

Star Wars and CNN showed how the technology could enhance communication and information presentation, but like many enabling technologies, AR can be used in a wide variety of application domains. Researchers have developed prototypes in medicine, entertainment, education and engineering, among others. For example, doctors can use AR to show medical data inside the patient body [Navab et al., 2007, Kutter et al., 2008], game players can fight virtual monsters in the real world [Piekariski and Thomas, 2002a], architects can see unfinished building [Thomas et al., 1999], and students can assemble virtual molecules in the real world [Fjeld and Voegtli, 2002]. Figure 1.1 shows a range of applications.

The potential of AR has just begun to be tapped and there is more opportunity than ever before to create compelling AR experiences. The software and hardware is becoming readily available as are tools that allow even non-programmers to build AR applications. However there are also important research goals that must be addressed before the full potential of AR is realized. The goal of this survey is to provide an ideal starting point for those who want an overview of the technology and to undertake research and development in the field. This survey compliments the earlier surveys of Azuma [1997], Azuma et al. [2001], Van Krevelen and Poelman [2010] and Carmigniani et al. [2011] and the

research survey of Zhou et al. [2008]. In the next section we provide a more formal definition of AR and related taxonomies, then a history of the AR development over the last 50 years. The rest of this survey gives an overview of key AR technologies such as Tracking, Display and Input Devices. We continue with sections on Development Tools, Interaction Design methods and Evaluation Techniques. Finally, we conclude with promising directions for AR research and future work.



(a) ARQuake outdoor AR game [Piekariski and Thomas, 2002a]



(b) AR architecture by Re+Public <http://www.republiclab.com>



(c) AR in medicine [Kutter et al., 2008]

**Figure 1.1:** Typical AR applications.



**ADVISORY COMMITTEE**  
DR.PRASHANT CSR  
DEAN ACADEMICS, PROF AND HEAD,  
DEPT OF CSE

PROF CLARA KANMANI A  
DEPT OF CSE

**STUDENT EDITORS**

VAIBHAV SHARMA  
SAHANA P REDDY

# NEW HORIZON COLLEGE OF ENGINEERING

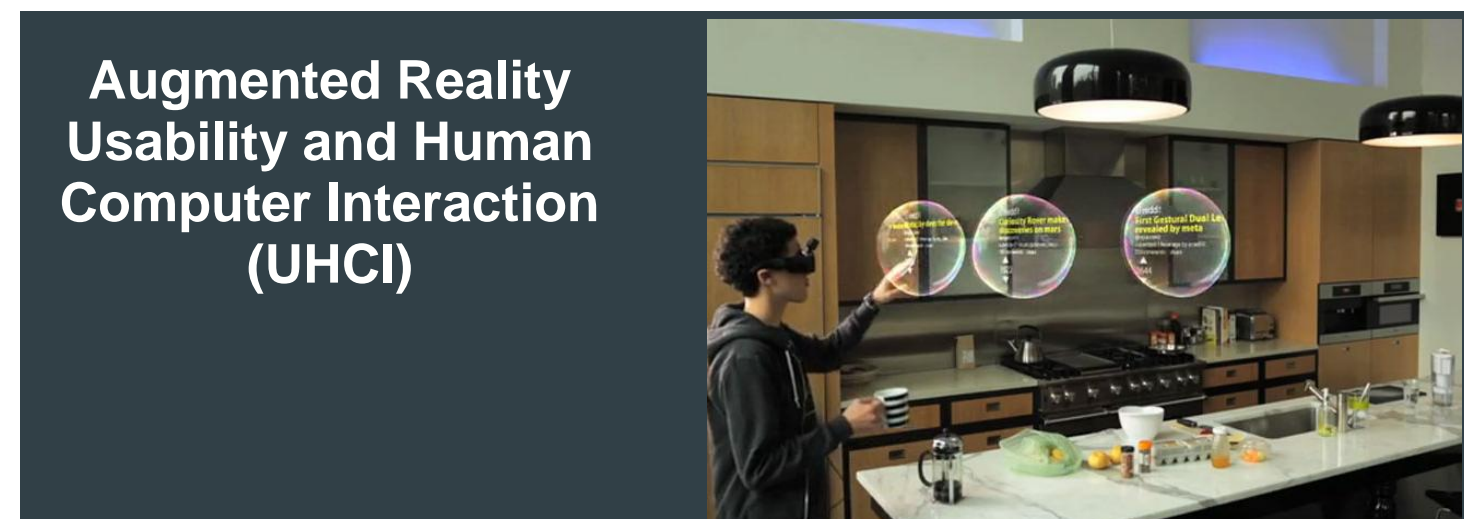


**USABILITY & HUMAN COMPUTER INTERACTION**  
**EMERGING TECHNOLOGY**



DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

UHCI / Q1 / SEP 2015



In 1977 many moviegoers were amazed as a small robot projected a three-dimensional image of a woman in mid air. With the words "Help me Obiwan-Kenobi, you're my only hope", a recording of Princess Leia delivered a message that would change Luke Skywalker's life forever. In this Star Wars scene, special effects were used to create the magical impression that three-dimensional virtual content was appearing as part of the real world. The movie forecast a future where people could interact with computers as easily as interacting with the real world around them, with digital and physical objects existing in the same space.

Thirty years later, in the 2008 US presidential campaign, a version of technology was shown for real. During the CNN election coverage reporter Wolf Blitzer turned to an empty studio and suddenly a life sized three-dimensional virtual image of reporter Jessica Yellin appeared beamed in live from Chicago.

The CNN experience is an example of technology known as Augmented Reality (AR), which aims to create the illusion that virtual images are seamlessly blended with the real world. AR is one of the most recent developments in human computer interaction technology. Ever since the creation of the first interactive computers there has been a drive to create intuitive interfaces. Beginning in the 1960's, computer input has changed from punch cards, to teletype, then mouse and key-board, and beyond.

One overarching goal is to make the computer interface invisible and make interacting with the computer as natural as interacting with real world objects, removing the separation between the digital and physical. Augmented Reality is one of the first technologies that makes this possible.