QiReco: I Am a Wireless Charger and I Can Recognize Your Phone

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1 INTRODUCTION

The increasing penetration of wireless charging base stations deployed in public areas like office buildings, restaurants, and airports [4] has presented new opportunities for precise user identification and indoor localization, where the base station learns the location and identity of the mobile device being charged. Leveraging the wireless charging infrastructure can provide even better accuracy, higher reliability (charging station location is already known), and lower deployment cost than previous RF-based indoor localization approaches [1, 2]. A key challenge is to reliably identify the wireless charging unit of mobile devices. Unfortunately, according to the Qi standard [3], the identity of a power receiver is defined by a Basic Device ID, which can be a software-generated random sequence that may change each time the power receiver is booted.

2 SYSTEM DESIGN

We have developed a practical system called QiReco which can reliably identifies Qi-compliant mobile devices based on the hardware fingerprints. Specifically, QiReco augments standard-compliant wireless charging base station to extract features from the oscillator, physical parameters of power receiving coil, and controller of a power receiver, while requiring no modification to existing Qi-compatible mobile devices. QiReco employs a servo motor to regulate the inductive coupling between the power transmitting and receiving coils, which allows for fine-grained fingerprinting of the power receiver while optimizing the efficiency of power transfer and compensates the parameter changing effect caused by the varying placement of the mobile device. The motor speed is adaptively controlled to reduce the measurement delay. While the charger coil moves, the MCU records and timestamps the data packets transmitted by the mobile device.

The features we use for recognition are: (1) the Control Error Packet (CEP) time intervals distribution, including the density peaks and their corresponding time interval values; (2) the distribution of CEP data values; and (3) the number of packets during a complete measurement. The extracted features from the devices are fed into SVM and Long-Short-Term-Memory (LSTM) classidier for identification. Our prototype is shown in Figure 1.

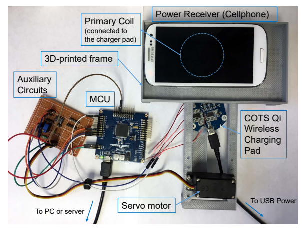

Figure 1: A prototype of the QiReco base station. The charger coil is controlled by the servo motor.

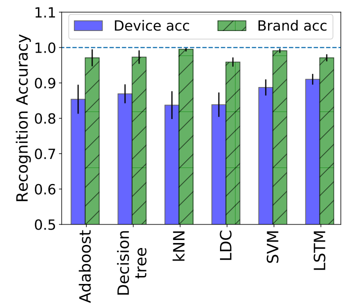

Figure 2: The cross-validation accuracy of device and brand detection from different classifiers.

3 SYSTEM VALIDATION

In our experiment, 26 Qi-compatible devices from 6 different brands are evaluated. The collected data are splited into training and testing sets with a ratio of 7:3. We adopt repeated random sub-sampling validation, also known as Monte Carlo cross-validation, to obtain the average classifier performance. Our results show that QiReco achieves an overall device recognition rate of up to 94.87% by LSTM and brand recognition rate of 99% by SVM, as shown in Figure 2. Other commonly-used classifiers are also implemented for comparison.

Our results also have important implications on user privacy. With the prevalence of wireless charging stations in public areas, how to prevent the leakage of user's location opens up new research questions.

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