Indoor Localization Supporting Smartphone Advertising

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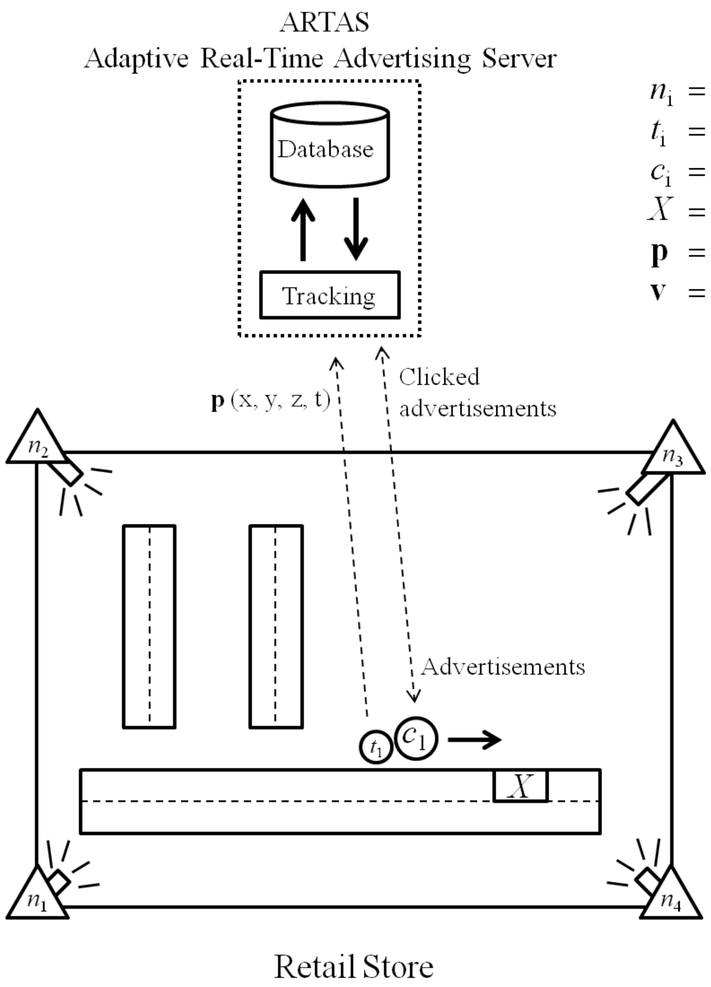
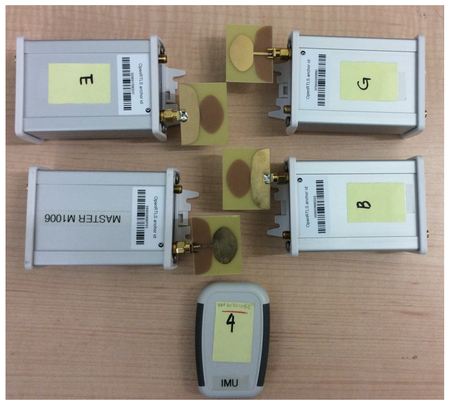
System Overview

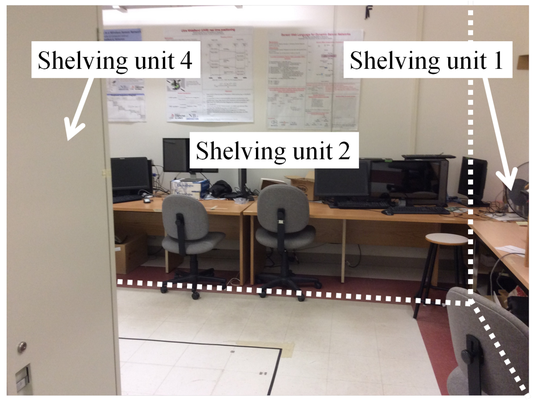


Experiment

Ultra-wideband (UWB) hardware from OpenRTLS



- 3 anchor nodes
- 1 master anchor node
- 1 tag

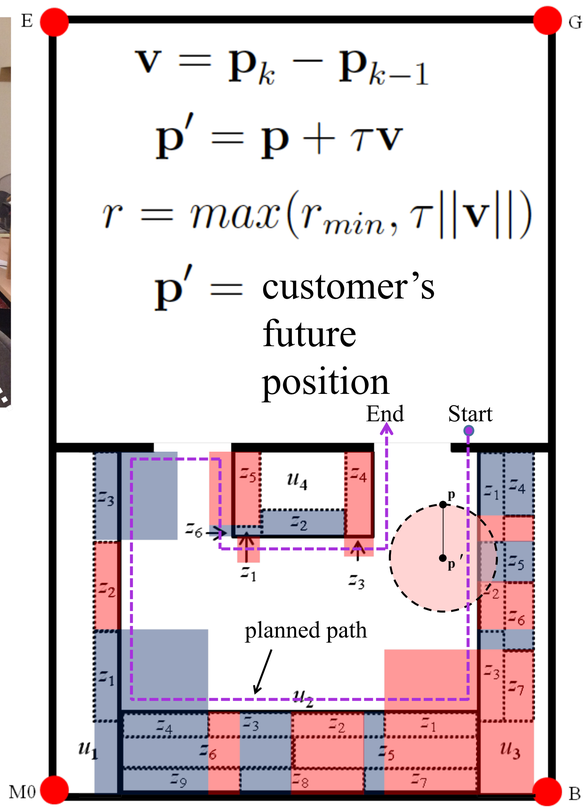


- UNB Computer Science IB214
- 4 simulated shelving units, 25 zones
- 57 items, 26 advertisements

$$S = \frac{\sum_{i=1}^{N} s_i}{N} = \frac{\sum_{i=1}^{N} \frac{T+0.5R}{M}}{N}, \quad \overline{S} = \frac{\sum_{i=1}^{n} S_i}{n}$$

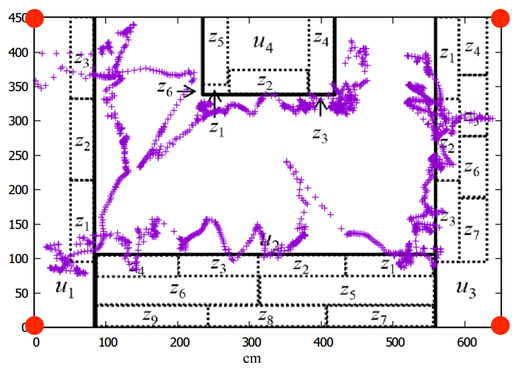
- Advertising score S measures the number of advertisements correctly ranked ($S \in [0, 1]$)
  T is the number of times all advertisements from a zone z_i were top ranked when the a simulated customer is nearest to zone z_i
- R is the number of times at least half of all advertisements were ranked when near a zone
- M is number of advertisements sent to the customer near a zone
- N is the number of overlapping zones (18 in the experiment)
- $\overline{S}$ is the average S in one or more experiments
- n is the number of test cases:16 for a single experiment, 32 for LOS and NLOS, or 64 for all experiments

$$\mathbf{v} = \mathbf{p}_k - \mathbf{p}_{k-1}$$
$$\mathbf{p}' = \mathbf{p} + \tau\mathbf{v}$$
$$r = max(r_{min}, \tau||\mathbf{v}||)$$
$\mathbf{p}'$ = customer's future position

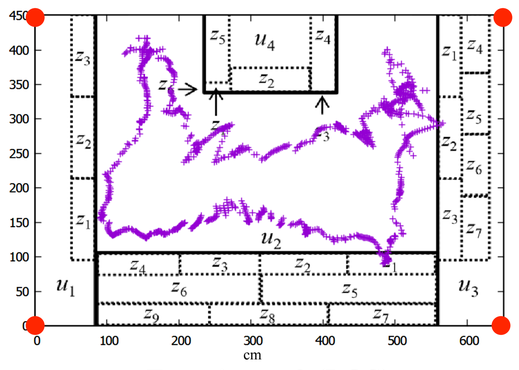


Non-line-of-sight (NLOS) setup with 4 anchor nodes showing18 overlapping zones arising from 25 advertising zones in the simulated store

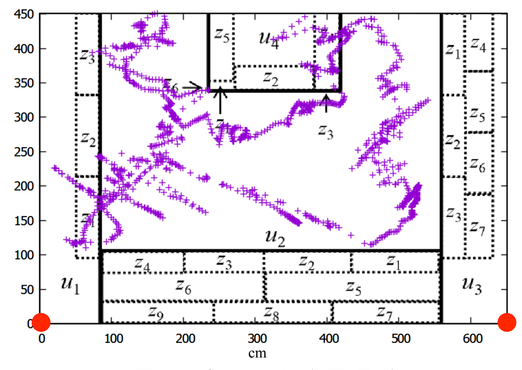
Simulated Store Results



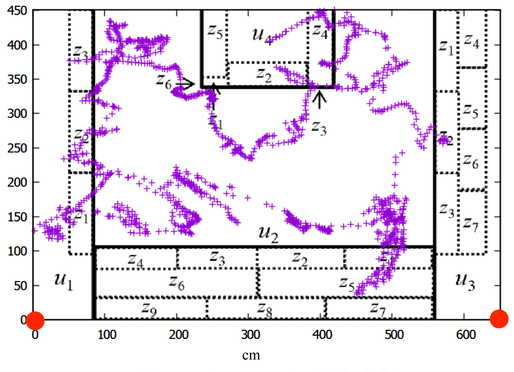
Experiment 1 (LOS)



Experiment 2 (LOS)



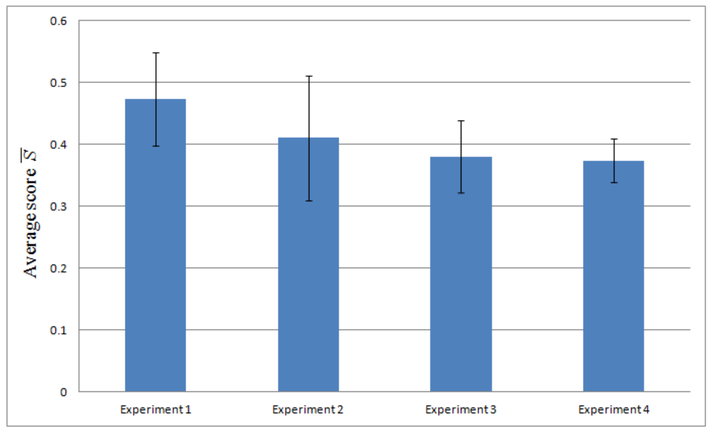
Experiment 3 (NLOS)

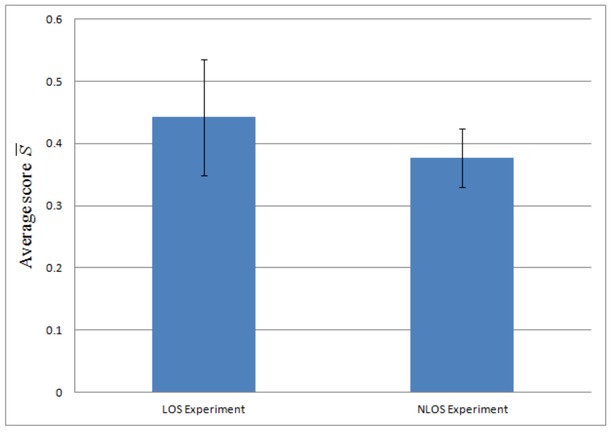


Experiment 4 (NLOS)

- Position estimates for line-of-sight (LOS) experiments (1 and 2) and non-line-of-sight (NLOS) experiments (3 and 4)

Conclusions





Experiment	$\overline{S}$ with current zones	$\overline{S}$ with current and next zones
1	0.473808363	0.610741116
2	0.410399146	0.564978273
3	0.380403349	0.468347866
4	0.373495182	0.424841859
LOS	0.442103754	0.587859694
NLOS	0.376949266	0.446594862
All	0.40952651	0.517227278

- Difference of means statistical test showed LOS and NLOS experiments are statistically different at 99% confidence level
- In a LOS environment correct advertisements are top ranked 44.4% to 48.6% of the time using position update rate $\alpha = 0.1$ seconds, advertisement update rate $\beta = 1$ second, advertisement delay $\omega = 0$ seconds, time scale factor $\tau = 1$ second, and minimum radius $r_{min} = 50$ cm.
- In a NLOS environment correct advertisements are top ranked 33.3% to 35.7% of the time using $\alpha = 0.5$, $\beta = 1$, $\omega = 0$, $\tau = 2$, and $r_{min} = 50$
- Counting advertisements from current and next zones increases average advertising score $\overline{S}$ by 0.108 (26.3%)

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