View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Technical Disclosure Common

Technical Disclosure Commons

Defensive Publications Series

May 2021

Position Localization for Non Ultra-wideband Devices

Alexander James Faaborg

Alex Komoroske

Follow this and additional works at: https://www.tdcommons.org/dpubs_series

Recommended Citation

Faaborg, Alexander James and Komoroske, Alex, "Position Localization for Non Ultra-wideband Devices", Technical Disclosure Commons, (May 05, 2021)
https://www.tdcommons.org/dpubs_series/4270

This work is licensed under a Creative Commons Attribution 4.0 License.
This Article is brought to you for free and open access by Technical Disclosure Commons. It has been accepted for inclusion in Defensive Publications Series by an authorized administrator of Technical Disclosure Commons.

Position Localization for Non Ultra-wideband Devices

ABSTRACT

The high-frequency, broad-spectrum properties of the UWB (ultra-wide bandwidth) communications protocol enable very accurate, e.g., millimeter-level, spatial and directional localization of devices. The high-precision localization ability of UWB enables fine-grained interactions with devices, e.g., the ability to send commands to specific devices when multiple devices are present in a space. This disclosure describes techniques to bootstrap precise positioning on non-UWB devices, such that UWB-style, fine-grained interactions are enabled even on non-UWB devices. The techniques leverage the presence of two or more UWB-enabled devices, e.g., one on a stationary device and another on a wearable device (or other non-stationary device), to precisely locate non-UWB devices.

KEYWORDS

- Ultra-wideband (UWB)
- Indoor positioning
- Precise positioning
- Local positioning
- Object detection
- Smart device
- Smart appliance
- Smart speaker

BACKGROUND

Ultra-wideband (UWB) is a short-range wireless communication protocol that operates at relatively high frequencies and wide bandwidths. The high-frequency, broad-spectrum properties of UWB enable very accurate, e.g., millimeter-level, spatial and directional localization of devices. For example, a UWB device can precisely lock onto an object, discover its location, and communicate with it.

When integrated into home devices, UWB introduces a number of natural, contextual interactions. Users can fling content from a phone to a specific TV; a smartwatch can remotely control the volume level of a particular speaker in the same room; a timer set on one stationary device can follow the user into another room; etc. A UWB-enabled lock can determine if an authentic user is inside or outside the doorway, automatically open if the user is approaching the doorway, and engage the lock when the user recedes past a certain position.

Integrating UWB into a smart device increases its bill-of-materials (BOM). Most smart devices currently in the market do not support UWB.

DESCRIPTION

This disclosure describes techniques to bootstrap precise positioning on non-UWB devices in a user's home or other venue, such that UWB-style, fine-grained interactions are enabled even on non-UWB devices.

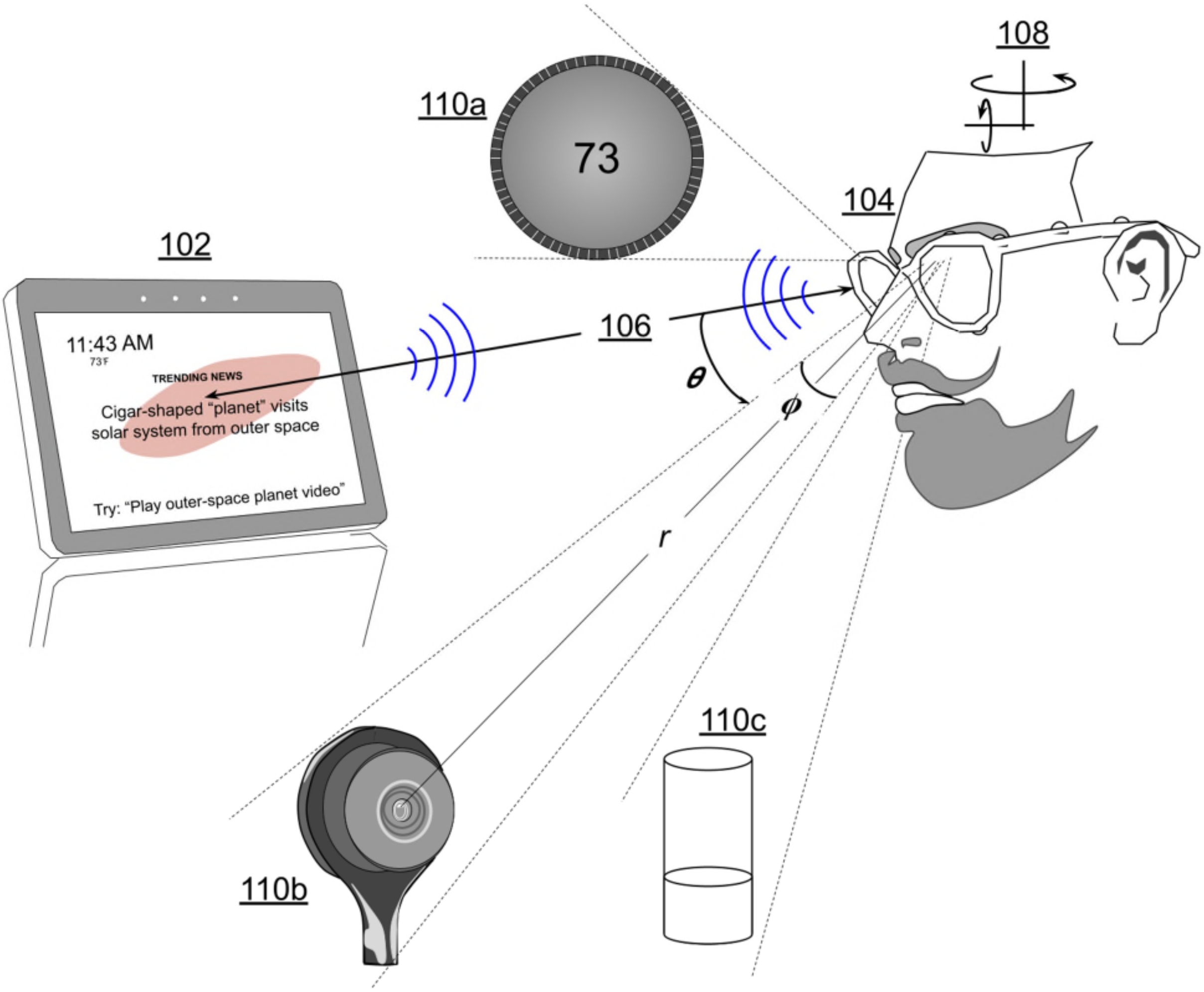

Fig. 1: Position localization for non-UWB devices

Fig. 1 illustrates position localization for non-UWB devices, per the techniques of this disclosure. The techniques leverage the presence of two UWB-enabled devices - one a stationary device, e.g., a smart display (102), and another on the user's person, e.g., smart glasses (104) or other wearable/non-stationary device (e.g., a fitness band, smartwatch, smartphone, etc.), to precisely locate other, non-UWB devices. With user permission, the two UWB-enabled devices communicate over UWB (106) to localize at high resolution the position of the wearable device, and thereby that of the user, inside their home.

Visual recognition on the user's smart glasses is used to bootstrap the precise locations of non-UWB devices in their home, e.g., a smart thermostat (110a), a smart camera (110b), a smart speaker (110c), etc. Visual recognition can estimate the radial distance r to a non-UWB device, e.g., by detecting its presence, by measuring its angular spread ϕ, and by comparing the measured angular spread to the known device dimensions. Inertial measurement unit (IMU) sensors onboard the smart glasses can report the angular distance $\boldsymbol{\theta}$ between the non-UWB device and the line connecting the two UWB-enabled devices by measuring the turn of the user's head along various axes (108). Knowing the radial and angular distances (r, $\boldsymbol{\theta}$) of a non-UWB device from the smart glasses, the coordinates of the non-UWB device with reference to the stationary UWB device can be determined to high precision.

Some advantages of high-precision localization of non-UWB devices in example use cases include:

- For audio devices, recognizing the audio currently playing and knowing which speakers are actively in use can differentiate one speaker from other speakers in the vicinity.
- For visual devices, e.g., streaming sticks or casting devices placed behind a television and out of view, visual recognition of the content displayed on the ambient screen such as generic artwork, user's personal photos, etc. can be utilized to recognize the specific device relative to other devices.
- Once a non-UWB device is assigned a fine-grained location at the venue, new, UWB-like features can be enabled on it, as if the device had UWB integrated into it. For instance, a user with a UWB-enabled phone can determine proximity and angle to a non-UWB device, so long as the non-UWB device was visually localized in the past.

If the non-UWB device is moved after the initial localization, its new position can be reestablished to high precision by repeating the procedure illustrated in Fig. 1. Alternatively, rather than dynamically determining device locations in the background as described above, a training mode can be enabled, where, in a camera viewfinder, the user is asked to identify different (non-UWB) devices in their vicinity (e.g., inside their home or another space) and corresponding locations. The training mode can also be leveraged by users to correct errors, e.g., after a (non-UWB) device has changed locations.

In this manner, the described techniques enable the building of a model, or map, of locations of the large number of legacy, non-UWB devices that are in use within spaces such as homes, offices, etc.

The described techniques of position localization are implemented with specific user permission. Data regarding devices in a particular space and their respective locations is utilized to enable features such as sending commands to a specific device. Such data is stored and utilized only for such user-permitted features, and in accordance with the user's preferences, e.g., only locally on the user's devices. Further, users are provided with options to exclude one or more devices from detection, or to disable the described features entirely.

CONCLUSION

This disclosure describes techniques to bootstrap precise positioning on non-UWB devices, such that UWB-style, fine-grained interactions are enabled even on non-UWB devices. The techniques leverage the presence of two or more UWB-enabled devices, e.g., one on a stationary device and another on a wearable device (or other non-stationary device), to precisely locate non-UWB devices.

REFERENCES

[1] Alam, Fakhrul, Nathaniel Faulkner, and Baden Parr. "Device Free Localization: A Review of Non-RF Techniques for Unobtrusive Indoor Positioning." *IEEE Internet of Things Journal* (2020).

[2] Tilman Reinhardt, “Using Global Localization to Improve Navigation” https://ai.googleblog.com/2019/02/using-global-localization-to-improve.html accessed on Mar. 27, 2021.