PROJECT SUMMARY

Overview:

This proposal considers the problem of enabling intelligent vehicles to provide evidence of presence, a means for a vehicle to convince a third party that they were indeed at a specific location and time, while still protecting the privacy. An evidence of presence is an important component to secure many emerging applications, such as traffic monitoring and control, urban participatory sensing, and so on, and protecting privacy is crucial to encourage greater public participation in these schemes. Our objective is to explore an environment-based approach that relies on hardware found on an intelligent vehicle to measure wireless signals and capture camera images to serve as evidence of presence. Our approach does not require any identifying materials, like secret keys or IDs, to be assigned a vehicle, nor does the vehicle need to perform any complex processing such changing pseudonyms, to protect privacy. This is a departure from traditional approach of using cryptographic primitives to build secure and privacy-preserving protocols. We believe our environment-based approach has distinct advantages over cryptography-based approach in providing privacy protections, simplifying deployment and management, as well as increasing resiliency in face of adversary compromise. The research combines wireless networking and computer vision to arrive at a secure solutions. The proposal also includes plans for on-road testing to demonstrate the efficacy of our solutions in the real world environment.

Intellectual Merit :

Our research will be to develop techniques that use physical layer measurements from wireless radio, and image detection and comparison from on-car cameras, to provide evidence of presence of a vehicle. The proposed research includes investigations into algorithms to optimal placement of road-side infrastructure; image comparison algorithms to estimate physical location from photographs; vision algorithms to estimate time of day from photographs; physical layer techniques to support encounters with public vehicles such as busses and police cars; and a unifying framework to incorporate evidence from physical layer measurements and captured photographs to derive an evidence of presence. Our motivating insight is that the natural environment exhibits spatial-temporal characteristics that can be captured by hardware found on modern vehicles. These characteristics can not only be harnessed to provide evidence of where and when a vehicle has been, but are also computationally expensive for an adversary to mimic.

The proposal's research has a strong interdisciplinary flavor, drawing together research from security, wireless networks, and computer vision. The research team consists of PIs with complimentary expertises in the areas of wireless security and vehicular networks (PI Tan), computer vision and image processing (Co-PI Ling), and network and mobile algorithms (Co-PI Wu), and are uniquely qualified to pursue this research.

Broader Impacts :

Our proposed approach of environment-based security is transformative in shifting away for relying solely on cryptography as a means of designing protocols. The project will inspire greater collaborations between previously distinct disciplines, wireless network and computer vision research, bringing them together to address challenges in security. The research findings are expected to provide fresh insights and new lines of inquiry for the respective disciplines. This proposal's focus will also have a broader societal impact by enhancing the overall security of a myriad of intelligent vehicle applications crucial to future intelligent transportation and Smart City systems. The PIs will integrate this research into their teaching and training activities to broaden the impact to a new generation of students working in the areas of security, wireless communications, and computer vision. The proposal also include outreach plans to reach out to underrepresented minorities through various activities, including a highly successful REU Site.

Keywords: wireless physical layer; computer vision; vehicular networks.