Boundless Security Systems, Inc.

the communications bandwidth experts

White Paper: *How to Spot Patterns Humans Can't See by Combining Outdoor Video Surveillance with Smartphone WiFi Monitoring*

Problem Statement

How does one determine when particular individuals are present, or if anyone is present ? How does one determine if anyone was present previously, and if so, who ?

One solution is video surveillance. But monitoring video from cameras, especially outdoor ones, to spot suspects is a daunting task. Humans lack the time and memory to continuously watch surveillance video, remember when every person and vehicle came and went during recent days or weeks, and spot patterns in this *big data* mountain of information. Distance, darkness, glare and vehicles conceal identities. Motion-activated video is useless with a busy street. Face recognition doesn't work at a distance or under variable lighting. Video analytics don't help when everything looks normal. Fighting a multitude of recurring crimes and terrorists suffers.

We're trying to answer some simple questions:

1) has a particular person ever been present at a particular location during a particular period of time ?
2) when were they present ?
3) who was with them ?
4) how far was the person or those people from the observation point ?
5) is that person there now ?
6) how can I find out when that person, or anyone, arrives ?
7) what do they and their vehicle, if any, look like ?

A New Solution

There is a new solution to the problem. It provides the detection and identification needed, and is available from us in several forms. As shown below, our *embeddable kit* is for use inside new or existing, outdoor enclosures for one or more CCTV and/or IP cameras. Another is a small outdoor housing for use with external CCTV and/or IP-cameras, or small internal cameras. A third is built into our covert and *reconfigurable* lines of outdoor video surveillance products. All are supported by our indoor products that help users associate human identities with specific mobile devices that, for many and a growing number of people, are inseparable from them.

Mobile devices, particularly smartphones, have become inseparable from many people and are being built into vehicles, eyeglasses and many common items. Every mobile device has a unique signature, analogous to a Vehicle Identification Number, called a ***WiFi MAC Address,*** that is ingrained in it at the factory. This signature enables mobile devices to find nearby WiFi networks and connect to the Internet without using expensive cellular networks. *The signature can be used as a proxy for the identity of the person or vehicle*. It can be read wirelessly within a radius of about 100 yards outdoors using only one or more tiny concealed antennas in the receiver. It can

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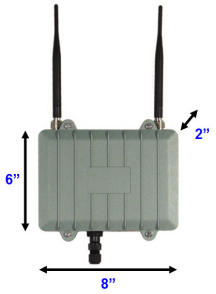
be read regardless of weather or time of day, often even when the person or vehicle cannot be seen clearly, or the person with the smartphone is concealed inside a vehicle. The range can be much greater with proper antennas, or limited for use indoors with proper antennas or software configuration.

Photo varies. Not all components shown. Approx. 3" x 4" x 2"

Smartphone WiFi Monitoring and Subminiature Network Video Recorder Kit can be built into new or existing outdoor enclosures with multiple internal and/or external, CCTV and/or IP cameras

http://tinyurl.com/cy78fu4



Outdoor Smartphone WiFi Monitoring and Subminiature NVR handles multiple external, CCTV and/or IP cameras, or small internal CCTV cameras

http://tinyurl.com/aggh9lk

Our ***Smartphone WiFi Monitoring and Subminiature Network Video Recorder***, or **Device** for short, integrates smartphone WiFi monitoring with outdoor video surveillance. It can monitor any mobile device that uses WiFi. (We use the word, "*smartphone*," in a general sense to mean any mobile device.) It is small, low power, and has a wide temperature range. Not just a component, it is a system-level solution.

Much more than just capturing WiFi information broadcast by smartphones, the Devices include our ***Rules-based Analysis System***. Our ***Rules-based Analysis System*** periodically reviews smartphone information it's received over long periods of time. It chooses to ignore certain smartphones while selecting others to trigger alerts. It quickly sends an alert when certain events occur. When one or more cameras are connected to Device, the Device also internally records the video continuously with better quality than could be sent live to a distant video recorder, and with currently three, bandwidth-saving resolutions. No external video recorder, or system integration with it, is needed. And, our internal, or optionally cloud-based, ***Media Server*** enables both live and internally recorded video to be viewed in a browser without any special viewing software.

Each alert not only enables viewing live video in a browser natively (no plugins or special software required), but also contains a list of the ten most recent times that same smartphone was detected. For each time identified, there is a link to internally recorded video starting 15 seconds before the smartphone was detected. One just clicks on a link to view the recorded video (not just a snapshot) in a browser. Recorded video can even be viewed at faster than normal speed.

By default, most smartphones, even when in one's pocket, search, or probe, for WiFi hotspots once every minute. Our Device passively listens for those probes, and analyzes, and records in its

internal database, only information that is publicly broadcast. This information contains the smartphone's unique WiFi signature, or WiFi MAC address, which is required for the smartphone to connect to any WiFi network. The WiFi MAC address also contains information that identifies the manufacturer of the smartphone or vehicle, although not all manufacturer information is available.

In addition to capturing these WiFi probes, and the date and time of each probe, the Device also measures the signal strength of each probe. This enables estimating the distance between it and the smartphone, and can be used to trigger sending of alerts based upon this distance.

The Device, unlike a wireless access point, does not solicit probes. It passively listens for probes sent spontaneously by smartphones and is therefore network-invisible. Outdoors, using tiny, concealed omni-directional antennas, the reception range is about 100 yards in all directions, providing a longer range and much larger field of view than cameras. Unlike cameras, which need illumination, time of day is not important for receiving WiFi probes. When used near a busy two-lane road, probes from thousands of smartphones may be received over several weeks' time. Probes from multiple smartphones may be received in a single second, often only milliseconds apart. Able to handle large numbers of devices, at one, four-way intersection, we have detected more than 45,000 different smartphones over a several month period.

In addition to using live and recorded video, our small, innocuous, ***Indoor Smartphone WiFi Monitor*** can be used to help associate a person's identity with their smartphone's WiFi signature. It can be placed in lobbies, interview rooms, booking desks, near timeclocks, and in other locations where persons' identities are known, and the time of their presence is known. A lower gain antenna is used to limit its reception range indoors. Users can arm our outdoor equipment with these smartphone WiFi signatures to send alerts when mobile devices with these signatures, and by extension, individuals, arrive in the vicinity of our outdoor equipment. One use, for example, is detecting when gang members are present at their hangout.

Assumptions are: (a) the individuals or vehicles you want to watch for have smartphones, and (b) the smartphone is turned on and looking for WiFi hotspots (usually the case). You do not need to know smartphones' WiFi signatures in advance. We integrate live and recorded video with smartphone WiFi monitoring to help users associate smartphone WiFi signatures with persons and vehicles. Smartphones may not be detected if they are not present long enough.

Our ***Smartphone WiFi Monitoring and Subminature Network Video Recorder Kit*** is intended for mounting in the same outdoor enclosure as one or more CCTV and/or IP cameras (depending on configuration), where currently standard definition IP-video streams are required. Standalone, almost turn-key operation is provided. It is not necessary for the user to operate a distant network video recorder, media server, or a server to receive and store WiFi monitoring information, integrate the viewing of live and recorded video with smartphone WiFi monitoring, and set up a system to continually analyze and respond to smartphone information, and send alerts. The user merely configures the cellular modem or router used with his/her IP-camera(s) to pass certain ports from the Kit to the Internet, and enters the local video URL(s) of the camera(s) into the Kit.

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Each ***Smartphone WiFi Monitoring and Subminiature Network Video Recorder*** currently works independently. No coordination with, or services from, outside agencies is required. Software in development will coordinate the operation of multiple nodes and enable searching within multiple nodes, and pattern-finding across multiple nodes, instead of one.

Ways to Use the System

Here are ways to use this new capability to spot subjects and patterns you have not been able to see before (Note: Some capabilities described are in development):

1) You want to know if anyone frequents an area.

This is the default mode of operation. It is useful when you are trying to find suspects for recurring crimes in a particular area.

Boundless' Kit builds a history of every smartphone WiFi probe it captures. Boundless' Rules-based Analysis System periodically reviews those probes, enters certain smartphone WiFi signatures into a list to be ignored, and some into a list to be watched. Residents' smartphones, and too-frequent detection, are automatically filtered out. When a WiFi probe is received whose signature is on a **Watch List**, an alert is sent so live video, and internally recorded video starting 15 seconds before the time of each of the ten most recent probes, can be viewed in a browser.

Rather than having to view hours of recorded video trying to spot patterns, the user can view short segments of video recorded in, and identified by, the system to see which vehicles and persons frequent the area under surveillance. The user can then associate a person or vehicle with a particular smartphone WiFi signature and vice-versa.

2) You want to watch for specific individuals or vehicles.

This is useful when you want to be alerted in real time when someone shows up. This is particularly useful in towns that limit gang members from associating with other gang members.

Once you know individuals' or vehicles' smartphone WiFi signatures, you can enter those signatures into the **Static Watch List** or **Static Skip List** in our Kit. The Kit sends an alert within a few seconds of its detecting a signature on its Watch List.

3) You want to know when someone lingers.

This is useful when a subject's home or business is near a busy road, and you want to be alerted when someone stops to visit or make a delivery.

Boundless' Kit measures how long each smartphone is present, and can send an alert when the duration exceeds a threshold. A steady stream of vehicles on the busy road is ignored.

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4) You want to associate an individual or vehicle with a particular smartphone WiFi signature.

If you know a WiFi signature, you can search Boundless' probe database for it and get a list of the times that signature was detected. You can view the video recorded internally at the times of each of those probes, and use it to visually identify a person or vehicle.

5) You want to know who was in an area at a particular time.

This is useful when you are trying to find suspects for previous crimes.

You search Boundless' probe database over a particular time period, and get a list of the WiFi signatures that were observed during that time. For each WiFi signature, you get a list that includes links for viewing recorded video starting 15 seconds before the time of each probe. You view the recorded video to spot suspects. Recorded video can be viewed at faster than normal.

6) You want to know if anyone was in an area at a number of particular times.

This is useful if there are recurring crimes in the area under surveillance, and you want to know if anyone was present during those crimes.

You specify multiple time periods during which you want to know if a particular smartphone was present. You get a list of smartphone signatures that were detected during those time periods, identifying each time period when it was present, and including links for viewing internally recorded video from those times.

7) You want to know if someone was with someone.

This is useful if one vehicle carries the seller, and a second vehicle carries the buyer.

You determine the times when a subject was present. You then search the Kit's probe database for those times to get a list of all WiFi probes detected during those times. The list includes links to video recorded internally during those times, and you view the selected recorded video segments to see what other persons and vehicles were present.

8) You want to know if anyone has visited multiple sensitive areas.

This assumes you have our ***Smartphone WiFi Monitoring and Subminiature Network Video Recorder*** in each sensitive area.

This is useful when you are looking for suspects for recurring crimes such as arson, or terrorists who have visited multiple sensitive areas.

You place our outdoor systems in those areas where you want to watch for suspects. You then specify multiple time periods during which you want to know if a particular smartphone was present previously. You get a list of smartphone signatures that were detected during those time

periods, identifying each location and time period when it was present, and including links for viewing internally recorded video from those times.

Conclusion

Monitoring video from surveillance cameras, especially outdoor ones, to spot suspects is a daunting task. Our ***Smartphone WiFi Monitoring and Subminiature Network Video Recorder*** is a system-level solution that is integrated with CCTV and IP cameras, and our ***Indoor Smartphone WiFi Monitor***. Its ***Rules-Based Analysis System*** detects patterns no human can see. Units can work alone or (work in progress) multiple units can work together and pool results. Its internal network video recorder and ***Media Server*** provide both live and internally recorded, multi-resolution, video in a browser in a bandwidth-friendly fashion. It's available as a kit for use within new or existing, outdoor camera enclosures, as an outdoor unit for use with external cameras, and built into our line of covert video surveillance products. Our ***Indoor Smartphone WiFi Monitor*** can be placed where persons' identities can be readily determined, such as interview rooms, booking desks, and timeclocks, to associate identities with smartphone signatures.

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