The Ethical Impact of the Internet of Things in Social Relationships

Technological mediation on mutual trust.

By Guiou Kobayashi,
Maria Eunice Quilici-Gonzalez,
Mariana Claudia Broens,
and José Artur Quilici-Gonzalez

©CANSTOCK PHOTO/JACKQ

In emerging consumer devices and systems using new technologies, it is hard to avoid the Internet of Things (IoT). Internet-connected consumer products have been in existence for years, and many home automation and security products are now connected to the Internet. Could these devices pose new ethical challenges in the future in addition to privacy concerns? This article provides an ethical view of the IoT from the perspective of its potential impact on mutual trust in social relationships. We will present concepts, such as affordances and social networks, considering the IoT in the context of the technological evolution of social networks.

First, we describe a hypothetical scenario to establish the context of our proposal: A middle-aged man, on his way home from work, stops at a shop window and looks at an item that attracts his attention. It is the second time this week that the man has looked at the same item in this shop. A high-resolution camera in the shop captures the man's gaze and, using eye tracking and pupil size measurements, identifies the item and the level of his interest in it. The camera also profiles his main physical characteristics, including his appearance and items, such as clothes and accessories. The camera is part

Digital Object Identifier 10.1109/MCE.2016.2556919
Date of publication: 10 August 2016

of a networked IoT sales system contracted by the shop's owner, who pays a fee for the service. This system uses knowledge acquired from millions of IoT sensors and billions of past transactions to send messages to the shop manager and guide the sales process. First, the system asks for a young saleswoman (the system already knows from the shop's registration details that such a person exists) and instructs her to go outside and say to the man: "Hi, this is the second time I noticed you passing through and looking at our shop. Are you interested in this item? Please, come inside the shop, I can show you, and you can look at it more closely." When the man has entered the shop and is examining the item, the system starts the second phase, instructing the saleswoman do say to the man: "Hi, I talked to the manager, and I was able to get a special discount for you. This item will be yours for only…."

If the sale is successful, the system's owner receives a percentage of the value of the transactions as a commission. Regardless of the sale's outcome, the system itself obtains valuable information that reinforces its knowledge database of sales strategies and becomes increasingly efficient.

AFFORDANCES, SOCIAL AFFORDANCES, AND TRUST

The notion of affordance is grounded on the ecological principle of mutuality that governs relations between environment and perception/action. According to Gibson [1], the ecological approach to perception/action is based on the reciprocity between organisms and environment that develops in an evolutionary way. Organisms and the environment coevolve with species adapting to environmental changes, leaving traces in the environment and creating niches. Niches are those aspects of the environment that include information about past and present actions of organisms. In their niches, organisms perceive possibilities of action, or affordances, in a direct and immediate way, according to high-order invariants that indicate what is available to the perceiver. *Affordances*, as defined by Gibson [1], constitute meaningful information specifying unambiguous (nonmediated) opportunities for action. An affordance is "…something that refers to both the environment and the animal…It implies complementarities of the animal and the environment." Affordances are inherently trustworthy, offering action possibilities that do not require subjective deliberation of observers. An example is shown in Figure 1.

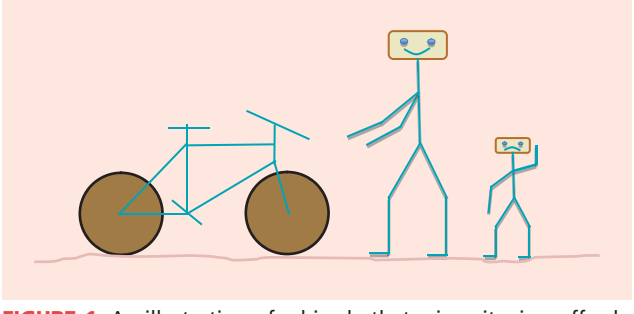

FIGURE 1. An illustration of a bicycle that, given its size, affords cycling to adults but not to children.

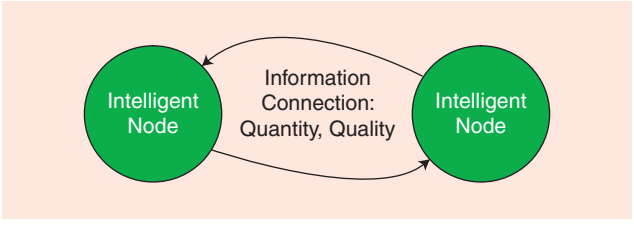

FIGURE 2. The elements of informational networks.

Likewise, *social affordances* allow the perception of the organism's dynamics in activities, such as nurturing, friendship, and response to threats, among others [2]. Basic social actions depend on the direct perception of social affordances involving mutual trust between the members of a group. Mutual trust creates appropriate conditions for the achievement of collaborative social practices and underlies expectations that group members do not engage in aggressive or potentially dangerous actions. The central hypothesis of this article is that mutual trust based on the direct perception of social affordances constitutes an important component of moral and political organizations. It can be strengthened or weakened due to long-term feedback processes that allow adjustment of patterns of action involving direct perception.

SOCIAL NETWORKS

Social networks are a special class of informational networks, characterized by their capacity to process information and to learn by means of intelligent nodes, exchanging information between them. The quality and quantity of connections determine the characteristics of the resulting informational network (Figure 2).

We consider that informational networks are fundamental to understanding human development influencing social structures since the beginning of civilization. In *Wealth of Nations* [7], Smith describes great increases in productivity associated with the division and coordination of labor, which were only possible in the more interconnected urban environment where the concentration of people and resources allowed the existence of informational networks, exchange of information, and learning. This process continues today. Bettencourt [8] presents an analysis of the impact of connectivity in modern informational networks, such as the Internet and *Wikipedia*, and the importance of the cost-benefit tradeoff of connectivity for the success of the network. The decreasing costs of connections and the growth of networks with large numbers of nodes and global reach may influence the future structural development of human society.

In his study of networks, Barabási [9] considered their emergence and evolution. Organisms, ecosystems, societies, and artificial networks (such as the Internet) all share common aspects. The works of Barabási [9] and Bettencourt [8] focus on quantitative aspects of networks. Barabási [9] provides greater graphical and topological structural analyses, whereas Bettencourt [8] is concerned with cost benefits and growth analysis of connectivity. However, neither one addresses qualitative aspects that support connections in social networks, such as mutual trust,

social interactions, and feedback processes. These can be as important as the quantitative aspects. For example, the strengthening of mutual trust leads to stronger social bonds with better sharing of information and improved learning and knowledge; this enables faster development of social groups. On the other hand, if mistrust emerges in the nodes, the creation and learning processes suffer, and all the connections may eventually be broken, disrupting the social group, independent of any accumulated information and knowledge.

We propose the use of social affordances as a way of characterizing interactions between social agents, embodying both quantitative (capacity, performance, and cost benefits) and qualitative (mutual trust and social interactions) characteristics of social connections (Figure 3). This approach simplifies the analysis and discussion of social networks because the many components of a complex issue, such as mutual trust (past history, type of relationship, psychological states, media propaganda, political issues, dominance, and dependence) become incorporated into the single concept of social affordance. In a real social context, mutual trust manifests itself as an embodied, embedded, and self-organized property grounded on social affordances, allowing confident collaborative interactions among humans. However, what might happen in artificial and mediated contexts?

TECHNOLOGICAL EVOLUTION OF SOCIAL NETWORKS

The evolution of transportation and communication technology in the past century has expanded the distance and time limits of social interactions. Traditional technologies, such as roads, mail, and the telephone, created and strengthened social networks formed by family, neighbors, schoolmates, coworkers, and business associates, among others. Newspapers, radio, and television have served to aggregate and create a sense of community, despite the feedback constraints associated with one-way communication. In this first stage of the technological evolution of social connections (Figure 4), social affordances expanded, assisting existing social networks, which was especially evident in the growing urban areas.

More recently, the Internet, mobile communications, and computer systems greatly reduced the cost of social communication and extended social networks by connecting distant people both spatially and temporally (such as college or childhood friends). The Internet popularized the creation of a new type of mediated social network, the cyber virtual network. This mediation of information services facilitates searching and the creation of new connections between people with common experiences, values, and interests. In this second stage of the technological evolution of social connections (Figure 5), the cost continues to fall, and the connections cover the entire planet (anybody, anywhere, and anytime). Global reach means that social affordances are expanded both qualitatively and quantitatively.

The current third stage of technological evolution is introducing a new element to the Internet: physical and virtual machines. Some of these are intelligent devices, whereas others are very simple sensors designed for installation in the physical environment and/or in computer systems. Some, which exist only in the virtual realm of the Internet, are designed to act as humans: the virtual robots [5]. The IoT (Figure 6) connects objects of the physical realm to the Internet without a central controller creating new possibilities for agent-environment interaction in a predominantly self-organized way. Human–machine interaction is starting to acquire a meaningful presence in social networks (Figure 7). From the ecological perspective, the increased connections involving IoT-enabled computer systems seem to be leading to a new scenario with potential changes in social connections.

IoT technologies allow the emergence of a new type of affordance, namely, *technological affordance* (or *technoaffordance*). According to Quilici-Gonzalez et al. [4], technoaffordances are "… functional, second order, emergent properties of a perception and action system." Technoaffordances offer possibilities of action in the context of the human–machine system. They are human affordances expanded by means of machines or the IoT.

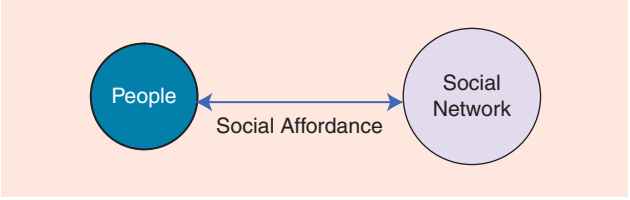

FIGURE 3. Social affordance as a social connection.

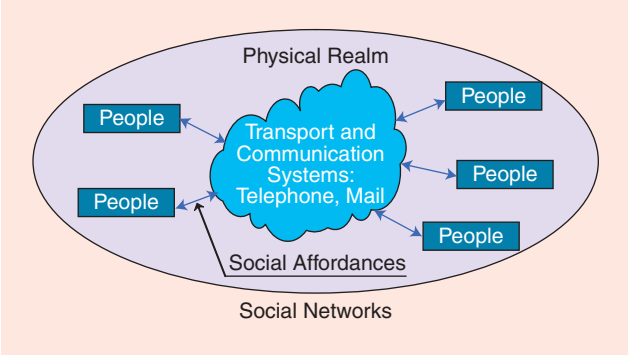

FIGURE 4. The first stage of the technological evolution.

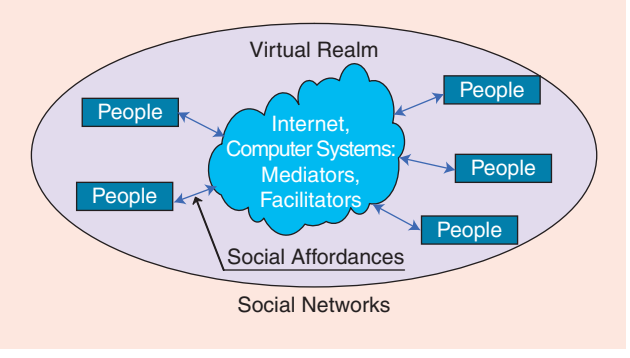

FIGURE 5. The second stage of the technological evolution.

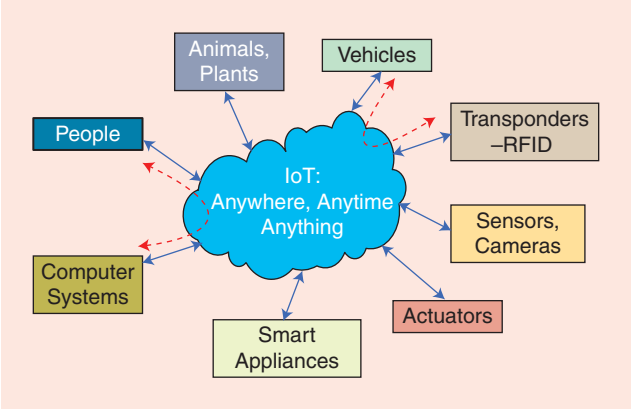

FIGURE 6. The IoT and the connection of machines in the physical world.

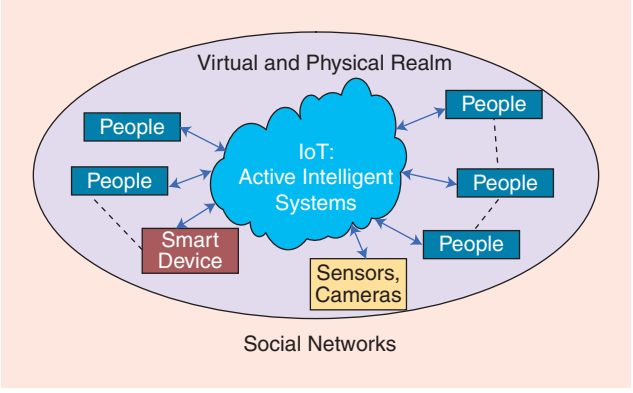

FIGURE 7. The third stage of the technological evolution.

Technologically mediated social networks should not be viewed only in terms of services (such as Facebook or LinkedIn). We believe that the social network paradigm can help in understanding and predicting the evolution of human society with the quantity and quality of (trusted) social network connections governing information exchange and task specialization, leading to innovation and the capacity to create new knowledge. This perspective is supported in the work of Bettencourt [8].

DISCUSSION

In the example given in the introduction of this article, IoT cameras, sensors, and other information systems at the shop provided the primary information required for the system to start the sales process. Using big data and data-mining technologies, the system selected the best sales strategy from its knowledge database after profiling the man's appearance and his behavior. The selected strategy aimed to create and strengthen a social affordance between the man and the saleswoman, and a persuasion system was used to try to conclude the sale of the item. Such persuasion systems are an evolution of the suggestion/recommendation systems already in use in e-commerce, and their action in the real world becomes viable due to the stronger social affordance capacity imparted by the IoT. The price the man finally paid for the item was determined by the system after tracking the man's image at other shops to find the best price he had seen previously.

In the contract agreed with the IoT service provider, the system was allowed to access and control IoT devices in the shop. In this example, the service provider could have contracts with thousands of shops worldwide using the huge influx of data and information to perfect its system. It could undertake experiments in the real world, randomly changing parameters and behaviors using genetic algorithms and creating and maintaining a knowledge system. It is important to note that, in principle, there is no privacy concern in this example because the data captured were not used to identify the individual but instead were used for the purposes of profiling, classification, and grouping. However, there is a clear ethical question: Is it right to build and operate a persuasion system? In synthesis, what might be the positive and negative effects of computer intermediation on social networks? The following possibilities can be considered.

MUTUAL TRUST AND MEDIATED SOCIAL NETWORKS

Mutual trust requires continuous feedback from the members of a community, whether virtual or physically present. The use, for example, of disguisers [5] in social networks with the intention of deceiving people by altering the informational content of messages can seriously affect mutual trust in social networks but not necessarily in a negative way. Disguisers and virtual robots can be used to construct and maintain strong relationships in a social group using algorithms designed specifically to reinforce social affordances by building mutual trust.

IoT mediation creates services that facilitate, expand, and strengthen social networks: search services, services that allow efficient use of time dedicated to social connections, and services that enable the sharing of ideas and experiences. However, searches can embed biases; the sharing of ideas and experiences can be filtered, and virtual entities can interfere in relationships generating misinformation and targeted opinions. Human relationships will be more sensitive to the social affordances and technoaffordances provided by IoT systems and consequently to their improper behavior and failure as well as to the effects intended by the owners of the systems and to the hackers that succeed in invading the system. Cases, such as the experiment described by Kramer et al. [3] in which 689,003 Facebook users had their emoticons modified without their consent are examples of the manipulation of individuals by mediated social interactions.

SYSTEMS WITH A PURPOSE

With the IoT, it will be possible for computer systems to interact with the real physical world, including people, machines, and the environment. Sensors and actuators will provide feedback to the systems built for specific purposes, allowing these systems to measure the impacts that their actions have in the real world. Data from the environmental realm can be merged, compared, and/or checked with data from the virtual realm of the Internet, integrating the physical and virtual worlds. Systems intended for the purposes of persuasion [6] can use the IoT (with disguisers

and virtual robots [5]) for enhanced feedback for the outcomes of actions. The improved data availability and accuracy, coupled with database integration capabilities and data mining, enable fine-tuning of the actions of these systems.

PRIVACY AND ETHICAL ISSUES

The IoT provides a rich capture of personal behavior and social interaction data, which raises other privacy and ethical concerns. In current virtual social networks, it is still possible to construct fake cyber identities, but the use of IoT communication technologies could enable health and physical parameters to be associated with actual physical personal identities.

The rich data and information gathered by IoT systems will produce valuable practical knowledge. The Internet world already has a few big players in an unregulated environment. As we have discussed, social networks can be seen as a source of innovation and knowledge production, potentially generating wealth. Who will own these data and knowledge, and who will use them and for what purpose?

CONCLUSIONS

In this article, we proposed the concept of social affordance to embody quantitative and qualitative aspects (including mutual trust) of social connections, and we highlighted the importance of the social network paradigm as a model for the evolution of human society. We also introduced the possibility that the technological evolution of social connections is shifting our social ecosystem from social affordance to technoaffordance.

Without any advance notice or consent, sophisticated and powerful sensors could collect data about us, even aspects, such as the heartbeat or the reaction of the iris on viewing a showcase or a cake. These data could be used to create new ways of connecting people with automated software generating networks of people who show similar reactions to the same objects. In the same way that our level of tolerance toward a well-established technological device, such as the telephone, has been altered, so also could social relationships of the future be changed by new IoT technologies. Friends might no longer be united by social affordances based on mutual trust but be connected automatically after being selected from a group of people who share common traits of which they may not even be aware.

Finally, one last question: Could an indebted man, many times the victim of an efficient IoT sales system, sue this same system for causing his fate?

ACKNOWLEDGMENTS

We would like to thank the Federal University of ABC, São Paulo State University, the São Paulo Research Foundation, and the National Counsel of Technological and Scientific Development for supporting this research.

ABOUT THE AUTHORS

Guiou Kobayashi (guiou.kobayashi@ufabc.edu.br) earned his B.S., M.S., and Ph.D. degrees in electrical and digital systems engineering from the University of São Paulo, Brazil. He is an associate professor at the Federal University of ABC, Santo André, Brazil. His research interests include ubiquitous computing, the Internet of Things, and fault-tolerant digital systems. He is currently the chair of the IEEE South Brazil Section (2015–2016). He is a Senior Member of the IEEE.

Maria Eunice Quilici-Gonzalez (gonzalez@marilia.unesp.br) earned her B.S. degree in physics and her M.S. degree in logic and philosophy of science. She earned her Ph.D. degree in 1989 at the University of Essex, United Kingdom. She is with São Paulo State University, Brazil. She is a founding member of the Brazilian Society for Cognitive Science; the Research Group on Cognitive Studies at São Paulo State University; and the Centre for Logic, Epistemology, and the History of Science Research Group on Self-Organization at the University of Campinas, Brazil. She is a Latin American representative of the International Complex Systems Society.

Mariana Claudia Broens (mbroens@marilia.unesp.br) is an associate professor of philosophy at São Paulo State University, Brazil. Her research interests include self-organization, common knowledge, embodied embedded cognition, ecological information, and naturalized ethics. She is a member of the Research Group on Cognitive Studies at São Paulo State University; the Research Group on Self-Organization at the University of Campinas, Brazil; the International Society of Ecological Psychology; and the Complex Systems Society.

José Artur Quilici-Gonzalez (jose.gonzalez@ufabc.edu.br) earned his B.S., M.S., and Ph.D. degrees in electrical and microelectronics engineering from the University of São Paulo, Brazil. He is an associate professor at the Federal University of ABC, Santo André, Brazil. His research interests include field-programmable gate arrays, ubiquitous computing, the Internet of Things, and the ethical implications of new technologies.

REFERENCES

[1] J. J. Gibson, *The Ecological Approach to Visual Perception*. Boston: Houghton-Miffin, 1979.

[2] L. Z. McArthur and R. M. Baron, "Toward an ecological theory of social perception," *Psychol. Rev.*, vol. 90, no. 3, pp. 215–238, 1983.

[3] A. D. I. Kramer, J. E. Guillory, and J. T. Hancock, "Experimental evidence of massive-scale emotional contagion through social networks," *Proc. Nat. Acad. Sci. USA*, vol. 111, no. 24, 2014.

[4] J. A. Quilici-Gonzalez, M. A. Broens, M. E. Quilici-Gonzalez, and G. Kobayashi, "Complexity and information technologies: an ethical inquiry into human autonomous action," *Sci. Stud.*, vol. 12, special ed., 2014.

[5] G. Kobayashi, J. A. Quilici-Gonzalez, M. A. Broens, and M. E. Quilici-Gonzalez, "Ubiquity of virtual disguisers and potential impact on ethical behavior," in *Proc. The 4th Int. Conf. Ubi-Media Computing*, São Paulo, Brazil, 2011.

[6] V. Singh, A. Mani, and A. Pentland, "Social persuasion in online and physical networks," *Proc. IEEE*, vol. 102, no. 12, Dec. 2014.

[7] A. Smith, *Wealth of Nations*. New York: Collier, 1902.

[8] L. Bettencourt, "Impact of changing technology on the evolution of complex informational networks," *Proc. IEEE*, vol. 102, no. 12, Dec. 2014.

[9] A. L. Barabási, *Linked–The New Science of Networks*. New York: Perseus, 2002.