AIDE: Augmented Onboarding of IoT Devices at Ease

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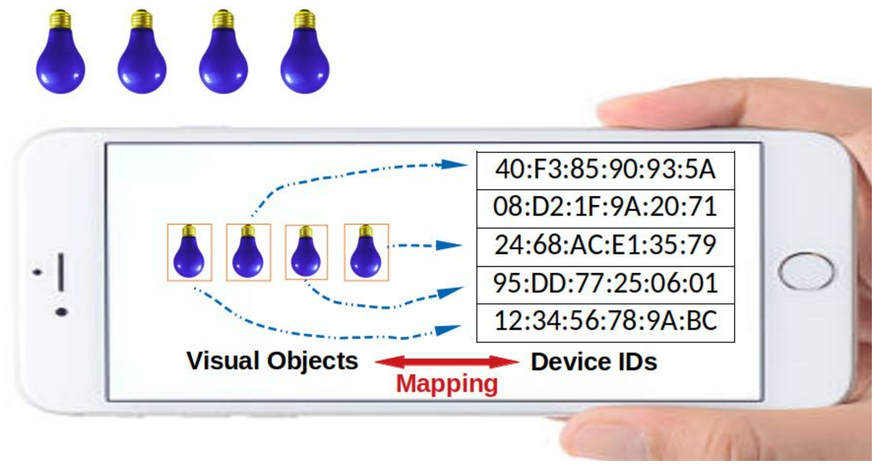
Research Background & Goals

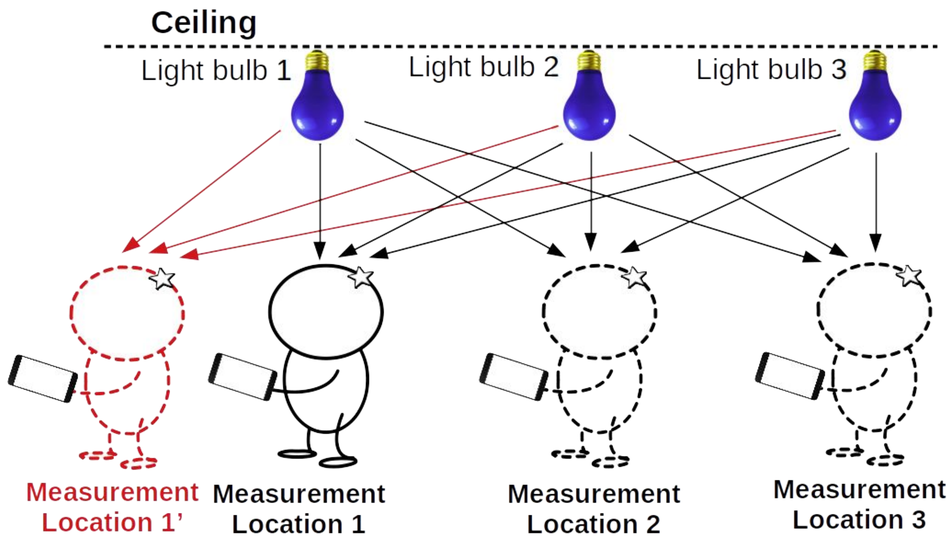
Legacy Manual Procedure
- Onboard each device one by one
- Verify

Shortcomings
- Tedious and error-prone
- Does not scale with number of devices
- Hard to verify(visually) for some devices



Our **proposal**: Map visual identity with beacon signals using smartphone

Measuring Procedure & Algorithm



We measure RSS at fixed positions closest to each target device. At each measurement location, we move our phone in a circular way when collecting RSS

$$D = \begin{bmatrix} d_{11} & d_{12} & \dots & d_{1N} \\ d_{21} & d_{22} & \dots & d_{2N} \\ \dots & \dots & \dots & \dots \\ d_{M1} & d_{M2} & \dots & d_{MN} \end{bmatrix} \Rightarrow V = \begin{bmatrix} \sum_{j=1}^{N}(d_{11}-d_{1j}) & \dots & \sum_{j=1}^{N}(d_{1N}-d_{1j}) \\ \sum_{j=1}^{N}(d_{21}-d_{2j}) & \dots & \sum_{j=1}^{N}(d_{2N}-d_{2j}) \\ \dots & \dots & \dots \\ \sum_{j=1}^{N}(d_{M1}-d_{Mj}) & \dots & \sum_{j=1}^{N}(d_{MN}-d_{Mj}) \end{bmatrix}$$

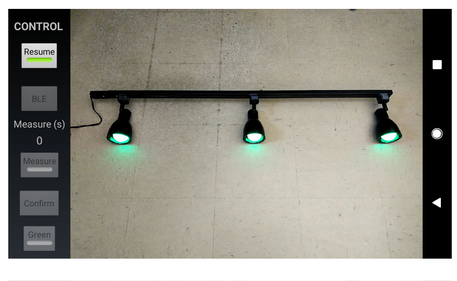
(a) RSS matrix (b) Vote matrix

- M: number of devices (including target and non-target devices)
- N: number of measurement locations

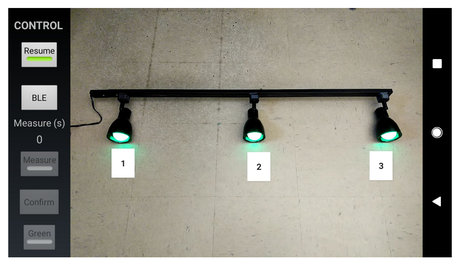
Traversing every combination of *N* devices out of *M* devices, and for those *N* devices we traverse every combination of *N* measurement locations. The result is given by the combination that has the largest summantion

Phone App Illustration

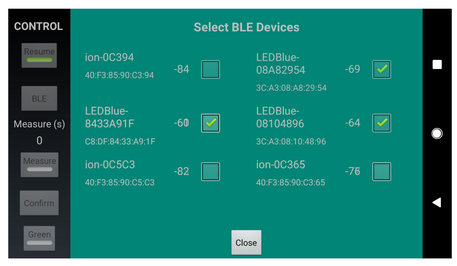
Step 1: open AIDE, focusing phone camera to the target light bulbs. Then, click Capture button to fix a picture of target light bulbs



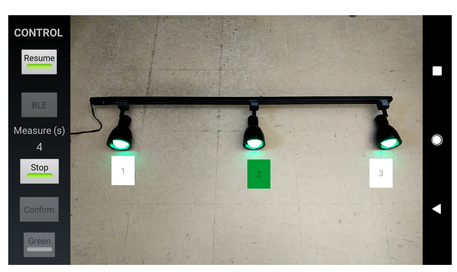
Step 2: click light bulbs on screen one by one, a button is added for each light bulb



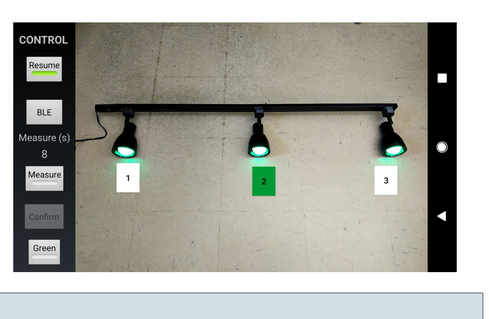
Step 3: click BLE button to select the BLE devices, including the target devices and non-target devices, then click Close button



Step 4: click each location to measure RSS. After measuring all locations, click Confirm button, which runs AIDE algorithm to associate each measurement label with a BLE

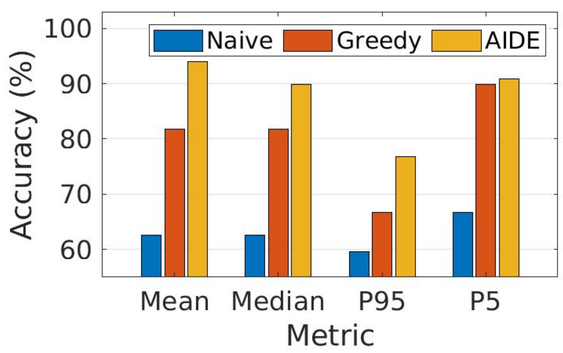


Step 4: the light bulbs can be controlled by selecting the label, and then click the togglebutton to change the color of that light bulb

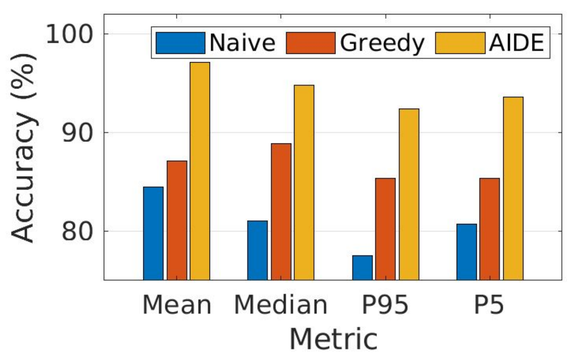


Results

2 Devices



Devices 2 feet apart



Devices 4 feet apart

4 Devices (Line) & 6 Devices (Grid)

Algorithm	Topology: Line 2 feet apart on ceiling	Topology: Grid 4 feet apart on ceiling
Naive	53.8 %	62.2 %
Greedy	76.5 %	64.4 %
AIDE	87.9 %	84.4 %

- **Naive**: At each location, select the strongest RSS as the target device
- **Greedy**: Iteratively select the strongest RSS at all locations
- **AIDE**: Voting-based algorithm considering likelihood of devices at all locations

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