engine." The standard no longer has an addressee in the event of driverless autos. The "driver" of highly autonomous vehicles is the same as the vehicle itself, even in situations where a human is still deemed to be in control of the vehicle (for emergencies).

Why then shouldn't they be allowed to use their phone as a passenger? Fourthly, when there are conflicts between some rules, the interpretive flexibility of legal norms also shows through. The example of traffic junction behavior regulations demonstrates that, depending on the circumstances, we may be expected to stop for safety or to leave the junction unobstructed. Determining the appropriate behavior in accordance with the rule requires careful consideration of the context. It is challenging to automate this flexibility in rule compliance, just as it is challenging to automate social interactions and unwritten regulations that are ingrained in drivers' behaviors, such as making eye contact with other vehicles at a crosswalk.

Fifth, it's crucial to remember that technology and social and normative practices co-evolve when it comes to controlling robots through code. When governing robot behavior through code, designers should consider not only driving behaviors that are socially and technologically shaped, but also how driving practices themselves are shaped. The robot's design may need to take into account this mutual shaping between the user, who adjusts her practices to the technology, and the technology, which ought to adapt to human behavior. It's crucial to think of the user as a component of the system rather than concentrating on automating behavior and informing the user of this. Therefore, regulation is the distribution of responsibilities within a hybrid system that consists of a robot and a human.

Lastly, it's critical to remember that technologies both influence and are shaped by the existing legal and normative environment. As we covered in the case of laws requiring drivers to pay attention to the road (by prohibiting, for example, using a cell phone while operating a vehicle), autonomous automobiles will require new regulations in addition to those that already exist. In general, communities may need to amend their laws in order to accommodate robotic technologies.

VI. CONCEPTUAL, TECHNICAL AND NORMATIVE ISSUES

The control of robot behavior by design poses a variety of normative, technical, and conceptual challenges. First of all, it is reasonable to wonder if functional design or regulation applies when creating robots that can adhere to legal requirements. After example, an urban robot's capacity to travel a distance and navigate its surroundings is just as crucial to its operation as its ability to stop at a traffic light. What role does regulation play? It is useful to make certain conceptual distinctions in order to answer this question. The "utility value" of technological artifacts is defined as "the value of being useful for a certain end, whether that end is good or bad." The degree to which the artifact accomplishes the intended purpose determines its quality, i.e., whether it is an excellent or subpar hammer. The functional needs of the artefact "are translated into technical specifications which are embodied in a certain physical structure" during the design phase. The desired utility value of the artifact serves as the basis for the functional design criteria. According to Van de Poel, one functional need for a pencil might be that it be comfortable to hold. The pencil's length, thickness, and form are examples of technical criteria that correspond to this functional requirement. The process of converting functional needs into precise technical specifications involves the designer.

Additional design specifications are determined by other variables, such as the preferences of various stakeholders and their unique needs, wants, and interests, rather than the purpose. Larger socio-technical systems in which the artifact is intended to be embedded may also specify additional design needs, commonly referred to as non-functional requirements (the legal system represents part of these socio-technical systems). Moral issues may also be a factor. Technical requirements are influenced by moral ideals such as sustainability, safety, human health, justice, and privacy. These values must be translated because they are frequently too nebulous to be applied directly in the design process. When creating and constructing objects like robots, a variety of requirements must be considered.

Because of their training and experience, engineers are drawn to functional requirements, which appear to be the central focus of the artifact. However, the line separating functional needs from non-functional requirements is not as clear-cut as it initially appears, and it depends on how the requirement is stated. A prime illustration of this is when an urban robot complies with the traffic signal requirement to stop at a red light. If the robot ignores red traffic signals, it might not be able to sustain its structural integrity for very long, hence this criterion could be viewed as functional. However, it is also possible to argue that stopping at a red light is only required by law. It is challenging to categorize the requirement to stop at a red light in this instance because the objectives of both the functional and legal requirements align. However, since the law establishing the red light as a traffic signal may change and call for the robot to perform differently, it should be seen as a legal necessity. It is reasonable to regard legal requirements as a separate category due to their (perhaps) dynamic character. We anticipate that designers will only consider those legal requirements that directly affect how the robot operates in its design, unless the entire collection of criteria is specifically and explicitly addressed. It takes a certain kind of skill to consider all pertinent needs.

Engineering in the field of robots requires knowledge about the specifics of the technology, pertinent legal frameworks, and the socio-technical context in which the robots will be deployed. This is similar to how implementing privacy by design requires a good understanding of the "state-of-the-art research in security and privacy technologies, legal frameworks, and the current privacy and surveillance discourses." We know from our experience with large-scale European projects that considering socio-legal-ethical criteria is not typical practice in sophisticated, cutting-edge engineering projects. This also holds true for how the various needs interact with one another; as noted by Seda Gürses et al., "The interaction between legal and technical requirements remains an under-researched field." Robots must apply the entire set of varied functional, safety, legal, social, and ethical requirements in order to reach their maximum potential.

The concept of embedding laws, whether legal or social, within machine executable code raises a second difficulty. "The idea of encoding legal norms at the start of information processing systems is at odds with the dynamic and fluid nature of many legal norms, which need a breathing space that is typically not something that can be embedded in software," write Bert-Jaap Koops and Ronald Leenes in reference to attempts to inscribe privacy regulations in software.There is a conflict between the rigidity of the code and the freedom and openness to interpret the law, which frequently calls for original thought, as Koops points out elsewhere. Can rules built into machines be flexible enough to be interpreted in response to changing conditions and cover a variety of scenarios? He highlights the challenges associated with applying the purpose specification principle (for data collecting) in software by looking at a case study of

- Determining the norm, which is frequently imprecise and open to interpretation;

- Turning the legal norm into a technological framework; and
- Putting the system into place due to competing stakeholder interests.

Therefore, Koops draws the conclusion that techno-regulation is challenging to apply and therefore to be avoided "if the norm is representationally complex, be it due to openness, fuzziness, contextual complexity or to regulatory turbulence." In the context of processing personal data, Koops addresses the challenges of enforcing regulations in computer code and making the system adhere to the purpose restriction principle. In the scenario he examines, data protection compliance can be attained in other ways, therefore there is no rigid requirement to apply the legislation in code. The systems in question are a component of a broader socio-organizal system known as the "data processing system," which is made up of both machines and people. Even though the IT system may function without human intervention after design (for example, there will be little human involvement in an online store that distributes digital content), humans still determine how the data in the system will be used (which may be implemented in software, but also in operational procedures and manual processes). As a result, humans are involved in the process.When it comes to highly autonomous robots, the system will need to be able to ensure that the rules of ethics and law are followed independently. As a result, unlike in the situations covered by Koops and Leenes, we find ourselves in a Catch-22 situation where we are unable to implement programmed legal compliance and cannot function without it. To the fullest extent possible, this problem needs to be solved before robots may be fully utilized in our daily lives. incorporated in the robot is crucial, especially for fully autonomous and driverless cars.This is due to the possibility of changing underlying legal regulations as well as the possibility of the robot operating in many countries, necessitating the ability to apply the appropriate rules.

The necessity of this type of robot regulation is a third point of contention. The construction of smart environments that purposefully regulate robot behavior and inadvertently elicit human behavior, and the ability of robots to act in a social environment in accordance with various legal and social norms, are closely related in both the automated vehicles case and the DustBot example. By creating smart settings that transmit certain information and extract pertinent data from the actual surroundings, robots' sensing systems can be enhanced. For instance, road infrastructures can transmit vehicles information on the flow of traffic so they can modify their behavior. This brings up fresh moral and legal concerns about the value of such extremely morally constructed surroundings.106 For example, David Smith107 has highlighted the potential for design-based devices to have both a moralizing and a demoralizing effect. Take, for instance, the waist-high ticket gates at London Underground entrances. Though it is a blatant violation of the norm, persons can nevertheless walk through these obstacles without a valid ticket; it is not impossible to do so. Leaping over a barrier serves to dramatize the decision between morality and immorality. Some ticket barriers, like those in Brussels and Paris, use a towering tourniquet to prevent anyone from accessing the Metro without a valid ticket.

According to Smith, a ticket system that eliminates all human choice and is difficult or impossible to get around could have a demoralizing effect and erode self-control. Brownsword goes one step further and contends that in a moral community, individuals follow the standard not merely out of moral obligation (or because the architecture design requires them to do so), but also—and maybe most importantly—because they adhere to the norm: Generally speaking, the completely moral course of action entails an agent acting morally both in terms of their acts and their motivations.A driverless car undermines this moral reflection. The car will always strictly observe the rules. Brownsword fears that this lack of moral reflection and moral choice will ultimately undermine the moral community and the legitimacy of the rules. This concern can also be observed in Koops's account of the acceptability of normative technology: '[T]he reduction of ought or ought not to can or cannot threatens the flexibility and human interpretation of norms that are fundamental elements of law in practice.'109 These concerns are all very valid from the perspective of maintaining a moral community and the rule of law, but again, if we want to achieve full utility of highly autonomous robots and vehicles we will have to shift legal compliance towards these artefacts, which does require programming them to observe legal and social norms.

VII DISCUSSION BASED ON VARIOUS SCENARIOS OVER TRAINING ROBOTS

7.1 Incompleteness and Ambiguity in laws

One of the main issues with first law is its ambiguity, making it challenging to define "come to harm" in the context of digitally coding hardware because there are so many potential outcomes. Whether these possibilities are endless or finite can be argued. Digital computers that use finite automata systems are unable to fully solve them if they are infinite. The second issue is that it will be challenging for a robot to assess what the understanding of consequences is in relation to any given action or decision. This would necessitate considering all of the many ways that effects could arise in the space-time continuum and assessing each one to determine whether to take the proper corrective action.

It is shocking that the laws that established the foundation for machine ethics are also immoral. Since the law views robots as tools, their creation is predicated on the idea that obedience is bestowed onto them by hard-coding, or the coding of patterns that should or could not be altered in the future. Today, people view robots as more than just tools—perhaps even as a distinct species. From a contemporary perspective, Asimov's principles appear to stem from racism, or more precisely, speciesism (S. L. Anderson, 2008), which is the desire for control over one's own species and the fear of rival species. The Frankenstein Complex, which is the dread of man entering God's domain and of not being able to control the creations he or she makes, can be linked to both of these anxieties. Human dread of an AI apocalypse is discussed by McCauley et al. (McCauley, 2007a, 2007b), some of which are proved to be unfounded. Allen et al. (Allen, Varner, & Zinser, 2000) talked about the creation of artificial moral agents as a result.By employing this, current state-of-the-art computational technologies can be used to overcome the issues provided by ethical conflicts. In order to continue the discussion, writers define artificial morality (Allen, Smit, & Wallach, 2005).

This is designed with human morals in mind to ensure compatibility between the two. True artificial moral agents would care about morals in addition to fulfilling commitments, whereas utilitarian morality would require robots to fulfill their obligations while upholding the master's stated minimum moral standards.For instance, if morality holds that lying is never moral, then there would be conflict if lying could guarantee a master's safety. There are currently no formal definitions for this field of study, nor is there any work pertaining to its practical use. Young scholars are encouraged to take on this challenge. Applications for robotics where the use of fatal force by robots is permitted are particularly significant.

Coding the rules of engagement in accordance with different laws of war, such as the Geneva Conventions, is a topic covered by Arkin et al. (Arkin, 2008). One suggested solution to stop the AI apocalypse is to offer human intervention through human-in-the-loop. Before making a choice, certain identification and confirmation procedures must be programmed. Nevatia et al. (Nevatia et al., 2008) show how beneficial it is to have a human in the loop when guiding a group of multiple robots engaged in a search and rescue mission in an uncharted area. In risky situations, an extra degree of safety can be added by adding a confirmation process before firing commands and requesting approval from a human agent (or agents).

Colgate et al. (Colgate, Peshkin, & Kloster-meyer, 2003) explored the application of intent detection utilizing force sensors in a non-lethal setting where people and robots collaborate on a mechanical job. The current state of technology has made only modest progress in these areas because sensor inputs may not always accurately reflect human intent. Mathematically, human aim is a complex function of numerous interconnected variables; it is yet unclear how these variables relate to one another. Developments in emotion recognition by broad physiological (K. H. Kim, Bang, & Kim, 2004) and video (Bassili, 1979), audio (Schuller, Rigoll, & Lang, 2003), and video (Cowie et al., 2001) sensors can assist in this approach.This will be crucial in dangerous situations like combat zones, where moral robots may recognize and identify feelings of rage and irritation before determining whether to follow orders to fire weapons. Due to the massive volume and variety of computational inputs from multi-agent architectures (which include multisensor and decision unit based systems), small-sized, high-performance, low-power computer and battery units are required.

7.2 Work towards defining robot-ethics

The main initiative to offer rules in the field is the EURON (Veruggio & Operto, 2006) robot-ethics roadmap. The structure for defining robot-ethics legislation is based on human-centric thinking and the urgency of the near future. For long-term compatibility, Myers et al. (Myers & Derakshan, 2004) propose forgettable memories because erasing incidents from the memory bank will allow making decisions that are entirely new (from undesirable past incidents) and prevent decisions from similar incidents from being interfered with when it is undesirable (preventing forceful repetition of mistakes). Weld et al. (Weld & Etzioni, 2009) offer software rules, such as granting varying degrees of access to robot(s) for memory location storing regulating programs, in order to prevent an AI doomsday scenario.For instance, the LATEX files that describe guidelines and manuals must be defined using a programming function that would prevent robots from accessing them in the future in order to ensure that they are never erased. It is necessary to clearly specify the scope of the actions, access levels, goals, and reboot alternatives.

According to Anderson et al. (M. Anderson & Anderson, 2007), there are suggestions to create two classifications: Autonomous Ethical Agents (AEA) that function without human guidance or control, and Explanatory Ethical Agents (EEA) that can function without it. It is suggested that AEAs make moral decisions in a similar way to how chess players do, which is by quickly weighing a wide range of potential outcomes to arrive at the right moral conclusion. The use of sophisticated machine learning architectures is currently suggested as a way to develop decision-making machines that take ethics into account and get better over time. These have the potential to improve and even reach perfection over time. It is unknown at this point if they will develop self-awareness while doing this practice.

7.3 Benchmarking performance analysis

Benchmarks are necessary in order to assess how well a robot performs human-like behavior. Six benchmarking criteria were put forth by Kahn et al. (Kahn, Ishig-uro, Friedman, & Kanda, 2006) for the creation and assessment of human-like robot performance. Autonomy, imitation, moral accountability, moral responsibility, privacy, and reciprocity are among them. In human subjects, autonomy is a contentious idea in and of itself. According to Dawkins (1976), "We are robot vehicles blindly programmed to preserve the selfeish molecule known as genes"—survival robots. A further examination of Asimov's rules reveals a tight connection between Dawkins's idea and philosophy of laws; that is, the laws reflect the desire on the part of humans to create robots that resemble humans psychologically as well as physically. Robots that follow Asimov's rules will therefore be just as autonomous as people as their main motivation will be to secure the survival of their masters and themselves. Future research is necessary as benchmarking performance is still in its early stages of investigation.

VIII. CONCLUSION

This article has analyzed and offered a technically and socially plausible interpretation of Asimov's concept of "embedding rules in the positronic brain of robots" in order to discern between various interpretations of "robo-regulation." Beyond science fiction, we've talked about the attempts and failures made to include legal norm compliance into robot design. In this way, addressing the regulatory concerns brought forward by robots also includes techno-regulating their behavior by incorporating certain guidelines into their architecture.

As to Asimov's second law of robotics, "robots are required to comply with any directive provided to them by humans." But we ought to consider if we truly want to command robots all the time. One could think of norms as a component of the environment the robot will work in.

Why are basic legal regulations like those found in traffic codes not regarded as a static component of the model to be implemented in the robot while conducting experiments with them outside of a laboratory? The question's relevance is highlighted in this paper. It is certain that robots will challenge and incorporate values, but they also need to be built with the understanding that existing values must be respected and a set of norms followed. As previously said, implementing legal and social norms in robots presents a number of technical challenges. When we consider the larger ethical issues, this is especially true. According to Mireille Hildebrandt's writing about ambient intelligence:

Legal protection will need to be rearticulated into the digital infrastructures that will soon govern our daily lives, our essential infrastructures, our professional and educational settings, healthcare, defense, and other areas in order to maintain the distance inherent in modern law. The legal protection of privacy, non discrimination, and due process will require that the distance required for hesitation and contestation be incorporated into the developing smart, real-time environments. For the implementation of smart infrastructure to be successful, the distance must be an integral component while maintaining the connection between the law and the digitally native population it seeks to safeguard. As previously mentioned, developing legal protection for the Ambient Intelligent environment (Ambient Law) would call for innovative collaboration between lawyers, attorneys, computer scientists, and the general public.

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