ConAuth - context for authentication (Nov. 2017)

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***Abstract*—With the growing number of wireless devices, we need efficient mechanisms to let the wireless devices communicate securely. The wireless devices sometimes share common sensors that can be leveraged to perform additional authentication procedures on a set of localized wireless devices. The problem which prevents such a judicious use of sensors is the orientation of wireless devices. Sensors such as gyroscope and accelerometer are commonly found in wireless devices, but their readings make no sense until their orientations are the same. We plan to conduct controlled experiments to investigate how different environmental factors impact the accelerometer performance and how the best accuracy can be achieved in an appropriate condition range. We also characterize the nature of an accelerometer to understand its performance in different conditions. Based on such comprehensive understanding, we propose to estimate the phone attitude and provide for opportunistic calibration of the accelerometer**

***Index Terms*—Contextual security, sensor funsion, Madgwick, device orientation.**

I. Introduction

WITH the growing number of IoT devices, securely pairing a new device into an existing set of devices is an extremely important yet burdensome task. Traditionally, these devices are paired manually, where an operator sets up an authentication with the existing network of devices. Specifically, we address the problem of a platoon ghost attack wherein an attacker device spoofs presence within a platoon to gain admission and subsequently execute malicious attacks [1]. To address such concerns, we present ConAuth, a novel autonomous admission scheme which binds devices to their physical context (i.e., locality).

ConAuth exploits the findings that devices in a local setting experience similar context to prove to each other over time that they are co-present [1]. Specifically, they experience similar events (e.g., people coming inside the room, knocking on the door). Our approach is based on the ability of the devices to capture this context, using sensors that both the devices share.

We design and implement the ConAuth protocol and evaluate a proof-of-concept implementation using a set of experiments. Our implementation will demonstrate that devices in the same room can be sufficiently distinguished by their context and this can be utilized to thwart platoon ghost attacks and similar misbehavior.

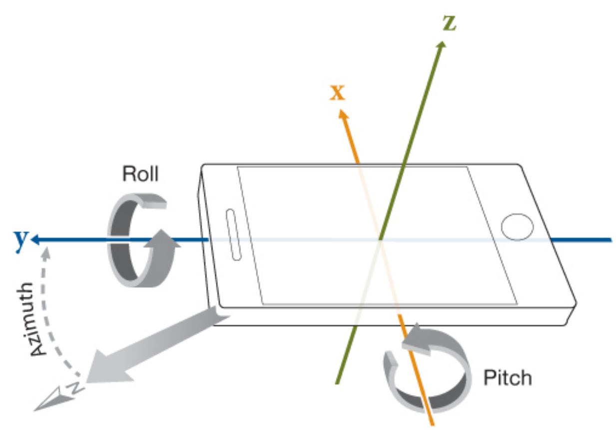

Fig. 1. A device's body orientation.

II. Problem Statement

With near-ubiquitous availability of wireless devices equipped with a wide variety of sensors, research in building context aware services has been growing. However, despite a large number of services proposed and developed as research prototypes, the number of truly context-aware applications available in wireless devices is quite limited. A major barrier for the large-scale proliferation of context aware applications is poor accuracy [2]. We address one of the key reasons for this poor accuracy, which is the impact of sensor orientation.

Devices have their sensors oriented in different positions. We first show that smartphone positions significantly affect the values of the sensor data being collected by a context aware application, and this in turn has a significant impact on the accuracy of the application [2]. Next, it describes the design and prototype development of a orientation discovery service that accurately detects a sensor orientation. This service is based on the sensor data collected from carefully chosen sensors. Finally, the paper demonstrates that the accuracy of an existing context aware service or application is significantly enhanced when run in conjunction with the proposed orienttion discovery service.

III. Technical Approach

The process to determine whether two devices share the same context consists of the following steps:

1) Determining the orientation of the devices in question.

a) Obtain sensor data from PowerDue with a sensor that contains a gyroscope, and possibly an accelerometer.
b) Obtain sensor data from a mobile phone using iOS app PowerSense. See Figure 2 and Figure 3 for an example of the type of data that may be collected with PowerSense.
c) Compute orientation difference using Madgwick algorithm.

2) Correlating the sensor data to determine whether sensors share context.

2 depends on 1, because knowing the orientation, or attitude, of two devices allows us take the difference between a devices body-orientation, as depicted in Figure 1, with respect to the geoframe, the earth's orientation. Existing algorithms, as described in the next two subsections, can determine the orientation, but we've chosen to use Madgwick because it is open source and well suited for small embedded devices [3]. The purpose of our remaining work is to determine 2, a technique for correlating data between two or more devices to allow us to determine shared context.

A. Computing the attitude of a device

The phone attitude is obtained by doing continuos integration on the angular velocity, and by taking the difference between the geoframe, the earth coordinate sytem, and the body-frame, the coordinate system of the device's body. Per [4], the best approach for calculating the difference between both coordinate systems is the Euler Axis/Angle method, which solves the problem from the geoframe's perspective. To compute the integration, the total device motion is split into multiple time windows, and the rotation of the device is the accumulated rotation of all the time windows.

B. Madgwick algorithm

Historically, the Kalman filter, and other techniques, including fuzzy processing and frequency domain filters, have been used as the basis for orientation algorithms; however, these techniques have several disadvantages [3]. For example, the Kalma filter is computationally expensive, and some of the other techniques are only effective under limited conditions [3]. Therefore, we plan to use Madgwick, an algorithm that employs a quaternion representation of orientation, which has had positive results despite the fact that it does not require the heavy computational load, or high frequency sampling of a Kalman-filter based algorithm [3].

IV. Pending work

Up until this point, our work has consisted of research, and more of it remains to be done; however, there are key steps that we need to follow through with in order to deliver results on the research:

1) Obtain a sensor with a gyroscope and accelerometer. None of the sensor at our disposal contain a gyroscope, which is the center piece of orientation-sensing algorithms. Therefore, it is imperative that we obtain one soon, because using a new sensor might entail having to modify or create drivers for the PowerDue.
2) Compute the attitude of the PowerDue.
3) Compute the attidue of a mobile phone.
4) Correlate the readings from the PowerDue and mobile phone.

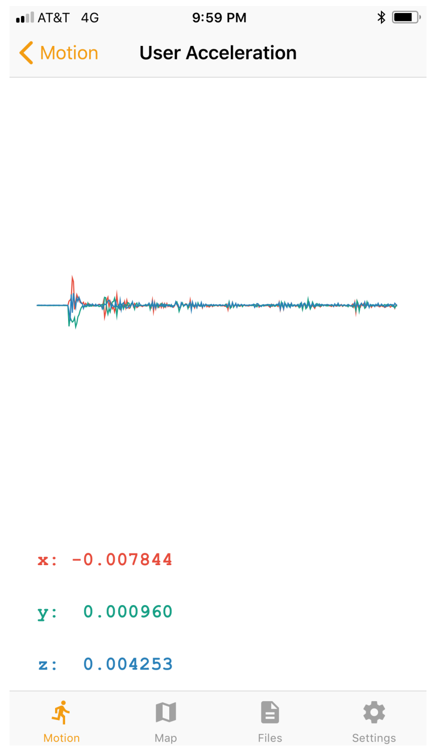

Fig. 2. User acceleration with iOS app PowerSense.

Our plan is to run experiments in which we repeat steps 2 - 4 under different conditions, but in all the PowerDue and the mobile phone are stationary when the sensor data is collected:

- Both devices have the same orientation and are in the same context.
- Both devices are in the same context, but their orientations differ.
- Devices are not in the same context, but have the same orientation.
- Devices are not in the same context, and have different orientations.

To deliver useful results, we have to correlate the data between different devices, and define what it means for two devices to share context. Also note that we plan to correlate the data between the devices by doing the analysis on our PCs, but ideally it would be more useful to deploy the model on the PowerDue, perhaps a task for future work.

References

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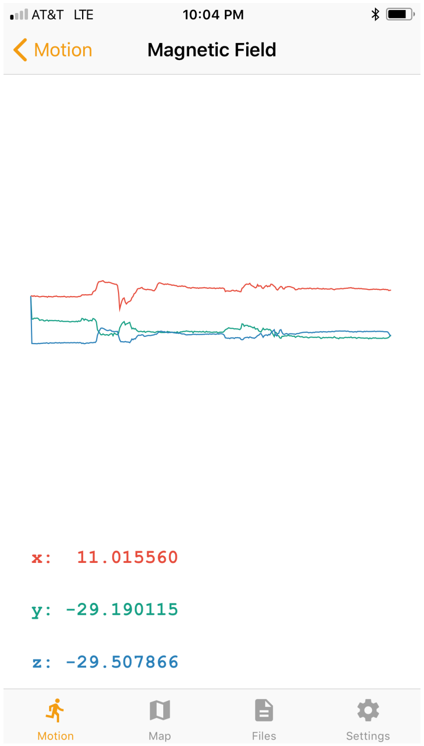

Fig. 3. Magnetic field with iOS app PowerSense.

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