

Tutorial Proposal for ICSR2023

Title of Tutorial

Secure Communication Technologies for Social Robotics

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Abstract

With the continuous development of robot technologies, the demand for collaboration among robots has become an important and urgent issue in the robot industry. There are a few wireless communication technologies to support communication among robots, but security concerns may block the development of communications for robots. It is then highly demanded that communication among robots should be securely protected from various cyber-attacks. This tutorial will address the importance of communication among robots, review some wireless communication technologies to support robot communication and disclose some vulnerabilities of wireless communication technologies. Then, we focus on the examples of security solutions for the 5G wireless networks including the support of device-to-device (D2D) communication, group communications, and mobile communications. Finally, some open research issues in robot communications with new challenges will be summarized for future research directions. The tutorial ends with a conclusion.

Objectives and Motivation

With the fast development of social robots, communication among robots has become a very important issue because communication among the robots is fundamental to unlocking the full potential of robots. It moves beyond individual robots to networked robot systems working together in a way no single robot could. Communication will become even more important as robots become more sophisticated, autonomous, and human-like in behavior. Communication among robots is normally supported by wireless communication technologies including wireless local area networks (WLANs), the 4th, or 5th generation wireless cellular networks, and sensor networks. Due to the open and dynamic nature of wireless communication technology, there are a lot of concerns about the security of communication among robots. The vulnerabilities existing in wireless networks should be addressed and the countermeasures against potential cyberattacks need to be investigated with the aim of finding effective and efficient secure solutions to overcome the security weaknesses and protect the smooth communication among robots.

To achieve the above-mentioned objectives, we have the motivation to investigate different potential wireless communication technologies for robot communication and various security

techniques to protect communications among robots. In this tutorial, we will systematically and comprehensively depict the technical details of various wireless technologies and explore key security techniques that are important for securing robot-to-robot and/or human-to-robot communications. We will focus on the introduction of a few state-of-the-art security solutions in 5G wireless networks as examples. Finally, we will highlight the potential open research directions and issues to promote the collaboration of the research activities in the field of secure communications among robots.

Intended Audience

- 1) Researchers in the academy including professors, research staff, and research students.
- 2) Researchers in the industry of robotics.
- 3) Engineers in the industry of robotics applications.

Outline on the Topics

This tutorial will take 2 hours to address the following 5 major topics including 1) the significance of communications among robots, 2) major communication technologies for robot communications, 3) vulnerabilities in different wireless communications, 4) examples of security solutions for robot communication, and 5) open research issues and conclusion.

The outline of the tutorial contents and tentative schedule are as follows.

1. The significance of communications among robots (15 minutes)
 - 1.1 Demand for Coordination
 - 1.2 Adaptability Supports
 - 1.3 Autonomy Requirements
2. Major communication technologies (30 minutes)
 - 2.1 WLAN
 - 2.2 Cellular communication networks
 - 2.3 Sensor networks
3. Vulnerabilities in communications (15 minutes)
 - 3.1 Eavesdropping and/or replay
 - 3.2 Impersonation
 - 3.3 Anomalous behaviors and attacks
4. State-of-the-art solutions (45 minutes)
 - 4.1 Security solution for 5G device-to-device communication
 - 4.2 Security solution for 5G group communication
 - 4.3 Security solution for 5G mobile communication
5. Open research issues and conclusion (15 minutes)
 - 5.1 Open research issues
 - 5.2 Conclusion

Speaker Biography



Professor Maode Ma, a Fellow of *IET*, received his Ph.D. degree from the Department of Computer Science at the Hong Kong University of Science and Technology in 1999. Now, Prof. Ma is a Research Professor in the College of Engineering at Qatar University in Qatar. Before joining Qatar University, he has been a faculty member at Nanyang Technological University in Singapore for over 20 years. Prof. Ma has extensive research interests including network security and wireless networking. He has led 26 research projects funded by the government, industry, military, and universities in various countries. He has supervised 25 research students to get their Ph. D degrees. He has been a conference chair, technical symposium chair, tutorial chair, publication chair, publicity chair, and session chair for over 100 international conferences. He has been a member of the technical program committees for more than 300 international conferences. Prof. Ma has more than 500 international academic publications including over 250 journal papers and about 250 conference papers. He has edited a few technical books and produced over 28 book chapters. His publication has received more than 10,000 citations by Google Scholar. He has delivered over 90 keynote speeches and 11 tutorials at various international conferences. Prof. Ma currently serves as the Editor-in-Chief of the *International Journal of Computer and Communication Engineering* and the *Journal of Communications*. He also serves as a Senior Editor for *IEEE Communications Surveys and Tutorials*, and an Associate Editor for the *International Journal of Wireless Communications and Mobile Computing* and the *International Journal of Communication Systems*. Prof. Ma is a senior member of the *IEEE Communication Society* and a member of *ACM*. He is now the Chair of the *ACM*, Singapore Chapter. He has been a Distinguished Lecturer for the *IEEE Communication Society* in 2013-2016 and 2023-2024.