Using the HoloLens' Spatial Sound System to aid the visually impaired

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HoloLens' Spatial Sound System

The Microsoft HoloLens is an augmented reality system, built inside a self-contained see-through head-mounted display. The device contains many sensors (see Figure 1), used to get an understanding of its context. In its current form, the HoloLens works best indoors, because of limitations of its sensors in bright light, its dependence on WiFi and the lack of GPS.

Figure 1. Sensors in the HoloLens

The depth cameras are used to compute a so-called Spatial Mapping (see Figure 2). The HoloLens uses this mapping to determine its position relative to its surroundings, which is called inside-out tracking. This enables the HoloLens to create holograms and sounds, as if they are placed in a real-world location. These locatable sounds are called Spatial Sound.

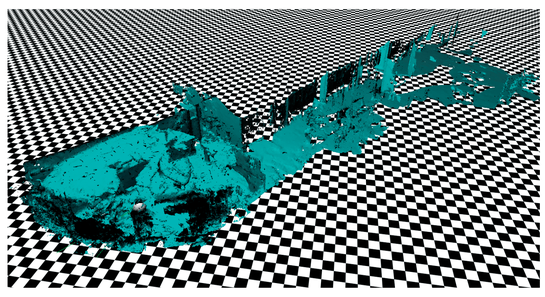
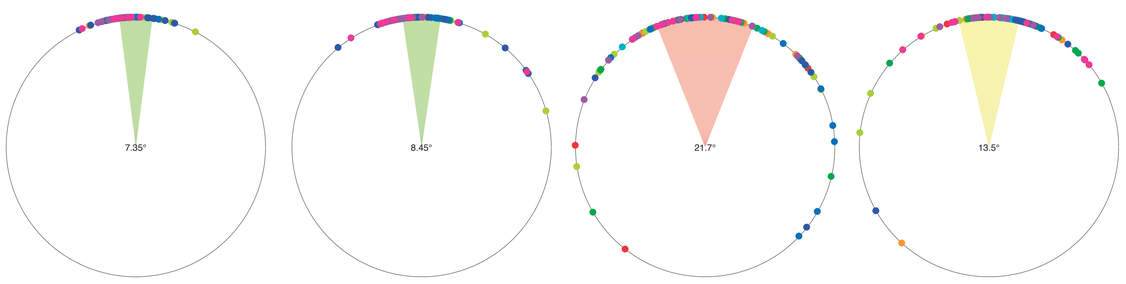


Figure 2. A Spatial Mapping

Experiment I: Direction

Spatial Sound can be used to guide a person in a certain direction. In the first set of experiments a subject is asked to point its face in the direction where a sound is coming from. The orientation of the HoloLens is continuously recorded and the angle of deviation from the actual direction is computed.

Figure 3 shows the results of 10 visually impaired persons. Each circle displays the results for a different sound configuration. Each dot on the circle is one trial with different colours representing different subjects, the coloured angle denotes the median deviation.



a) Constant noise
b) Noise at an interval
c) Half a second of noise
d) High tone

Figure 3.

Experiment II: Routes

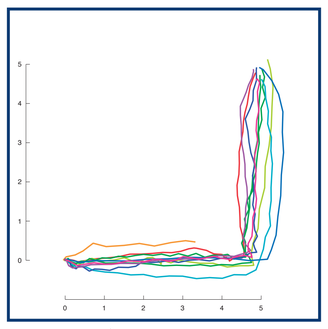
Spatial Sound can also be used to track a moving object. In the second set of experiments a subject is asked to follow a sound by continuously walking towards it. The sound moves along a pre-set path maintaining a fixed distance from the subject, until the end of the path is reached.

Figure 4 shows the results of 10 visually impaired persons. Each graph displays a different route, with different coloured lines representing different subjects and the black line denoting the pre-set path. In each graph the same sound configuration was used.

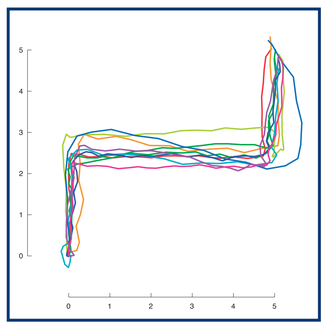
To measure the performance of the subjects, the total time needed and (extra) distance travelled is computed as summarised in Table 1.

Route	Med. dist. (m)	Med. time (s)	Path dist. (m)
1	9.80	21.75	10
2	10.11	19.12	10
3	20.07	30.85	20

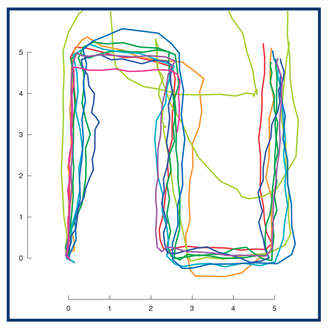
Table 1. Summary of route metrics



a) Route 1



b) Route 2



c) Route 3

Figure 4.

Findings and Future Work

The experiments have demonstrated that sounds created by the HoloLens' Spatial Sound system are accurately locatable and the system can be used to guide a person through a space. However, in its current form, the device is not yet accurate enough to replace the white cane or a guide dog. The HoloLens needs a long time to thoroughly scan the environment and to build an accurate mapping. This could be improved by pre-loading the map of a building or by using real-world markers to calibrate the mapping. Figure 5 shows the features of a toilet sign, marked by software called Vuforia, which is able to detect to these markers, or even to recognise objects.

Other ways to aid the visually impaired are by embedding software to recognise people's faces, or even expressions, using the HoloLens' camera. Figure 6 shows facial expression recognised by Project Oxford developed by Microsoft.

Lastly, a useful application available for the HoloLens is software for reading text and converting it into speech. This makes it much easier for visually impaired people to get along in public areas.

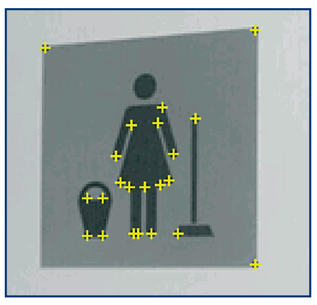


Figure 5.
Vuforia

Figure 6.
Project Oxford

Figure 7.
Text recognition

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