The Isolation Booth – A Device MAC Address and Facial Features Binding System Based on RF Signal Attributes

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Smartphones and personal computers have become a staple of modern life, with the number of active wireless subscriptions approaching the world's population. Since most mobile devices are equipped with Wi-Fi interfaces, media access control (MAC) addresses can be employed to uniquely identify them and study their interactions in the socio-physical world. At the same time, facial recognition algorithms are rapidly becoming a mature technology, with several application program interfaces featuring excellent performance. It is therefore possible to develop a platform to collect the MAC address of a personal device and, subsequently, bind it to a unique set of facial features. In other words, one can link personal devices to their respective owners with high confidence using statistical signal processing. This process can take place in an inconspicuous fashion, using passive sensing agents in monitor mode to gather Wi-Fi metadata from received packets. The revealed information can be used in a plethora of applications, ranging from taking attendance in classrooms to halting the progression of epidemic diseases through early warning messages directed at potentially infected individuals.

This research initiative examines a proof-of-concept implementation of such a system, where radio signal properties are used in conjunction with cameras to link MAC addresses to facial features. The proposed booth-like structure, which we call Isolation Booth, employs Wi-Fi signals in industrial, scientific, and medical radio (ISM) bands together with multi-perspective sampling to identify unique attributes associated with the occupant and their smartphone. Concurrently, facial features are extracted from pictures and catalogued in a database. As a person proceeds through the Isolation Booth, their device's network packets are isolated, and the source MAC address from these packets is associated with an image triggered by their presence. The performance of the Isolation Booth is studied as a function of the number of sensing antennas and their individual radiation patterns. Guidelines on efficient designs are provided, with highly discriminating antenna systems leading to low probabilities of error. The likelihood of a device being tied to a specific set of facial features can be refined over time, as the owner of the device re-enters the booth.

The monitoring system is based on `pcap` (packet capture), a programming suite frequently used in the field of computer network administration. Data is stored in an `SQL` database, and it can be queried remotely. One of the technical challenges associated with Wi-Fi monitoring comes from the sheer number of active devices found in typical buildings. While the device of an occupant is very likely to be picked up by the booth, distinguishing the correct MAC address from those of other nearby devices forms the crux of this statistical problem. The multi-perspective approach proposed herein and the use of directional or pattern reconfigurable antennas are key in completing this task with a high success rate.