Cover Letter

February 2, 2016

Dear Committee Members,

I wish to apply for the tenure track Assistant Professor position in the Electrical and Computer Engineering Department at Virginia Commonwealth University. Currently, I am a PhD candidate at University at Buffalo - SUNY in the Department of Computer Science and Engineering under the supervision of Dr. Kui Ren.

During my PhD study, my primary research topic is exploring the novel ideas and techniques to solve practical problems and security issues for mobile sensing and cyber physical systems. In the context of mobile sensing systems, I am interested in smartphone-enabled crowdsourcing approaches that can help build large-scale information infrastructures conveniently at a very low cost. I also study cyber-physical system security from the physical layer, leveraging various related characteristics to enable inherently secure and dependable wireless communications. My research made important contributions in the cyber-physical research community and have been published in several highly selective research venues on sensor and sensor-enable smart systems. As for a research agenda immediately after my PhD, I will focus on two hot topics in the cyber-physical domain: mobile crowdsourcing system and sensor-assisted mobile authentication system. My ultimate goal is to explore untapped challenges brought by emerging technologies and investigate novel ideas and techniques to tackle practical problems for today's and tomorrow's cyber physical systems.

As a graduate student, I was very fortunate to have valuable opportunities to teach and mentor students, and I enjoyed them immensely. As my teaching statement indicates, my teaching roles have included teaching assistant, guest lecturer, and mentor. I feel confident about lecturing courses in areas of cyber physical system, smartphone sensing, cloud computing system, smartphone security, and applied cryptography. I feel excited about the opportunity to mentor great graduate students. My ultimate goal is to foster their diverse talents and strengths and guide them on the way to become self-motivated leading researchers. In doing so, I will bring the highly supportive and collaborative culture in which I have been raised by my graduate school professors.

Enclosed are my curriculum vitae, teaching philosophy, research plans and references list. letters of recommendation are being sent under separate cover, and if desired, I would be happy to provide documents in support of my application. Please do not hesitate to contact me if further information is needed.

Sincerely yours,

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Highlights

- Strong research background in cyber-physical system security, security and privacy on smart wearable device, mobile security, cloud-assisted mobile sensing and wireless system.
- Active involvement in the preparation and development of grant proposals submitted to different government agencies and companies, such as NSF and MSR.
- Experience in teaching and mentoring both undergraduate and graduate students
- Experience in research collaboration in multicultural environments

Research Interests

My research interests include cyber-physical system security, wireless system and smartphone-enabled crowdsourcing system, with current focus on exploring and improving the cloud-assisted mobile sensing security.

Teaching Interests

I feel confident about lecturing courses in areas of computer architecture, cyber-physical system security, advanced computer network, cloud computing security, smartphone security, smartphone sensing, and applied cryptography. I am also interested in contributing to new courses and seminars related to security and privacy on smart wearable device, mobile wireless security and crowdsensing system.

Education

- **University at Buffalo - SUNY, Buffalo, NY, USA**
  Ph.D. Candidate in Computer Science and Engineering, starting from August 2012
  Advised by Professor Kui Ren
- **University at Buffalo - SUNY, Buffalo, NY, USA**
  M.S. in Electrical Engineering, May 2012
  Thesis: "Groundwave Modelling and Online Simulation System for Advanced HF Radio Networking"
  Advised by Professor Tommaso Melodia
- **China Agricultural University, Beijing, China**
  B.S. in Measuring & Control Technology and Instrumentations (School of Engineering), June 2010

Publications

Conference Papers

C-1. **Si Chen**, Muyuan Li, Kui Ren, Xinwen Fu, Chunming Qiao. Rise of the Indoor Crowd: Reconstruction of Building Interior View via Mobile Crowdsourcing. ***The 13th ACM Conference on Embedded Networked Sensor Systems (SenSys'15)****, Seoul, South Korea, November 1-4, 2015,* ***13-page****.*
Acceptance ratio $< 20\%$.

C-2. **Si Chen**, Muyuan Li, Kui Ren, Chunming Qiao. CrowdMap: Accurate Reconstruction of Indoor Floor Plan from Crowdsourced Sensor-Rich Videos. ***The 35th IEEE International Conference on Distributed Computing Systems (ICDCS'15)****, Columbus, Ohio, June 29 - July 2, 2015, pp. 1-10,* ***10-page*** *.*
Acceptance ratio = 70/543 = 12.89%.

C-3. Muyuan Li, Haojin Zhu, Zhaoyu Gao, **Si Chen**, Le Yu, Shangqian Hu, Kui Ren. All your location are belong to us: Breaking mobile social networks for automated user location tracking. ***The 15th ACM international symposium on Mobile ad hoc networking and computing (Mobihoc'14)****, Philadelphia, PA, August 11-14, 2014, pp. 43-52,* ***10-page*** *.*
Acceptance ratio = 40/211 = 18.9%. **Citations > 22.**

C-4. Eric Koski, **Si Chen**, Scott Pudlewski, Tommaso Melodia. Network simulation for advanced HF communications engineering. ***The 12th International Conference on Ionospheric Radio Systems and Techniques (IRST'12)*** *York, UK, May 15-17, 2012, pp. 45,* ***5-page*** *.*

C-5. **Si Chen**, Lina Ling, Yuan Rongchang, Longqing Sun. Classification Model of Seed Cotton Grade Based on Least Square Support Vector Machine Regression Method. ***The 6th IEEE International Conference on Information and Automation for Sustainability (ICIAfS'12)****, Beijing, China, 2012, pp. 198–202,* ***4-page****.*

C-6. Rongchang Yuan, Zhengjiang Li, **Si Chen**. Movement and deformation of virtual object based on argument passing method. ***The IEEE International Conference on Virtual Environments, Human-Computer Interfaces and Measurement Systems (VECIMS'12)****, Tianjin, China, 2012, pp. 103-106,* ***5-page****.*

C-7. Rongchang Yuan, **Si Chen**, Zhengjiang Li, Shengrong Lu, Li Wang, Haigan Yuan. Simulation and Models on Control of Pests with Ozone in Greenhouses Plant. ***The IASTED International Conference on Modeling, Simulation, and Identification (MSI'11)****, Pittsburgh, PA, Nov 7-9, 2011,* ***5-page****.*

C-8. Rongchang Yuan, HaiganYuan, **Si Chen**, Longqing Sun, Feng Qin, Han Zhang, Yukun Zhu, Daokun Ma. Research on the k-coverage local wireless network and its communication coordination mechanism design. ***the 5th International Conference on Computer and Computing Technologies in Agriculture (CCTA '11)****, Beijing, China, Oct 29-31, 2011,* ***12-page*** *.*

Journal and Magazine Articles

J-1. Bingsheng Zhang, Qin Zhan, **Si Chen**, Muyuan Li, Kui Ren, Cong Wang, Di Ma. PriWhisper: Enabling Keyless Secure Acoustic Communication for Smartphones. ***IEEE Internet of Things Journal (IoT)****, 2014.* Accepted for publication. Citations > 10.

Conference Posters

P-1. **Si Chen**, Muyuan Li, Zhan Qin, Kui Ren. IndoorCrowd2D: Building Interior View Reconstruction via Mobile Crowdsourcing. *The IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), 2015.*

P-2. **Si Chen**, Muyuan Li, Kui Ren. The power of indoor crowd: Indoor 3D maps from the crowd. *the IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), 2014.*

P-3. **Si Chen**, Muyuan Li, Zhan Qin, Bingsheng Zhang, Kui Ren. AcousAuth: An acoustic-based mobile Application for user authentication. *the IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), 2014.*

P-4. Muyuan Li, **Si Chen**, Kui Ren. Enabling private and non-intrusive smartphone calls with LipTalk. *the IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), 2014.*

Papers Under Submission

U-1. **Si Chen**, Sixu Piao, Cong Wang, Qian Wang, Kui Ren. You Can Hear But You Cannot Steal: Defending against Voice Impersonation Attacks on Smartphones. ***The 14th ACM International Conference on Mobile Systems, Applications, and Services (MobiSys'16)****, Singapore.*

U-2. **Si Chen**, Kui Ren, Xinwen Fu, Chunming Qiao. IndoorCrowd2D: Building Interior View Reconstruction via Mobile Crowdsourcing. ***IEEE Trans. on Parallel and Distributed Systems (TPDS)****, 2016.*

U-3. **Si Chen**, Kui Ren, Su Lu, Chunming Qiao. The power of indoor crowd: Accurate Reconstruction of Indoor Floor Plan from Crowdsourced Sensor-Rich Videos. ***IEEE Trans. on Mobile Computing (TMC)****, 2016.*

Research Experiences

- **Ubiquitous Security and Privacy Research Laboratory.** Jan. 2013 - Present
  Research Assistant
  - **AcousAuth.**
    This project aims at developing a **highly secure alternative NFC system** based on friendly jamming technique for acoustic short-range communication.
    - Proposed an alternative NFC technique which provides NFC-like functionalities commercial smartphone applications, and enables much stronger security guarantees but requires less strict hardware support.
    - Designed a smartphone empowered system for personal authentication featuring a seamless, faster, easier and safer authentication process without the need of special infrastructure.
    - Shortlisted in the 19th Annual International Conference on Mobile Computing and Networking (ACM Mobicom'13) App Competition **(Top 10)**.
  - **FreeTrack: Tracking Mobile Social Network Users.**
    This project serves as a **critical security reminder** of the current LBSNs pertaining to a vast number of users.
    - Identified severe location privacy leaks from popular location based social networks (e.g. Momo, Skout and Wechat) that allows non-priviledged attacker to effectively pinpoint users' locations and even performed long-term tracking to reveal identity.
    - Developed an automated user location tracking system and tested it on the these LBSNs.
    - Demonstrated its effectiveness and efficiency via a 3 week real-world experiment with 30 volunteers.
    - The evaluation results showed that this system can geo-locate a target with high accuracy and can readily recover users' Top 5 locations.
    - Proposed using grid reference system and location classification to mitigate the attacks.

- **IndoorCrowd**
  This project is **the first to propose, design and implement** a smartphone-based crowdsourcing system that explores the power of untrained individuals to generate building interior views at scale. It **breaks away from established approaches** to reconstruct indoor scenes, and explores an advanced architecture based on crowdsourcing and mobile-sensing.
  - Proposed a low-cost crowdsource-based method to reconstruct indoor floor plan that by utilizing sensor-rich video data from mobile users.
  - Innovatively exploited the sequential relationship between consecutive frames to improve system performance.
  - Achieved a significant improvement of accuracy compared with other indoor scene reconstruction systems, according to a long-term real-world experiment on 30 volunteers.
  - Readily deployable in real-world scenarios. It is also expected to extend existing online map services (e.g. Google Map) to the indoor environments at an unprecedented scale, which is currently cost prohibitive.
  - Served as an important stepping stone towards economically-viable massive indoor 3D model reconstruction.
- **Wireless Networks and Embedded Systems Laboratory.** 2011 - May. 2012
  Research Assistant
  - **Ground Wave Simulator.**
    The aim of this project is to **accomplish an online simulation system based on NS-2** open source network simulator to simulate advanced high frequency (HF) network, so as to be useful for analyzing HF radio networks under real-world conditions.
    - Studied models of HF channel characteristics, waveforms, protocols, and typical traffic loads.
    - Designed an online simulation system to calculate the electric field strength and basic path loss in the real-world environment.
    - Implemented an online ground wave simulation system based on NS-2 open source network simulator, GRWAVE and VOACAP Software to simulate advanced high frequency (HF) network.
  - **Relay-Assisted D-OFDM for Cognitive Radio Networks.**
    The aim of this project is to **improve the throughput of the network** by using a relay-assisted D-OFDM algorithm and resource allocation algorithm.
    - Implemented an relay-assisted D-OFDM and resource allocation algorithm to improve the throughput of the network.
    - Implemented TCP/IP protocol into GNU Radio testbed USRP2.
    - Established bridge and framework abstraction for cognitive radio framework.
- **National University Student Innovation Program.** 2009 - May. 2010
  Research Assistant
  - **Intellectualized Greenhouse Measuring & Control System.**
    This project aims at **developing a greenhouse management system** using wireless sensor network.
    - Designed a mathematical model specialized for simulating greenhouse environment.
    - Used CC2430 wireless node and Zigbee stack (Z-stack) to measure and control a greenhouse model's humidity and temperature.
    - Used Python, PHP, Javascript (jQuery), MySQL and C to create a realtime B/S System.
    - Designed a PCB with controllers that can use CC2430 with computer to remote control the greenhouse model.

Teaching Experience

- **Guest Lecturer** for the graduate course CSE 664 *Applied Cryptography and Computer Security*, Spring 2014/2015, CSE 706 *Selected Topics in Privacy and Security*, Fall 2015, *Sensing, Crowdsourcing with Smartphones and Wearable Devices*, Fall 2014, *Security and Privacy in Emerging Applications*, Fall 2013, *Advanced Topics on Privacy Enhancing Technologies*, Fall 2012 and the undergraduate course CSE 241 *Digital Systems*, Spring 2013.
  Gave guest lectures with security related topics ranging from: web security, cyber-physical system security, security and privacy on smart wearable device, mobile wireless security, smartphone security and malicious software.
- **Teaching Assistant** for the graduate course CSE 664 *Applied Cryptography and Computer Security*, Spring 2014/2015.
  Developed all the course projects including video privacy for public IP camera. Led the quiz reviews and Q&A sessions for a class of 40 students, and graded the project reports.
- **Lab Assistant** for the undergraduate course CSE 241 *Digital Systems*, Spring 2013.
  Led quiz reviews and answered questions for a class of 80 students.

Professional Activities

- **Conference Reviewer** for ICCCN'16, ACM CCS'15, ICDCS'15, ESORICS'15, AsiaCCS'15, Cloud'15, ICCCN'15, DBSec'15, CoudCom'15, ACM CHI'15, CloudNet'15, ISC'15, Securecomm'15, IEEE MSN'15, IPCCC'15, INFOCOM'14, ACM CCS'14, ICDCS'14, ESORICS'14, ICNP'14, AisaCCS'14, MobiHoc'14, CNS'14, CloudNet'14,DBSec'14, SecureComm'14.
- **Journal Reviewer** for IEEE Trans. on Parallel and Distributed Systems, IEEE Trans. on Services Computing, IEEE Trans. on Smart Grid, IEEE Trans. on Vehicular Technology, IEEE Trans. on Wireless Communications, IEEE Security & Privacy magazine, IEEE Network Magazine, Journal of Computer Security, Journal of Mobile Communication, Computation and Information, Journal of Parallel and Distributed Computing.
- **Webchair** for the 27th IEEE Annual Computer Communications Workshop (CCW'13).

Graduate Coursework

Computer Architecture, Applied Cryptography and Computer Security, Wireless Network Security, Theory of Computation, Modern Network Concept, Wireless Networking and Mobile Computing, Multimedia Wireless Sensor Network, Principle of Information Theory and Coding, Operating Systems, Optimization of Wireless Network, Computer Vision and Image Processing, High Performance Computing, Multimedia Systems, Analog Circuits, Biomems & Lab-On-a-Chip, Algorithms Analysis and Design, Consumer Optoelectronics

Honors and Awards

- The 19th Annual International Conference on Mobile Computing and Networking (ACM Mobicom'13) App Competition Finalists (top 10), 2013
- Student Travel Grant Awards, IEEE ICDCS 2015
- Top 100 Excellent Graduate Theses in China Agricultural University, 2010
- Excellent Graduate Award in China Agricultural University, 2010
- National University Student Innovation Program Award, 2009-2010
- Undergraduate Research Program Award, 2007-2008
- Third Prize of International Interdisciplinary Contest in Modeling (ICM), 2009
- Third Prize of Scholarship for Excellent Academic Performance, 2007, 2008, 2009
- Awarded "The best debater" title in debate competitions, 2006, 2007

Teaching Statement

Philosophy

I always believe teaching and mentoring are two of academia's greatest appeals to me. As a graduate student, I was very fortunate to have valuable opportunities to teach and mentor students, and I enjoyed them immensely. These experiences taught me that teaching is not just transferring knowledge and skills to individuals, but inspiring the intellectual thought of young minds. Because of each student's unique background, interacting with students provides the best opportunity to connect ideas and spark creativity. It is here that I find teaching is most rewarding, and becoming an inspiring teacher is one of my life's purposes. In particular, I believe that the goal of education should be to encourage seeking answers, instead of directly giving answers. Helping the students to develop the ability to think creatively and learn independently is the main theme of my teaching philosophy. On the other hand, we should not downgrade the difficulty level of the course content to ensure average GPA and course satisfaction. Nothing shall be too complex to explain to general audience. A person always knows more than what he/she can express, and thus I believe there is always room to improve one's teaching skill no matter how experienced the lecturer is. For instance, I followed the same course - Cryptography more than 3 times taught by different lecturers from various institutes/universities - University at Buffalo, Stanford (via coursera), and University of Maryland (via coursera); the purpose is to study/learn the most effective way to present the "complex" cryptographic/security concepts and primitives to general students, especially to those with weak mathematical background. With regard to student supervision, involvement of graduate students in research is another critical aspect of my teaching philosophy. In the past years, I gained tremendous gratification from training and mentoring with bright, energetic undergraduate/graduate students.

Teaching

I have rich experience in independent teaching (in English) at both undergraduate level and postgraduate level. In particular, I earned class teaching experience at University at Buffalo, where I started as a guest lecturer. In CSE 664 Applied Cryptography and Computer Security course, I have introduced many latest trending and important topics into the syllabus, which include cyber-physical system security, security and privacy on smart wearable device, mobile wireless security, and smartphone security. I have also designed new course projects that require in-depth knowledge over the new security technologies. These renovations to the course were well received by the students. Moreover, I also gave a 15% seminar course for Security and Privacy in Emerging Applications at University at Buffalo. Therefore, I feel confident about lecturing courses in areas of cyber physical system, smartphone sensing, cloud computing security, smartphone security, and applied cryptography. I am also interested in contributing to new courses and seminars related to computer architecture, distributed system and advanced computer network.

Mentoring

During my years as a senior PhD student at Ubiquitous Security and Privacy Lab (UbiSeC Lab), I mentored several junior graduate/undergraduate students with the support of my advisor, including four Master students as they progressed toward their theses. With each student, I held regular meetings, discussed the progress of research, and provided individual support on technical and sometimes emotional sides of graduate study. I also received valuable feedback from my advisor on mentoring techniques, and learned how to keep students motivated and inspired with their research and how to balance the level of direction each student needs. Through mentoring students and performing the role of a senior PhD candidate, I have been able to practice the essential skills to become a successful advisor. Undoubtedly, these invaluable lessons will enormously benefit my transition to the next level.

As an assistant professor, I feel excited about the opportunity to mentor great graduate students. My ultimate goal is to foster their diverse talents and strengths and guide them on the way to become self-motivated leading researchers. In doing so, I will bring the highly supportive and collaborative culture in which I have been raised by my graduate school professors.

Plans for Research

As we are entering the era of mobile computing, the wide proliferation of sensor-equipped smartphone is increasingly influencing our daily life. Since smartphone equipped sensors (e.g. microphone, camera, accelerometer, gyroscope, compass) collect an increasing amount of sensitive information, security issues has inevitably critical impact in mobile computing. My current research focuses on exploring the novel ideas and techniques to tackle critical security issues and practical problems for the smartphone sensing systems. In particular, I study smartphone security from the physical layer, leveraging various related characteristics to enable inherently secure and dependable wireless communications. Moreover, I am also experienced in smartphone-enabled crowdsourcing approaches that can build large-scale information infrastructures conveniently at a very low cost. My research approach is in general characterized by the innovative integration of interdisciplinary ideas and synergy through extensive collaborations. First, I find it intriguing to innovate ideas from multiple domains and creatively apply them to solve complex problems. For instance, my previous research integrated ideas from mobile sensing, cloud computing and signal processing to address challenges of securing short-range wireless communication with acoustic wave. Second, my research draws on advanced mathematical models, which allows the system designs to have a solid theoretical foundation. It helps pave the way to achieve robust result, even from inherently incomplete, opportunistic, and noisy crowdsourced data. Third, I am passionate in hands-on research, and believe that intensive experiment implementations on real cloud platforms are indispensable to ensure that my system design is practical and deployable. Finally, my research is invigorated by collaborations with others from diverse backgrounds: professors, industrial research scientist, engineers, and fellow students. Engaging other researchers' expertise not only offers alternative perspectives to approach research objectives, but also diversifies my knowledge and skills as a researcher. The following summarizes my research experience, related projects that demonstrate my research strategy, and my vision of future research directions.

Previous and Current Research

Securing Short-Range Wireless Communications - As an emerging advanced short-range communication technology, near field communication (NFC) is undergoing a fast rate of expansion with many promising benefits including low power, small size, and peer-to-peer communication, without incurring complex network configuration overhead. However, current NFC technologies suffer from one practical limitation: almost all NFC enabled applications require built-in NFC chipsets. Such low levels of penetration of special NFC hardware has stymied its applications on most mobile devices in the market. In addition, from the security perspective the confidentiality of the transmitted data has not been satisfactorily addressed by current NFC technologies, which do not incorporate any security at the physical or MAC layers by assuming that the extremely short range of communication itself has offered a degree of protection physically.

My research in this direction focuses on alternative NFC technologies, with an emphasis on line-of-sight based NFC and acoustic based NFC, which are compatible with legacy devices and

existing infrastructure, and can provide a high level of security guarantee. For secure line-of-sight-based NFC, I have formalized the security analysis based on geometric models, and proposed physical security enhancement mechanisms for barcode communication by manipulating screen view angles and leveraging user-induced motions. For secure acoustics-based NFC, I have adopted the emerging friendly jamming technique from radio communication to achieve data confidentiality, leading to software-based solution to secure smartphone communication without the traditional key agreement phase. Based on the theoretical results, I further design and implement a cloud-assisted mobile system named AcousAuth. AcousAuth is designed for personal authentication. It features a seamless, faster, easier and safer user authentication process without the demand for special infrastructure. Potentially, any mobile devices or computers with microphone and speaker can use AcousAuth, regardless of the underlying hardware and operating systems. The cloud-assisted mobile sensing system provides a purely software-based solution to secure smartphone short-range communication without key agreement phase, and it is potentially well suited for legacy mobile devices. Both alternative NFC techniques have potential to provide NFC-like functionalities to the commercial smartphone applications, and enable much stronger security guarantees, yet with much less strict hardware support. These preliminary results are reported in the IEEE Internet of Things Journal [3]. The system prototype – AcousAuth is in the top 10 finalist from the ACM Mobicom App Competition [1]

Crowdsourcing Systems - Crowdsourcing is a technology with the potential to revolutionize large-scale data gathering in an extremely cost-effective manner. It provides an unprecedented means of collecting data from the physical world, particularly through the use of modern smartphones, which are equipped with high-resolution cameras and various micro-electrical sensors. My research in this area currently addresses the critical yet demanding task of reconstructing the indoor floor map and interior view of a building from crowdsourced data. A typical indoor floor map succinctly illustrates spatial correlations of rooms, hallways and other features of the architecture from a top-down view over a floor. It plays an essential role in many indoor mobile applications, such as localization and navigation. However, unlike outdoor environment, acquiring digital indoor floor plan information is very challenging. The state-of-the-art Google Indoor Maps only have 10,000 locations available on-line, which is not in a position to compete with the total number of indoor environments around the world. The complexity of the indoor environment is the major obstacle to achieve ubiquitous coverage. Existing centralized collection and on-site calibration techniques demand professional devices and multi-party coordination, which are time consuming, inconvenient and costly.

In light of these challenges, I propose and demonstrate CrowdMap, a crowdsourcing system utilizing sensor-rich video data from mobile users for indoor floor plan reconstruction with low-cost. The key idea is to first jointly leverage crowdsourced sensory and video data to track user movements, and then use the inferred user motion traces and context of the image to produce an accurate floor plan. In particular, I exploit the sequential relationship between each consecutive frame abstracted from the video to improve system performance. The experiments in three college buildings demonstrate that our techniques achieve a significant improvement of accuracy compared with other crowdsourcing floor plan reconstruction systems. Going beyond 2D, I further propose, design, and prototype IndoorCrowd2D, a smartphone-empowered crowdsourcing system for indoor scene reconstruction. In particular, I formulate the problem via trackable models and employ a divide and conquer approach to address the inherently incomplete, opportunistic, and noisy crowdsourced data. By utilizing the image information and sensory data in a coordinated way, my system performs high result accuracy, as well as allows a gradual build-up procedure of the

[1] http://www.sigmobile.org/mobicom/2013/app_finalists.html

hallway skeleton. This is corroborated by my evaluations on reconstructing college buildings from 1,151 datasets uploaded by 25 users. It also shows that my image and sensor hybrid method is more robust to overcome errors and outliers compare to image-only method. Once fully hardened, I believe that this system is able to extend existing digital map services to indoor environment on a world scale. Moreover, IndoorCrowd2D can also serve an important stepping stone towards the ultimate goal of economically-viable massive indoor 3D model reconstruction. These preliminary results are reported at IEEE ICDCS [1] and ACM SenSys [2], a highly selective research venue on systems issues of broadly-defined sensors and sensor-enabled smart systems.

Other Collaborative Research - I have also explored research frontier of mobile social networks security, with representative works centering around the proliferation of smart mobile devices. The problem tackled relates to location-based social networks (LBSNs), which features friend discovery by location proximity, and has attracted hundreds of millions of users world-wide. While leading LBSN providers claim the well-protection of their users? location privacy, for the first time my work shows through real world attacks that these claims do not hold. In the identified attacks, a malicious individual with the capability of no more than a regular LBSN user can easily break most LBSNs by manipulating location information fed to LBSN client apps and running them as location oracles. My developed automated user location tracking system could geo-locate any target with high accuracy and readily recover his/her top 5 locations, according to a 3-week real-world experiment on 30 volunteers over leading LBSNs, like Wechat, Skout, and Momo. Besides the attack, I also help develop a framework that explores a grid reference system and location classifications to mitigate the attacks. The result serves as a critical security reminder of the current LBSNs pertaining to a vast number of users. This work was reported in ACM Mobihoc [4].

Future Research

- **Sensor-assisted Mobile Authentication Systems:** I am looking forward to studying practical solutions for securing biometric-based mobile authentication. A lot of interesting yet challenging problems remain to be fully explored, including designing secure mechanism to defend against biometric-based impersonation attacks (e.g. voice impersonation attacks) on smartphones. Given the fact that there is a natural demand for users to control their mobile device in a convenient and non-intrusive way, many biometric-based mobile authentication applications have been developed. However, the human biometrics, e.g. human voice and human face, are often exposed to the public in many different scenarios. Traditional security mechanisms for these biometric authentication systems focus on data encryption and other post-processing techniques, but the biometric themselves often remain vulnerable to attacks in the physical/analog domain. If an adversary captures and manipulates a physical/analog signal prior to digitization, no amount of digital security mechanisms after the fact can help. Fortunately, nature imposes fundamental constraints on how these analog signals can behave. As for my future research, I will study the sensor-assisted mobile physical challenge-response authentication scheme to protect mobile authentication systems against impersonation attacks occurring in the physical/analog domain.

- **Mobile Crowdsourcing Systems:** As we are entering the era of mobile computing, the wide proliferation of sensor-equipped smart phones is increasingly influencing our daily life. Yet challenges remain on system efficiency, functionality, and security. I will continue the line of important research topics discussed earlier and explore the following three directions: First, I will further improve the cloud-assisted mobile systems to build a large-scale information processing cyber-infrastructure with low cost. Second, I will explore the possibility

of utilizing unmanned aerial vehicles for advanced automated crowdsourcing system design with potentially improved accuracy and efficiency. Finally, I am interested in extending existing ubiquitous cloud-based crowdsourcing systems and focus on further processing of the crowd-sourced visual information to extract more context information from the indoor environment, such as object detection and object recognition. By combining technologies from different research domains, e.g., mobile sensing, computer vision, and machine learning, I plan to construct systems that are able to better digitalize our daily life by solving more practical problems.

Selected Publications

[1] Si Chen, Muyuan Li, Kui Ren, Chunming Qiao, "CrowdMap: Accurate Reconstruction of Indoor Floor Plan from Crowdsourced Sensor-Rich Videos". *in Proceedings of the 35th IEEE International Conference on Distributed Computing Systems (ICDCS)*, 2015.

[2] Si Chen, Muyuan Li, Kui Ren, Xinwen Fu, Chunming Qiao, "Rise of the Indoor Crowd: Reconstruction of Building Interior View via Mobile Crowdsourcing", *in Proceedings of the 13th ACM Conference on Embedded Networked Sensor Systems (SenSys)*, 2015.

[3] Bingsheng Zhang, Qin Zhan, Si Chen, Muyuan Li, Kui Ren, Cong Wang, Di Ma, "PriWhisper: Enabling Keyless Secure Acoustic Communication for Smartphones", *in IEEE Internet of Things Journal*, 2014.

[4] Muyuan Li, Haojin Zhu, Zhaoyu Gao, Si Chen, Le Yu, Shangqian Hu, Kui Ren, "All your location are belong to us: Breaking mobile social networks for automated user location tracking", *in Proceedings of the 15th ACM international symposium on Mobile ad hoc networking and computing (Mobihoc)*, 2014.

References

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