Augmented Reality Smartphone Compasses: Opportunity or Oxymoron?

Conference or Workshop Item

How to cite:

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Version: Poster

Link(s) to article on publisher’s website:
http://dx.doi.org/doi:10.1145/3341162.3343777

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Augmented Reality Smartphone Compasses: Opportunity or Oxymoron?  
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So, which way IS North?

The Issue

- Smartphone and tablet Compasses use magnetometers to sense direction
- Like any compass, a magnetometer measures only the local magnetic field inside the device
- Which is subject to magnetic influences (errors)
- The error for a calibrated device varies with the local magnetic field
- A deviation curve shows the errors against heading, typically combining a linear offset with sinusoidal components

The Experiment

12 markers were placed around the edge of a field. At the centre of the field is a stool. Participants sit on the stool and use a smartphone compass to measure the direction to each marker in turn.

17 participants, each with a different device, completed the task 4 times

The Implications

- Deviation errors in the compass used to sense smartphone orientation will mean that AR markers may be positioned incorrectly
- This is usually avoided by registration of the image against (known) object maps
- Almost by definition, people will use AR navigation apps in unfamiliar territory
- If registration is not possible, e.g., in open country or on the sea, markers will be unreliable
- Users need to understand the Apps’ limitations
- Consider the following mock-up of an AR screen

- Markers A and B are separated by less than 9°;
- B and C are about 6° apart.
- Only one points to a landmark essential to avoid submerged rocks—but which one?

The Results

- The large graph below combines the deviation curves for all 17 devices
  - “Heading” is the orientation of the device
  - The data for each device is shown beside its graph
  - “offset” - linear error
  - “amp” - amplitude of deviation curve
  - “rmse” - root mean square error after recentering to correct offset

Summary

- All tested devices display a significant deviation curve
- Maximum mean error (offset + amplitude) from 6 to 10 degrees
- Uncalibrated errors are typically much larger
- Calibration appears not to persist
- Different Apps on a device may suffer different deviation curves
- This must impact on the degree to which they can be trusted.

An iPad 2 and a 2018 iPad running the same AR compass app (CompassEye) in “plan” mode. They’re side by side, but the displayed orientations differ by 61 degrees. Which one is correct? And the difference isn’t caused simply by the magnets in one iPad affecting the other...