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Autonomous intelligent cars: proof that the EPSRC Principles are future-proof

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ABSTRACT
Principle 2 of the EPSRC's principles of robotics (AISB workshop on Principles of Robotics, 2016) proves to be future proof when applied to the current state of the art of law and technology surrounding autonomous intelligent cars (AICs). Humans, not AICS, are responsible agents. AICs should be designed; operated as far as is practicable to comply with existing laws and fundamental rights and freedoms, including privacy by design. It will show that some legal questions arising from autonomous intelligent driving technology can be answered by the technology itself.

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1. Introduction

It is five years since the publication of the Engineering and Physical Sciences Researching Council's (EPSRC's) principles of robotics developed by a panel of robotics and Autonomous Intelligence (AI) experts at an EPSRC/Arts & Humanities Research Council (AHRC) funded retreat (Principles of robotics, 2017). The principles, which were aimed at "regulating robots in the real world" were stated in the form of five "rules" and seven "high-level messages". The principles have indeed played a serious role in robotics research, and continue to provoke substantial debate (Moore, 2016; Science and Technology Committee, 2016; Winfield, 2016a, 2016b; Winfield). Since presently public concern about the development of robot technologies is heightening we consider useful to revisit the principles to consider their continued relevance according to the following criteria.

Our contributions focus on the second principle: *Humans, not robots, are responsible agents. Robots should be designed; operated as far as is practicable to comply with existing laws and fundamental rights and freedoms, including privacy*. In fact this second principle of the EPSRC's principles of robotics is twofold. On the one hand the principle deals with responsibility – including liability – for the actions of the robot, on the other, the principle entails methods of machine design that can aid with the compliance of existing laws and fundamental rights and freedoms, including privacy.

Since both liability and design form the backbone of the introduction of robotics technology, as for instance incorporated in autonomous intelligent cars (AICs) in our society, we

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will test this twofold principle by focussing on the current development and deployment of AICs. Whether this second EPSRC principle can be considered as future proof, will be tested against the criteria of validity, sufficiency, and generality and utility.

2. State of the art

2.1. State of AICs

Before putting the principle to the test we will shortly introduce the state of the art of AICs. Currently consumer cars are increasingly being equipped with technology that assists in certain aspects of driving. Examples of such technology include lane keep assistance, emergency braking, parking assistance and adaptive cruise control. In the near future, higher levels of car automation will become available, eventually leading to the introduction of fully autonomous vehicles.

Also now some cars are already equipped with certain forms of automation. There are even prototypes available that can drive without a human operator. Google is currently pioneering in self-driving car technology, and has put a fully functioning AIC prototype to road tests in Bay Area, California in early 2015 (O'Brien, 2014). Also in the European Union, car manufacturers concentrate on the development of AIC technology (see for instance CES 2014: BMW shows off 'drifting' self-drive cars – BBC News, 2014; Hachman, 2011; Volvo Car Group's first self-driving Autopilot cars test on public roads around Gothenburg, 2014). Scania is testing "Platooning": a road train of self-driving trucks which were autonomously following a human-controlled truck heading the convoy was deployed on the Dutch roads (see Scania lines up for platooning trials – Scania Group, 2012). Volvo planned to deploy 100 cars which should be able to take over all aspects of driving in Sweden by 2017 (Stoklosa, 2015) and in Germany, a part of the A9 Autobahn between Munich and Berlin is reserved for the extensive testing of autonomous vehicles in the coming years (Edelstein, 2015).

A definition of AICs consists of three elements. *Autonomy* relates to the level of human intervention necessary for operation, which can be seen as a spectrum: a lower need for human intervention implicates a higher level of autonomy. *Intelligence* relates to the ways in which a system can perceive its surroundings, and is able to adapt behaviour to changing environments. It includes the ability to learn, to process complex information and to solve problems.[1] *Cars* are motorised vehicles, used for the transportation of goods and/or people and for carrying out services.

AICs can contribute to finding solutions for challenges our society is currently confronted with. Road safety will increase dramatically when "human error" is taken away as a factor in the causation of accidents. AICs could significantly reduce the risks of car accidents since 93% of traffic accidents are caused by human failure (Walker Smith, 2013), leading to 1.3 million deaths and 50 million serious injuries worldwide per year (OECD, 2013, also cited in Yeomans, 2014, p. 5). Besides contributing to road safety, AICs can lead to more efficient use of the road network, reduce CO_2 emissions and assist in improving the mobility of disabled people.[2] The introduction of AICs could thus provide answers to reduce currently manifest risks that are the result of technological innovation in the past decades.[3]

However, not everyone is optimistic about a driverless future. It is stated that whilst AICs could be beneficial to road safety, other risks will follow from the introduction

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of autonomous vehicles. AICs will be vulnerable to hacking for example. Furthermore, technology might not be flawless, especially in the early stages of development. Also, business models and employment in taxi and transportation markets will change significantly whilst drivers may eventually become obsolete after the autonomisation of driving (see, for example, Le Vine and Polak, 2014, p. 14).

Furthermore, accident risks could increase when autonomous and non-autonomous cars co-exist on the same roads (see Cunningham & Goodwin, 2013).

2.2. State of the law

Sufficient certainty about legal status is essential for growth in and societal acceptance of consumer technology. Uncertainty causes the opposite. Could the machine itself provide answers to the legal questions it arises? Below we will briefly discuss the liability issues currently challenging the introduction and deployment in society of AICs and touch upon possible technology incorporated in AICs to for instance record evidence for liability cases, as solutions for some of these challenges that also might involve privacy by design.

2.2.1. Liability

Current regulation in the EU addressing responsibility and liability for damage that might be caused by AICs pose challenges in terms of innovation in the field of AICs and societal acceptance thereof. On the one hand producers of AICs fear that under the Product Liability Directive (PLD) they can be easily held liable for damage caused by AICs that are defective, which would have a chilling effect on innovation (see Palmerini et al., 2014, p. 60). Whereas on the other hand the current framework on product liability does in fact not provide an easy toolkit for consumers to hold AIC manufacturers liable for defects in their products at all. A rather heavy burden of proof rests at consumers to establish that there was actually a defect in the AIC, as well as on the causal relationship between defect and damage that has occurred. Providing evidence will be more complex when autonomy and intelligence in cars increase, for victims will have to conduct an in-depth (technological) analysis of *inter alia* the (original) software, the updates and the operational data an AIC is equipped with, in order to establish the precise cause of an accident. At the same time, manufacturers have ample opportunity to defend themselves against liability claims. When confronted with AICs, the PLD does not optimally protect the interests of consumers by providing them easy means to get remuneration for damage they suffered caused by defective AICs from manufacturers.

Room for improvement of current legislation is furthermore formed by the different non-harmonised European regimes on liability for motor vehicles. There are to date 28 different frameworks in place in the European Union. For instance French "Loi Badinter"[4] imposes a *strict liability regime* in order to assess whether or not the driver or the custodian of a car is to remunerate damages of victims (other than the driver)[5] of accidents in which motor vehicles are involved. Liability can only be exonerated, if the driver (or custodian) can prove a *faute inexcusable* by the victim (see also Tunc, 1996, p. 335). The Netherlands' "Wegenverkeerswet" appoints (semi-strict) liability to the owner or keeper (note: rather than the driver or a custodian) of a motor vehicle that is involved in an accident where damage occurred to non-motorised road users.[6] At least 50% of the damage suffered needs to be remunerated, unless *force majeure* can be proved.[7] In the UK, negligence rules are applied to establish

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whether a driver of a motor vehicle can be held liable. Although Brexit is upon us, it remains interesting to be looking at this UK example, as we do not know yet what form Brexit will precisely take. In such cases there is no strict liability regime in the UK, although the standard of care required from the drivers of motor vehicles is rather high. Case law explains that a driver losing consciousness through no fault of his own is nevertheless acting negligently (Roberts v. Ramsbottom, 1980, also cited in van Dam, 2006, p. 364, footnote 52), and so is the driver whose brakes fail when this failure could not have been foreseen.[8] However, the victims of accidents caused by motor vehicles have to prove that the drivers were at fault, that is: they had acted negligently.[9] The significant differences in the way liability for motor vehicles is addressed throughout the Member States, is not beneficial for development, insurance and deployment of AICs in Europe. In any case national regimes appointing liability to *drivers* of motor vehicles need to be updated in order to be able to address liability for vehicles without a human driver.

2.2.2. Privacy

Whereas the advent of AICs technology is promising, in terms of increased safety on the roads (resulting in less damage to be covered), insurance companies observe that when an accident happens caused by autonomous technology, it "would need extensive software and hardware analysis expertise in order to know how and why it occurred" (Yeomans, 2014, p. 18). One of the options to assess the cause of an accident, and therefore to assist in answering the question of where liability lies, could be to equip vehicles with black boxes, or with telematics solutions connecting AICs to a dedicated infrastructure, and/or to remote servers (Yeomans, 2014, p.18. See furthermore Anderson et al., 2016, pp. 94–95). The objectives of these types of technologies are, amongst other things, to record the movements of autonomous cars and operational choices that are made by either the car itself or the driver controlling its movement, as well as data concerning events and objects in the vicinity of an autonomous vehicle. Black box technology records and stores the gathered data inside a vehicle and offers a potential for later assessment. Telematics technology may have wider applications. Data could not only be used for assessing errors and the causes of damage after occurrence of accidents, it could even have a preventive effect. Vehicle-to-Vehicle communication (V2V) and Vehicle-to-Infrastructure (V2I) communication could be used for real-time prevention of accidents, and serves "safety, mobility and environmental benefits" in general (Anderson et al., 2016, RAND report, p. 81). Although black box technologies and telematics solutions such as V2V and V2I (hereinafter referred to as "tracing technology") may be promising in terms of preventing accidents and apportioning damage caused by AIC accidents, these also impose risks in terms of the right to (information) privacy of people inside and in the vicinity of cars equipped with these technologies (Figure 1).

Information privacy of citizens is strictly regulated in the European Union by the Data Protection Directive (DPD)[10] and will become even more strictly regulated after the General Data Protection Regulation (GDPR)[11] has come into force. The current and forthcoming framework prescribe for example that already during the design phase of AICs equipped with tracing technology, a privacy impact assessment should be carried out. Furthermore:

> appropriate technical and organizational measures to protect personal data against accidental or unlawful destruction or accidental loss, alteration, unauthorized disclosure or access, in

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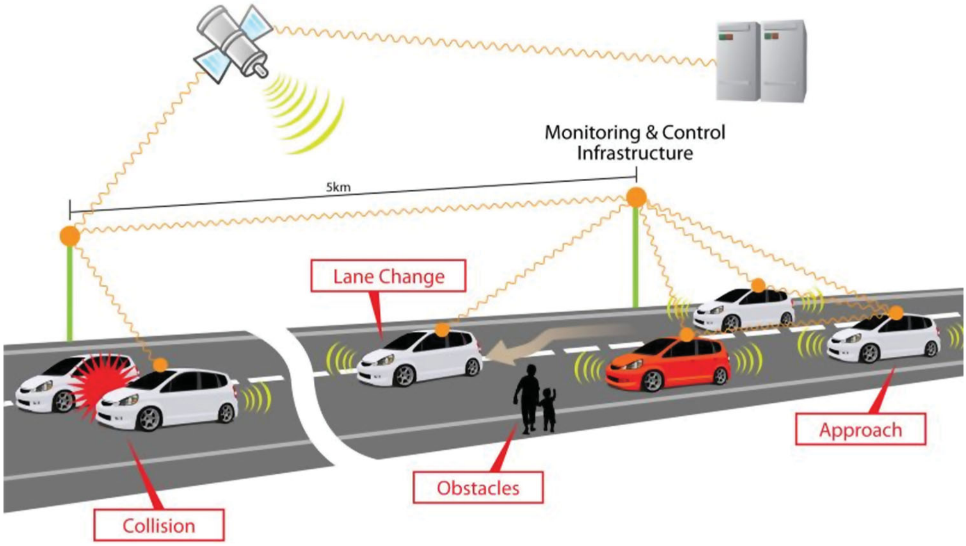

Figure 1. Eric Peters, graphical representation of V2V/V2I communication. Source: Via http://ericpetersautos.com/2014/01/07/car-doesnt-talk/v2v-2/ (Peters, 2014).

> particular where the processing involves the transmission of data over a network, and against all other unlawful forms of processing

must be implemented (European Commission, n.d.b). The GDPR regulates that these measures should be "built in" new technology as much as possible, whilst these measures must *inter alia* aim at data minimisation, and must be enabled by default (European Commission, n.d.c). State of the art security and implementation costs must be taken into account for the implementation of measures. Furthermore, these "shall ensure a level of security appropriate to the risks represented by the processing and the nature of the data to be protected".

Another even more recent challenge is formed by the recent decision of the European Court of Justice to declare invalid the "Safe Harbour Framework", which forms the bases of many exchanges of personal data between the EU and the US. It is likely that tracing technology incorporated in AICs will constitute the international transmission of (personal) data, across the borders of the European Union, and possibly import these data to the United States for instance through cloud computing. The ECJ ruled that the US does not offer an adequate level of protection for personal data, for it became clear after the revelations of Edward Snowden, that US authorities such as the National Security Agency have easy access to personal data processed by US companies and institutions.[12] The court ruled that the powers of the European supervisory authorities are undermined by the US practices, which may not be enabled by a decision of the European Commission. This ruling implies that the export of personal data to the United States is no longer possible on the basis of the safe harbour framework. Although the United States and the European Commission are presently negotiating an alternative treaty,[13] in the meantime exchange of personal data between the EU and the United States is not allowed based on the yet invalid Safe Harbour rules.

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3. Put the principle to the test

In this part we will assess whether the EPSRC principle can be considered as future proof with regard to AICs. It will be tested against the three criteria of validity, sufficiency, and generality and utility:

(1) *Validity* – is the principle correct as statements about the nature of robots, robot developers and the relationship between robots and people, or is it ontologically flawed, inaccurate, out-dated or misleading.
(2) *Sufficiency/generality* – is the principle sufficient and broad enough to cover all of the important issues that might arise in the regulation of the robotics in the real world or are significant concerns overlooked.
(3) *Utility* – is the principle of practical use for robot developers, users or law-makers, in determining strategies for best practice in robotics, or legal standards or frameworks, or are they limited in their use by lack of specificity or through allowing critical exceptions.

3.1. Validity

Both given the current state of technology and of the law the first part of the principle *Humans, not robots, are responsible agents* has indeed proven to be still valid. It is a correct statement about the nature of robots, robot developers and the relationship between robots and people. Robots, currently, are not complex a capable enough to be reasonably attributed with legal responsibility. There can be always either a human being or a legal entity held responsible and liable for the actions of the AICs. The specific creation of a separate legal entity for AICs seems presently far-fetched given the current technological and legal status of AICs, it would furthermore not contribute to solving the liability challenges met as described in Section 2.2. The same is true for the second part of the second principle that states that Robots should be designed; operated as far as is practicable to comply with existing laws and fundamental rights and freedoms, including privacy has proven to be still valid. With an eye to the technology-of-evidence (to be) incorporated within AICs this fundamental idea has proven to be even more true than one might have envisaged upon its design. As we have seen in Section 2.2 in fact the flaws of the current liability regime can partially be solved by smart evidence collecting and saving systems build into the AIC. These evidence collecting and saving systems should be designed in such a way that personal data collected is protected as much as possible: privacy by design and privacy by default must be incorporated in AICs (tracing technology) at all times, as this follows from the new GDPR which is applicable in all EU Member States the same. Besides the requirement to comply with data protection rules, protecting the fundamental right of privacy will likely enhance consumer trust in AIC technology.

3.2. Sufficiency/generality

At the same time the principle remains still sufficient and broad enough to cover all of the important issues that might arise in the regulation of the AICs in the real world. *Humans, not robots, are responsible agents Robots should be designed; operated as far as is practicable to comply with existing laws and fundamental rights and freedoms, including privacy.* No

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significant concerns seem to be overlooked. Although some authors seem to argue that legal entity should be created for autonomous intelligent machines, making the robots the responsible agent (see for instance Boyle, 2011, p. 6. See furthermore Günther et al., 2012, as cited in Leroux et al., 2012; Robolaw, 2014, p. 24), this has not been convincing for many (see for instance Asaro, n.d.; Solum, 1992) and certainly not for us. The challenges posed by the introduction in society of AICs and their liability for damage in itself do not seem to require a separate legal personhood. It would merely add one more actor for the attribution of liability. At the same time it would require the substantial redesign of the liability system as currently applied to the real world, whilst technology is still in its developing stage bearing the risk of under or overregulation.

3.3. *Utility*

As far as the current legal means are nor exhausted, *inter alia* by aiming at further harmonisation of EU legislative liability regimes in combination with effective technology-of-evidence, there is no evidence that would underpin a complete paradigm shift by the introduction of AICs as responsible agents in themselves. The principles underlying the fundamental right of privacy as well as liability rules may remain intact. Since AIC can indeed be designed and operated to comply with existing laws the utility of this principle remains evident. However, black box technologies and telematics solutions such as V2V and V2I may be promising in terms of preventing accidents and apportioning damage caused by AIC accidents, since these also impose risks in terms of the right to (information) privacy of people inside and in the vicinity of cars equipped with these technologies the systems would need to include privacy by design to protect this fundamental rights as laid down in International and European treaties.[14] It is crucial that these requirements of law and technology are met before the challenge of the introduction and deployment of AICs in society can be met.

4. Conclusion

We can diligently conclude that Principle 2 of the EPSRC's principles of robotics as developed by robotics and AI experts at the EPSRC/AHRC funded retreat, has proven to be still valid and (near) future proof when we applied to the current state of the art of law and technology surrounding AICs. Therefore, it would not hinder the development and accepted deployment of AICs in the near future with confidence. Humans, not AICS, are responsible agents. AICs should be designed; operated as far as is practicable to comply with existing laws and fundamental rights and freedoms, including privacy by design. Therefore giving evidence to the fact that the answer of the machine is at least partially in the machine itself, meaning, that the machine can provide some answers to the legal questions it arises.

Notes

1. See De Cock Buning, Belder, and De Bruin (n.d.) working paper at pp. 3–4 and the references to Chopra and White (2011, p. 10) (autonomy) and Davies (2011, pp. 601–619) (intelligence); and De Cock Buning, Belder, and De Bruin (2012).
2. See, for example, Yeomans (2014, p. 5). Also Pawsey and Nath (2013, p. 1). Available on the Internet at < http://www.parliament.uk/briefing-papers/post-pn-443.pdf > (POSTnote 2013); Robolaw (2014, p. 42).

3. Pollution, climate change, societal exclusion of "weaker parties", and high accident risks on the (European) roads can all be seen as the outcome of the modernisation and individualisation processes that took place in the past century. These side effects must now in turn be dealt with. See for the identification and a study on the concept of *risk society* by Beck (1992).
4. Loi "*tendant à l'amélioration de la situation des victimes d'accidents de la circulation et à l'accélération des procédures d'indemnisation*" which translates as the "Improvement of the Situation of the Vicitims of Traffic Accidents and for the Acceleration of Compensation Proceedings Act" (1985).
5. See Tunc (1996, p. 330). Article 3 reads: "Les victimes hormis les conducteurs [. . .] sont indemnisées des dommages résultant des atteintes à leur personne qu'elles ont subis, sans que puisse leur être opposée leur propre faute", which translates as "Victims, other than drivers, shall be compensated for damage [. . .] without being able to oppose them their own fault".
6. Compensation for damage suffered by victims *inside* a motor vehicle is governed by the general rules on liability laid down in Article 6:162 of the Dutch Civil Code (n.d.).
7. Marloes de Vos e.a (1995) and Saïd Hyati e.a. (1997). The notion of "Betriebsgefahr" is borrowed from the German Straβenverkehrsgesetz.
8. Henderson v. HE Jenkins & Sons and Evans (1970), cited in van Dam (2006, p. 364, footnote 53). van Dam further takes note of Worsley v Hollins (1991), in which the judges held that the victim's claim for negligence failed because the defendant could prove that although his braking systems had failed, thereby causing damage, his minibus had recently been serviced and passed its MOT.
9. There is one rule of a statutory duty that – to some degree – establishes strict liability for drivers of motor vehicles approaching a crossing in the road: "The driver of every vehicle approaching a crossing shall, unless he can see that there is no pedestrian crossing, proceed at such speed as to be able, if necessary, to stop before reaching such crossing", as cited in van Dam (2006, p. 365, footnote 57), referring to Reg. 3 of the Pedestrian Crossing Places (Traffic) Regulations (1941), replaced by the Zebra Pedestrian Crossing Regulations (1971), SI 1971, No. 1524. A defence that a driver has in this respect is *force majeure*.
10. European Commission (1995), *Official Journal* L 281, 23/11/1995 P. 0031–0050.
11. European Commission (n.d.a). Please note that the trilogue between European Commission, Council of Europe and European Parliament has concluded on the final text of the GDPR, this text has however not been formally published yet.
12. Case C-362/14, Maximilian Schrems/Facebook (Maximillian Schrems v Data Protection Commissioner, 2015).
13. See for the latest news on the "EU-US Umbrella Agreement" (Agreement between The United States of America and The European Union on the protection of personal information relating to the prevention, investigation, detection, and prosecution of criminal offenses): European Commission Newsroom (2015).
14. See for example art. 7 & 8 of the Charter of Fundamental Rights of the European Union and article 8 of the European Convention on Human Rights (EU Charter of Fundamental Rights, 2000; European Convention on Human Rights, 1950).

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No potential conflict of interest was reported by the authors.

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