Analyzing Augmented Reality Applications in Picturebooks
Dr. Frank Serafini (serafini@asu.edu)
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Bridging virtual and real worlds, augmented reality technology is used to create experiences that enhance and augment traditional reading experiences that are not possible in print-based environments. Augmented Reality (AR) applications use visual markers to view and manipulate virtual graphics and sound effects in a real-world environment, in particular a print-based picturebook. AR integrates interactive sequences into picturebooks and makes them "come-to-life" through interactive visualizations, 3D graphics, simulations, and audio accompaniments. As readers turn the pages of a print-based picturebook and focus the camera of a hand-held device, for example an iPad, the software application (app) reads the visual markers using a form of vision based tracking technology and allows the reader to interact with the app to manipulate virtual objects and events connected to the visual images and multimodal features of the picturebook.

The digital or AR application downloaded onto a hand-held device expands the affordances of the print-based picturebook in revolutionary and unique ways and requires new abilities for readers to take advantage of the interactivity and enhanced features of these apps.

Virtual reality is a totally immersive environment, whereas augmented reality blends virtual components with real-world environments and objects. Picturebook augmentation begins with a literary world that is both virtual (visualized in readers heads) and real-world (the images and text in the picturebook) and augments or superimposes virtual and 3D graphics and audio files onto the picturebook reading experience.

Early examples of AR use in picturebooks:
- MagicBook
- Paddles or QR codes (fiducial markers) were used as markers to signal the technologies to activate elements on a picturebook page
- Envisioned as a digital "pop-up" book
- Originally used in the fields of medicine, the military, robotics, and manufacturing, AR is increasingly used in advertising & entertainment.

Review of research on AR
- Most research has focused on the technology of AR
- Early research focused on how the reader used the applications and technology –issues about how the technology did or did not work.
- Cognitively-based research has focused on issues of cognitive overload, cognitive change, and increased spatial abilities.
- Viewing AR as a concept rather than simply a form of technology
- Not many studies looking at AR and actual readers

The advent of the hand held device and natural tracking features has started the current revolution in designs and uses of augmented reality.

Essential Characteristics of AR
- Combines real world and virtual environments
- Interactive in real time
- Requires digital technologies

Features of Picturebook Augmented Reality Applications
- Hand-held devices and natural tracking technology (vision-based)
- On-the Fly reconstruction (localization)
- Embodied interactions
- Enhancement of narrative features through AR images and texts
- Initially considered as "digital pop-up" books

An Emerging Typology of Augmented Reality Picturebooks
- *Narrative Augmentation* – take elements from picturebook and add animation to existing characters, objects, or the setting. (Morris Lessmore)
- *Visual Augmentation* – add visual elements, virtual objects and characters, to picturebook storyworld not in print version. (Horrible Hauntings)
- *Information Augmentation*– information is provided that was not part of the original story or informational picturebook, video clips, text, and images. (Bugs 3D, iSolar System)
- *Environmental Augmentation* – adding graphic elements from the book to the environment. (iDinosaur)
- *Game-Based Augmentation* – adds gaming modules to the narrative aspects of the picturebook. (The Numberlys)

Future Research Projects
- Using augmented reality apps and video / tablet recording devices; investigate the actions of young readers accessing augmented reality picturebooks.
- Continue the analysis of potential affordances and limitations of new and varied augmented reality picturebooks.

Selected References
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