Non-Visual Augmented Reality as an Accessibility Tool for People with Visual Impairments

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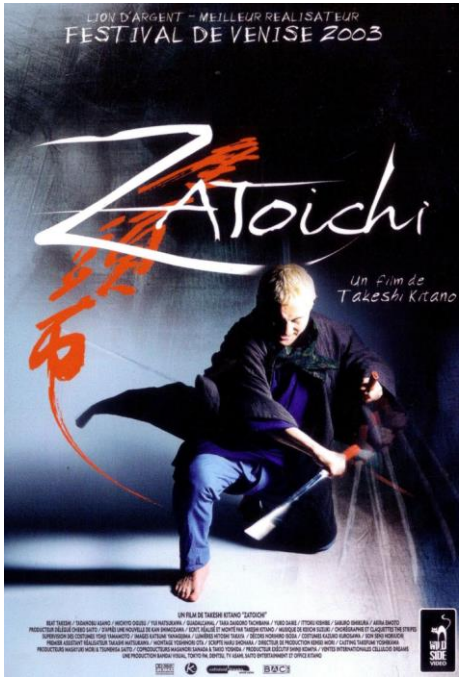
Singing Highway?
Non-Visual Speed limit Alert

Albuquerque's Singing Highway

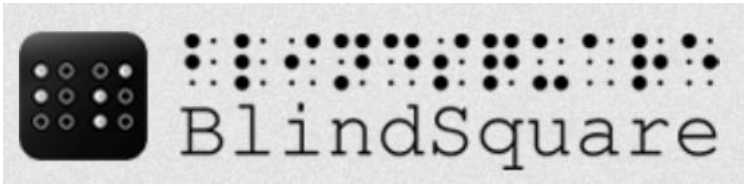
"America the Beautiful" plays for those who drive the speed limit

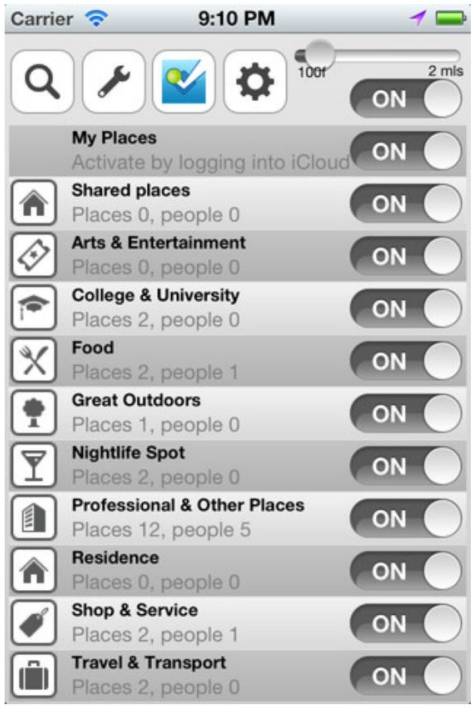
https://www.hemmings.com/magazine/hmn/2015/03/Albuquerque-s-Singing-Highway/3748211.html

What blind people can do with non-visual (spatial) information?



From Foursquare to BlindSquare(**Accessible Navigation**)





Blindsquare uses Foursquare data and Open Street Maps to guide the visually impaired

Non-visual AR

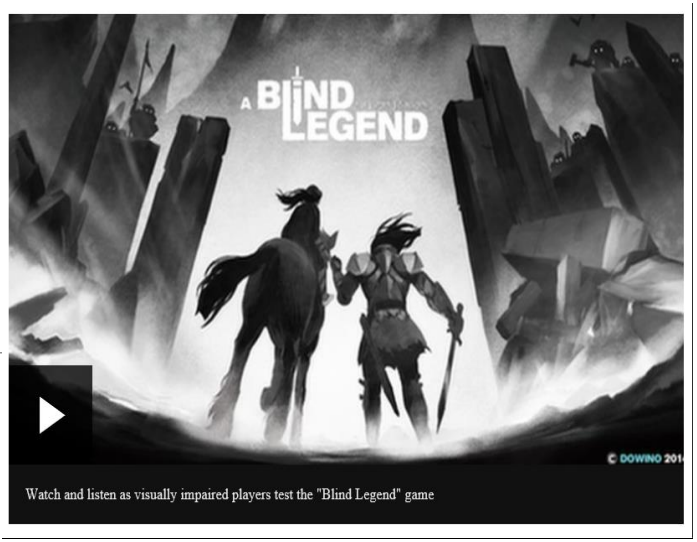
- Augmented Reality system that does not rely or create primarily visual stimulus or images in order to function
- Non-visual augmented reality is anything that adds to the user's environment without requesting attention from the user's vision.Rather, other senses are augmented and stimulated in the system.
- **Haptic, or Touch-Based Augmented Reality**
- **Location (GPS data)-Based Augmented Reality**
- **Audio-Based Augmented Reality**

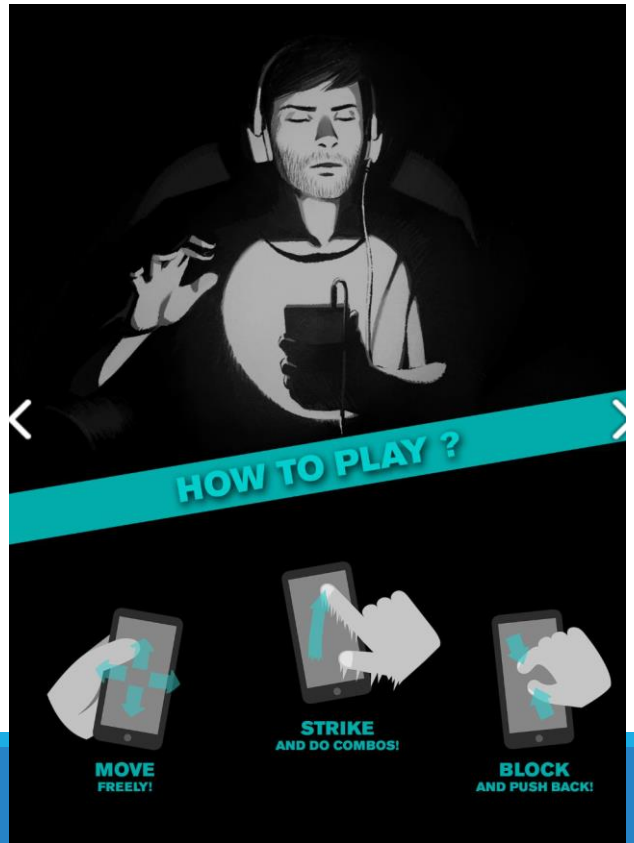
=>Towards a Multisensory Augmented Reality (Map)

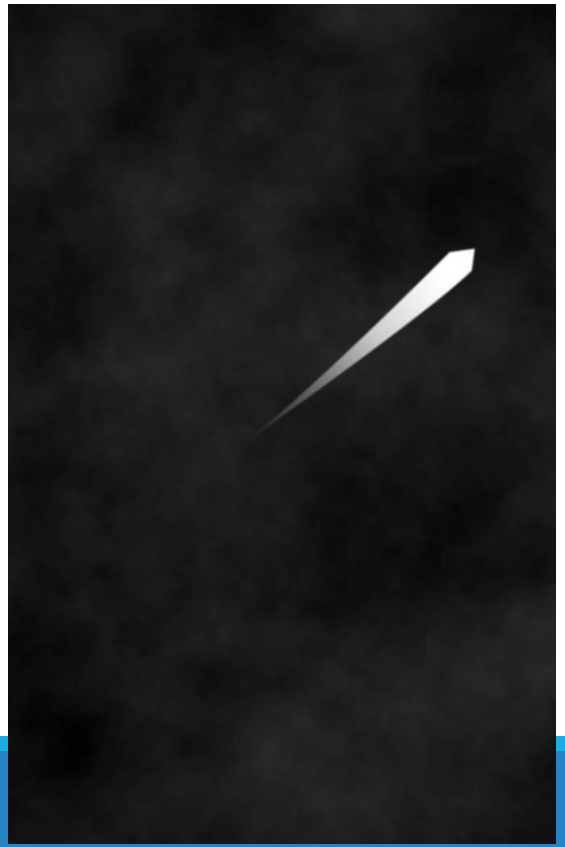
http://cyborganthropology.com/Non-Visual_Augmented_Reality

Non-Visual Game

Blind Legend: Audio Game







Why non-visual information?

For Location literacy(Orientation and Mobility) training

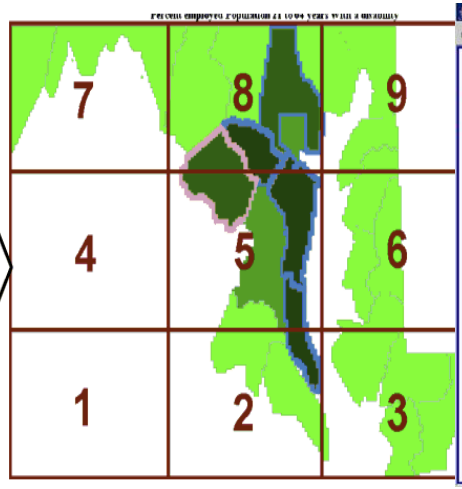
Audio Information

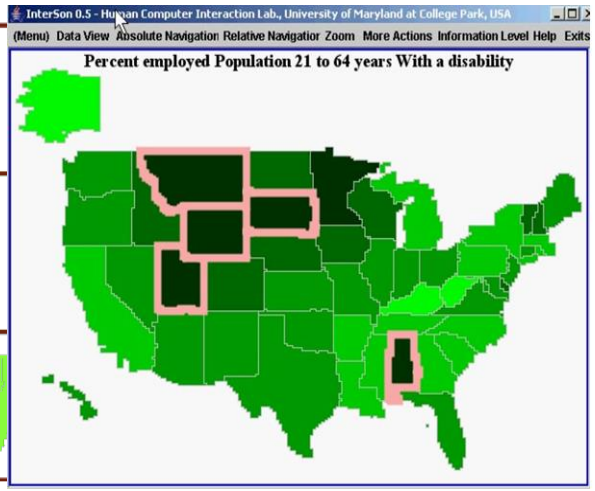
Haptic(Tactile) Information

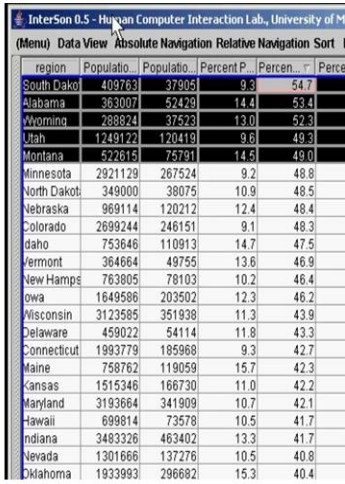
Accessibility in Graphics(map) -Sound

iSonic(Interactive Data Sonification for Blind Users)

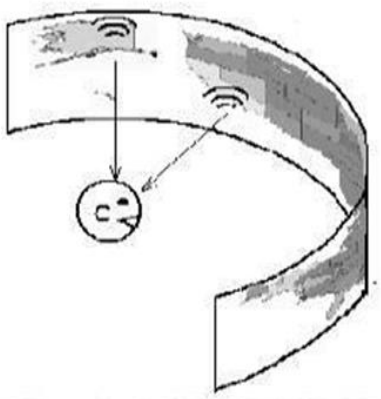
region	Population 21 t...	percent Popul...	Percent em...
Howard	9680	6.1	62.1
Anne Arundel	33639	11.5	54.9
Calvert	5643	11.3	51.1
Montgomery	33163	6.1	44.7
Baltimore	46651	10.3	43.6
Prince George's	53402	10.6	36.9
Baltimore city	64477	18.4	31.2
Allegany	0	0.0	0.0
Caroline	0	0.0	0.0
Carroll	0	0.0	0.0
Cecil	0	0.0	0.0
Charles	0	0.0	0.0
Dorchester	0	0.0	0.0
Frederick	0	0.0	0.0







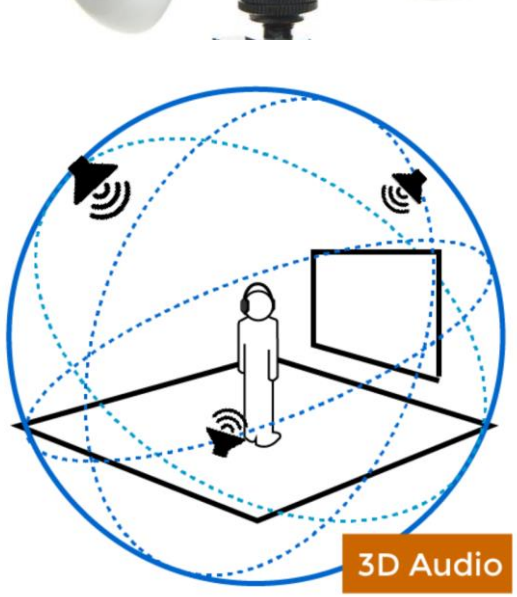
region	Populatio...	Populatio...	Percent P...	Percen...
South Dako	409763	37905	9.3	54.7
Alabama	363007	52429	14.4	53.4
Wyoming	288824	37523	13.0	52.3
Utah	1249122	120419	9.6	49.3
Montana	522615	75791	14.5	49.0
Minnesota	2921129	267524	9.2	48.8
North Dakot	349000	38075	10.9	48.5
Nebraska	969114	120212	12.4	48.4
Colorado	2699244	246151	9.1	48.3
daho	753646	110913	14.7	47.5
Vermont	364664	49755	13.6	46.9
New Hamps	763805	78103	10.2	46.4
owa	1649586	203502	12.3	46.2
Wisconsin	3123585	351938	11.3	43.9
Delaware	459022	54114	11.8	43.3
Connecticut	1993779	185968	9.3	42.7
Maine	758762	119059	15.7	42.3
Kansas	1515346	166730	11.0	42.2
Maryland	3193664	341909	10.7	42.1
Hawaii	699814	73578	10.5	41.7
ndiana	3483326	463402	13.3	41.7
Nevada	1301666	137276	10.5	40.8
Oklahoma	1933993	296682	15.3	40.4

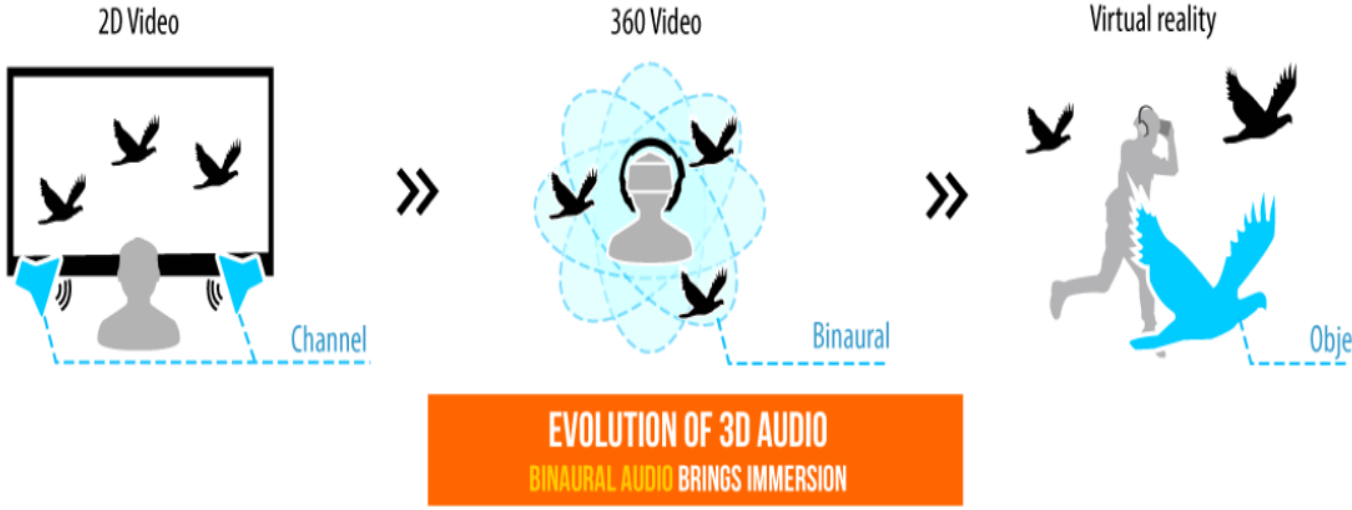


http://www.cs.umd.edu/hcil/audiomap/

Accessibility in Graphics(map) -3D Audio(Binaural audio)

Binaural audio Mic

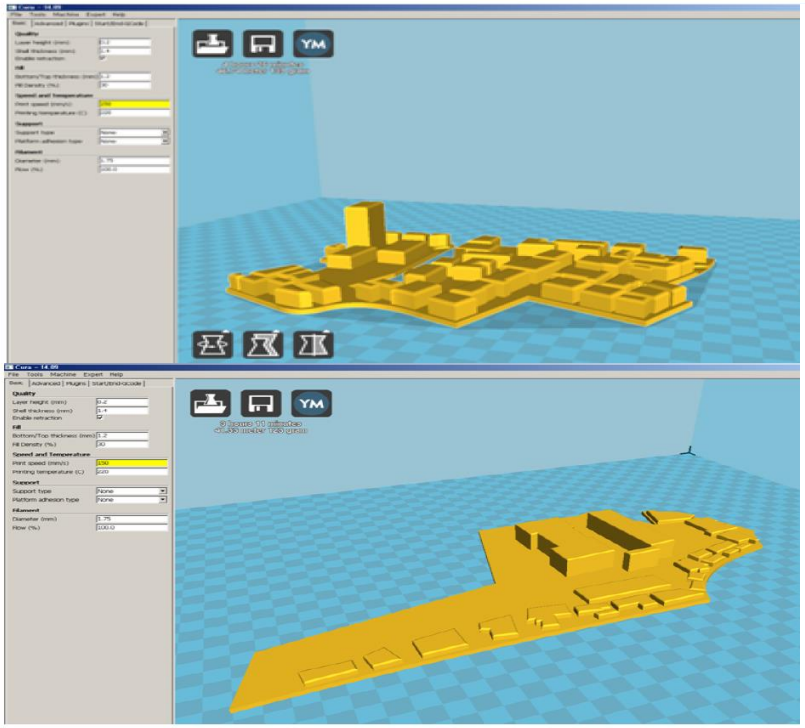




https://arvrjourney.com/binaural-audio-how-3d-audio-hacks-your-brain-a3de0ceb4196

3D Tactile design for Blind people

- Finger map Project(korea)

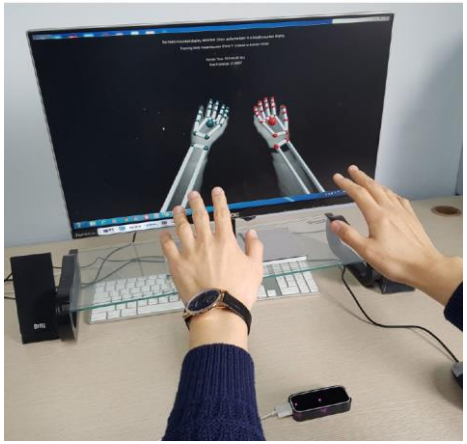


음성 가이드 라인

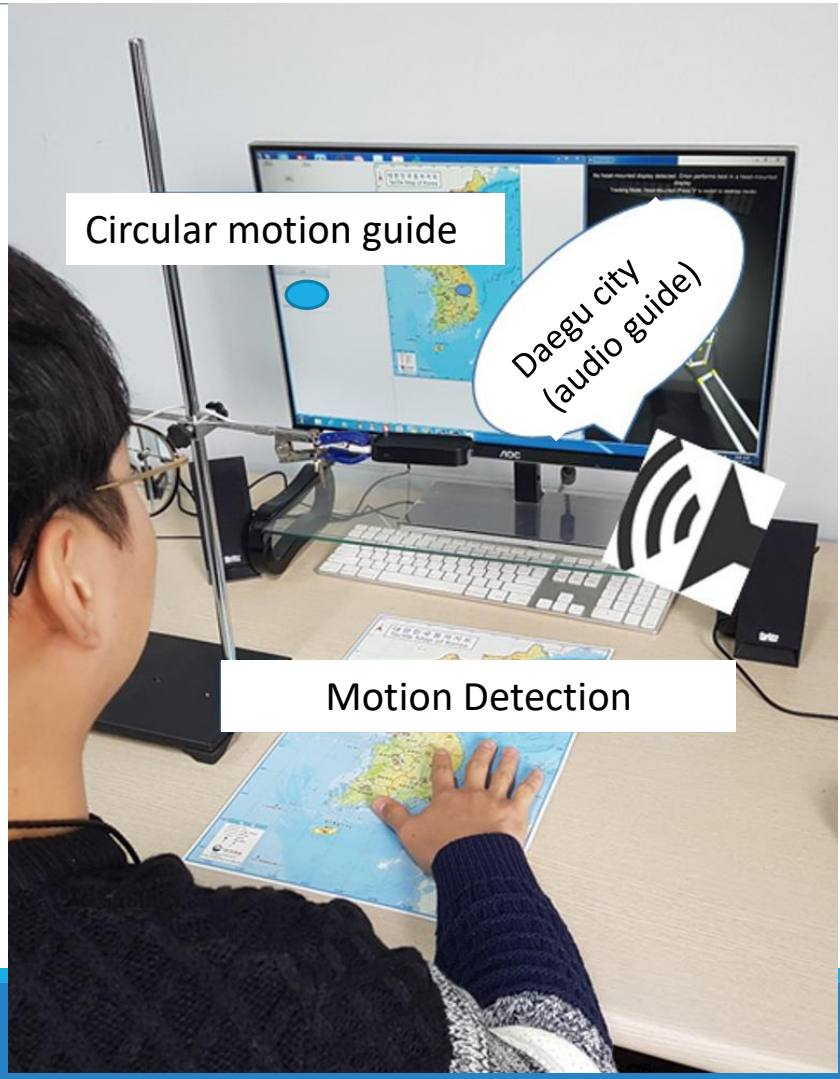
이인해, 김지은, 2016, 3D촉지도 디자인 사례

Audio Tactile Map with Motion Detection Device

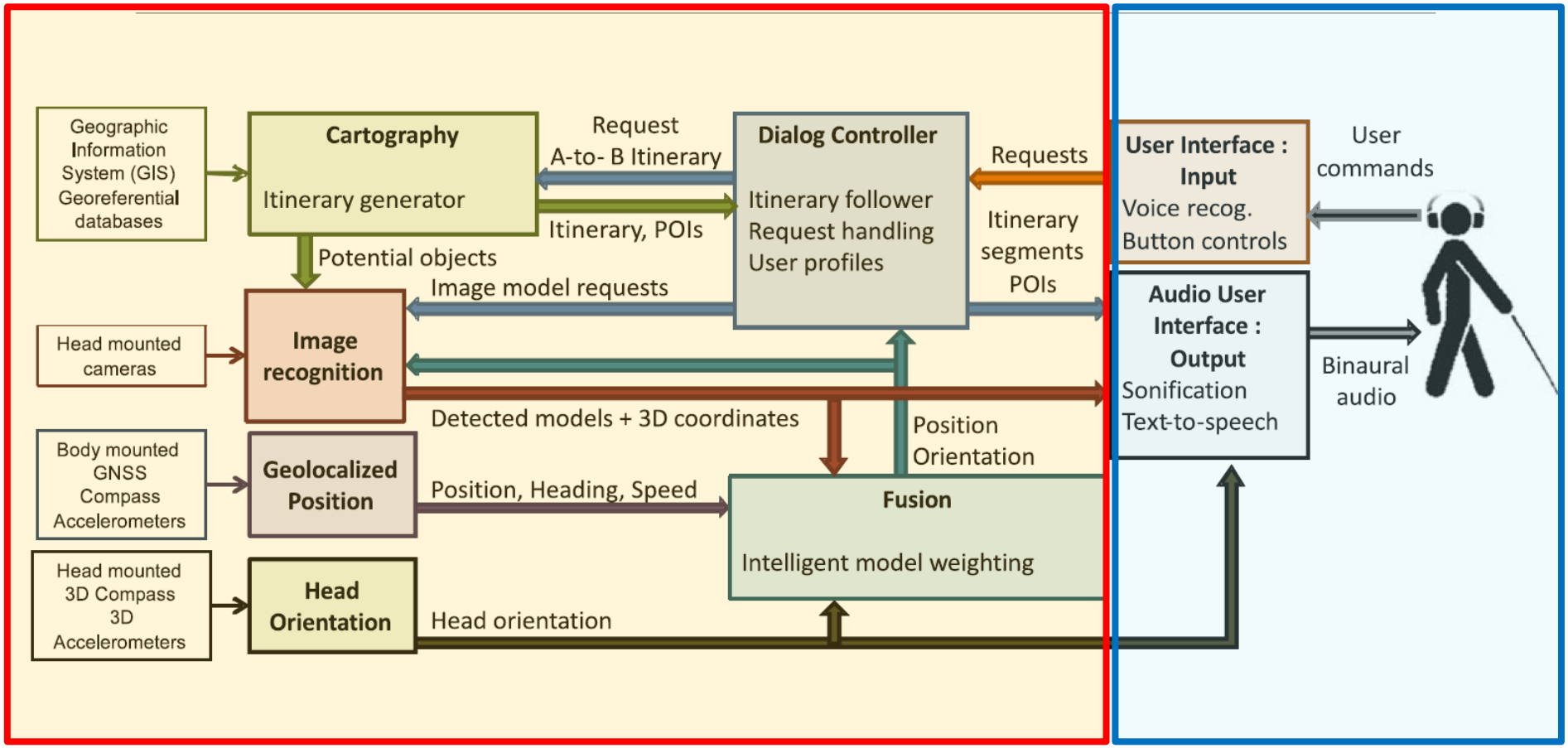
Tactile Map



Motion Detection Device



Visual information in Non-visual AR?



Visual Information

Non-Visual Information

Brian F. G, et.al, 2012, NAVIG: augmented reality guidance system for the visually impaired

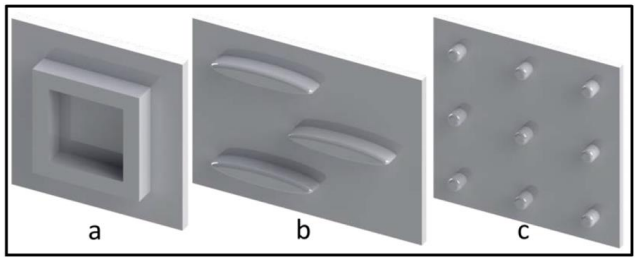
Conclusion: Accessibility for AR and VR

- Improve Augmented Accessibility

=>Augmented Reality environment accessible to disabled users

- Universal Design Support for geographical information for visually impaired and all other people
- Necessity of standardization of Non-Visual AR

  (Non-verbal expression such as color symbol)



Color Symbol shapes for:
(a) sky blue, (b) purple and (c) yellow.

Symbol	Colour represented	Symbol	Colour represented
	Red		White
	Blue		Black
	Yellow		Sky Blue
	Green		Light Pink
	Orange		Fuschia
	Purple		Apple Green
	Brown		Grey

RAMSAMY-IRANAH, S. ...et al., 2016. A comparison of three materials used for tactile symbols to communicate colour to children and young people with visual impairments. British Journal of Visual Impairment, 34(1), pp. 54-71