SYSTEMS AND METHODS FOR TARGET DEVICE PREDICTION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The current application claims the benefit of and priority under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application No. 62/907,367 entitled "Systems and Methods for Device Localization and Prediction" filed Sep. 27, 2019. The disclosure of U.S. Provisional Patent Application No. 62/907,367 is hereby incorporated by reference in its entirety for all purposes.

TECHNICAL FIELD

[0002] The present technology relates to consumer goods and, more particularly, to methods, systems, products, features, services, and other elements directed to localization and/or target device prediction in media playback systems or some aspect thereof.

BACKGROUND

[0003] Options for accessing and listening to digital audio in an out-loud setting were limited until in 2003, when SONOS, Inc. filed for one of its first patent applications, entitled "Method for Synchronizing Audio Playback between Multiple Networked Devices," and began offering a media playback system for sale in 2005. The SONOS Wireless HiFi System enables people to experience music from many sources via one or more networked playback devices. Through a software control application installed on a smartphone, tablet, or computer, one can play what he or she wants in any room that has a networked playback device. Additionally, using a controller, for example, different songs can be streamed to each room that has a playback device, rooms can be grouped together for synchronous playback, or the same song can be heard in all rooms synchronously.

[0004] Given the ever-growing interest in digital media, there continues to be a need to develop consumer-accessible technologies to further enhance the listening experience.

SUMMARY

[0005] Systems and methods for localizing portable devices are illustrated. One embodiment includes a method for locating a portable device in a network that includes several reference devices. The method includes steps for measuring characteristics of signals transmitted via signal paths between each of several reference devices over a period of time, measuring characteristics of signals transmitted via signal paths between a portable device and each of the several reference devices, normalizing the measurements to estimate characteristics of the signal paths between each of the several reference devices and between the portable device and each of the reference devices, and estimating the likelihood that the portable device is in a particular location using the estimated characteristics of the signal paths between each of the several reference devices and the estimated characteristics of the signal paths between the portable device and each of the several reference devices.

[0006] In a further embodiment, at least some of the several reference devices include different transmitter implementations.

[0007] In still another embodiment, the portable device has a transmitter implementation that differs from the transmitter implementations of at least one of the reference devices.

[0008] In a still further embodiment, the measured characteristics of a particular signal includes at least one of a received signal strength indicator (RSSI) value, an identifier for a sending reference device that transmitted the particular signal, and a timestamp for the particular signal.

[0009] In yet another embodiment, estimating the likelihood includes computing a set of probabilities that the portable device is near each of at least one reference device of the several reference devices.

[0010] In a yet further embodiment, normalizing the measurements for a first reference device comprises calculating a first signal-strength ratio of signals received at the first reference device from the portable device to signals received at the first reference device from a second reference device, and calculating a second signal-strength ratio of signals received at the second reference device from the portable device to signals received at the second reference device from the first reference device, wherein computing the set of probabilities for the first reference device includes computing a ratio of the first signal-strength ratio to the second signal-strength ratio.

[0011] In another additional embodiment, normalizing the measurements for a first reference device comprises calculating a first signal-strength ratio of signals received at the first reference device from the portable device to signals received at the first reference device from a second reference device, and calculating a second signal-strength ratio of signals received at a third reference device from the portable device to signals received at the third reference device from the second reference device, wherein computing the set of probabilities for the first reference device includes computing a ratio of the first signal-strength ratio to the second signal-strength ratio.

[0012] In a further additional embodiment, computing the set of probabilities comprises identifying an offset based on a difference in RSSI values for the first signal path and the second signal path, and determining a normalized set of one or more RSSI values for the first and second signal paths based on the identified offset.

[0013] In another embodiment again, normalizing the measurements to estimate characteristics of a particular signal path between a first reference device and a second reference device includes computing a weighted average of at least one characteristic for a first set of one or more signals from the first reference device to the second reference device and a second set of one or more signals from the second reference device to the first reference device.

[0014] In a further embodiment again, the weighted average is weighted based on timestamps associated with the first and second sets of signals.

[0015] In still yet another embodiment, the method further includes steps for estimating which of the reference devices is closest to the portable device based on the estimated likelihood.

[0016] In a still yet further embodiment, the method further includes steps for selecting a computing reference device of the several reference devices for performing the steps of normalizing the measurements and estimating the likelihood.