
Privacy Norms in the Context of Connected & Self-Driving Cars

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Abstract

The upcoming transition to self-driving cars could lead to a seismic shift in society, one that affects industry practices, regulation landscapes, as well as personal decision-making and social norms around privacy. Major tech companies and traditional auto manufacturers have started working together to conceive an optimal regulatory environment for autonomous vehicles. However, the issue of privacy in the process of collecting, managing, and using data generated from self-driving and connected cars remain one of the biggest challenges yet to be solved. In this position paper, I highlight key privacy challenges and issues in the context of connected and self-driving cars.

Author Keywords

Self-Driving Cars; Autonomous Vehicles; Connected Cars; Privacy; Privacy Norms; Human Computer Interaction.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): User Interfaces; H.5.2.: User Interfaces: User-centered design; K.4.1. Public Policy Issues: Privacy.

Introduction

Self-driving cars may be considered one of the most transformative opportunities through which innovative

technology and services can have a wide and positive impact on society. Reducing the number accidents and traffic congestion [2,18] for example, are clear positive social externalities. Driverless cars can also improve the quality of life for older citizens and members of the disabled community through increased access to independent transportation [2,23]. Without doubt, these innovative changes can positively reshape our communities through the commercialization of self-driving cars. However, the increasing industry practices of collecting, sharing, and monetizing personal data through autonomous / connected vehicles call for an urgent and better understanding of identifying and negotiating privacy norms and risks.

Personal Data in the Age of Self-Driving Cars

To take an educated guess of how people's data will be used in autonomous vehicles, start by looking at connected cars. It is predicted that data and mobility services in connected cars could increase the automobile market by up to 30%, adding a \$1.5 trillion in revenue by 2030 [6]. Industry experts see connectivity as an "important enabler" [17] to self-driving cars and all the services and features that go with them. What allows this connectivity is the vast amount of data collected from both the individuals and the car itself. Some cars began collecting data decades

ago through EDRs (Event Data Recorders) or black boxes to track air bag effectiveness or to help reconstruct the last few seconds before a crash. Today however, vehicles are becoming more creative and sophisticated data-consuming-and-generating machines, providing predictable insights into people's lifestyles and preferences. For example, researchers have explored ways to measure and communicate the driver's stress level to nearby cars and passengers by painting the car's surface with thermochromic paint. This changes the car's color based on the driver's physiological signals [8]. By measuring the driver's palm sweat, forceful grasping of the steering wheel, heart rate variability, voice pitch and volume, researchers are exploring ways for the vehicle to tune its behavior by recommending music channels or by adjusting temperature settings [24]. Collectively, these bio-sensing automobiles aim to predict and create visual maps of stress levels by regions and routes through the collection and monitoring of real-time biometric data on hundreds of drivers in the area. Furthering these transformative developments is certainly exciting. Yet, what needs equal attention from researchers in these contexts, is identifying the nature of tradeoffs taking place at the risk of individual privacy [19]. A key step is to first understand what data is being collected (see Table 1).

Data Type	Description	Scenario of Collection and Use
Real-time driving behavior	<ul style="list-style-type: none"> • Idling habit • Braking pattern • Acceleration habit • Vehicle speed • Seat belt use • Air-condition use • Head-light use 	<p>With greater precision in collecting and monitoring driving behavior, insurance companies are expanding Usage-Based Insurance (UBI) products, such as Pay-As-You-Drive (PAYD) or Pay-How-You-Drive (PHYD) policies [25]. These insurance policies rely on an assessment of the driver's real-time driving behavior to determine appropriate prices.</p>
Location	<ul style="list-style-type: none"> • Real-time geographic location • Distance traveled • Recent/ frequent destinations 	<ul style="list-style-type: none"> • Aggregation of location and distance traveled as well as routes taken, all synced with precise time stamps can be used to build a user profile to predict future destinations, customized through the driver's travel patterns. • Food trucks use telematics technology to send automatic GPS location updates via Twitter and Facebook to their followers. The same technology can be potentially used to reverse the communication by signaling the driver's real-time location updates or past social media check-ins to nearby businesses.
Real-time biometric data	<p>All information pertaining to the driver's physical or biological characteristics that serves to identify the person in the car:</p> <ul style="list-style-type: none"> • Facial recognition [12,26] • Iris authentication [14] • Hand gesture/ gait [5,12] • In-vehicle health metrics using wearable technology [11] <ul style="list-style-type: none"> ○ Blood pressure ○ Blood glucose ○ Heart rate 	<ul style="list-style-type: none"> • Jaguar is developing a face and gait recognition system for drivers to unlock their cars: <p>“Cameras located on the driver's door below the window line would take a static image of the driver's face, as well as a moving image of his or her gait or walking style, or another physical characteristic such as a hand gesture” [5].</p> • Volkswagen's Sport Coupé Concept GTE uses the driver's smartwatch to measure his or her vital functions, such as heart rate, to determine “whether to select a route that includes an exciting country road or a gentle route instead” [1].
Communication	<ul style="list-style-type: none"> • In-coming/ out-going phone calls • Email 	<p>BMW's ConnectedDrive technology uses speech-recognition algorithms to allow drivers to compose text messages and emails by dictating original messages from over a million recognized words in their database [9,15].</p>

Table 1: Types of data that collected by connected cars or vehicles equipped with autonomous technology

"New technology may provide increased convenience or security at the expense of privacy, and many people may find the tradeoff worthwhile. And even if the public does not welcome the diminution of privacy that new technology entails, they may eventually reconcile themselves to this development as inevitable" [26 cited in 17]"

- United States Supreme Court Justice, Samuel Alito from United States vs. Jones

HCI researchers have been collaborating with industries on studies that leverage a vast amount of personal data in the autonomous/ connected car context.

Nonetheless, what has yet to be explored is how these data are being managed and used in the conception of such products and services. Understanding the process of collection, monitoring, storage, as well as the entities with data access are still yet to be undertaken. In the next section, I highlight relevant key challenges.

Why Data Privacy in the Context of Self-Driving Cars is Difficult

Degree of Autonomy and Different Combinations of Technology

Legal scholars have argued that privacy risks may depend on the degree to which self-driving cars are autonomous (how much control the driver has vs. no driver at all)¹ as well as communicative (how much information is on board vs. transmitted to 3rd parties or company servers) [4,7]. The spectrum varies widely across companies, making concerted efforts on privacy regulation difficult. Some consider Google's driverless car, which contains all collected information on-board less privacy invasive [3] compared to cars that transmit data through wireless networks via V2V (Vehicle-to-Vehicle) or V2I (Vehicle-to-Infrastructure) technology. While certain firms strongly favor the vision of driverless vehicles, others are working on enhancing smart-sharing of authority between the car and the driver. This means that different companies use "different combinations of technologies" [28] with

¹ The National Highway Traffic Safety Administration (NHTSA) currently recognizes 5 levels of autonomy, ranging from Level 0 (No-Automation) to Level 4 (Full Self-Driving Automation). See [27] for more detail.

varying visions of how and what kind of autonomous vehicles should be on the road in the near future. As with any other technological systems, the lifecycle and treatment of data for connected/ autonomous cars will depend on the precise technologies used and the organizations that govern them. This makes data privacy more complicated to grasp. Mapping out how and where data flows to whom for what purpose is a critical starting point of understanding the true value and weight of privacy tradeoffs.

Multiple 3rd Party Data Access Across Industries

Another key challenge is the question of who has access to the data. Auto companies have been aggressively forming partnerships with wireless carriers, software firms, and retailers to provide connective features or telematics services² to drivers [22]. For example, General Motors partnered up with AT&T through which people can subscribe their vehicles to 4G data access [21]. The auto-manufacturer is also working with Progressive Insurance, Dunkin Donuts, Audiobooks.com, and Priceline.com, allowing these retailers to reach individuals based on their real-time vehicle location or driving behavior [22]. With multiple third parties using and accessing driver/ passenger data, proper regulation of data ownership and management becomes more complicated. Yet, before laws can work through these complications, companies create norms for what they consider to be "best practice" or industry standards. For example, in their terms of agreement, Nissan claims the customer owns all rights to the data collected. However, by accepting

² Telematics includes services that provide security and entertainment, such as remote road-side assistance and access to infotainment systems through wireless connection.

the agreement, the customer also gives Nissan a “worldwide, royalty-free, fully paid, transferable, assignable, sublicensable...[and] perpetual license to collect, analyze and use any and all data” [20] as well as permission to grant data access to other “service providers” [20]. In other words, while the individual technically owns the data, the company has free license to use it for various purposes and share it with third parties that are not fully listed or revealed to the owner. Furthermore, it is difficult for drivers to opt-out of such services that rely on this data, which also include safety and security features, ultimately locking people into less privacy-friendly default settings.

How Will Social Norms Around Privacy in Autonomous Cars Develop?

What is the New Normal?

It is well known that a variety of factors influence people’s attitudes towards privacy [16]. Autonomous and connected cars are not an exception. For example, people were put off by the concept of usage based auto insurance when it first came out due to privacy concerns [13]. However, with the pervasiveness of smartphone use and rising familiarity with the “quantified self” lifestyle, people are becoming more interested in pay-as-you-drive insurance models that rely on a close monitoring and tracking of one’s personal data [13,25]. Another example is the aggressive marketing effort that emphasizes, above anything else, convenience and low-price: adding one’s connected car to people’s existing data plan for only \$10 per month is just as easy as adding another smartphone device [21]. Understanding the factors that determine what evolves into the new privacy normal will become increasingly critical in the long-run [29].

For example, Sleeper et al. examined people’s attitude towards vehicle-based sensing and recording and discovered that privacy attitudes vary based on the types of space, perceived benefits, and identifiability of activities [19]. In their discussion, the authors bring attention to the “acceptance challenge”[10] of shifting people’s perceptions to vehicles as “potential ubiquitous recording devices” [19]. As such, exploring emerging vehicle technology and its manner of deployment will be critical in understanding how social norms and mental models around privacy may develop in relation to autonomous/ connected vehicles.

Who Will Shape the New Normal?

In the rise of artificial intelligence systems in cars, it is critical to examine how privacy norms will develop and the entities that may shape the evolving discourse of people’s privacy perceptions. In recent years, the landscape of players has been changing with different corporations emerging in the autonomous vehicle industry. Not too long ago after Samsung announced its acquisition of Harmon, Apple also confirmed its development of self-driving vehicle, following Google’s lead. The tech industry’s push into the space of automobiles is certainly exciting, but also understanding how they play a role in influencing privacy norms is essential. Will people’s privacy attitudes around self-driving cars depend on their brand recognition of the tech titan (e.g., Apple vs. Google) they prefer one over the other? What kind of industry norms and practices make negotiating privacy rights more difficult? These are some of the questions that researchers must ask to understand how people’s privacy norms in the context of self-driving and connected cars will be negotiated in the near future.

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