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TUS Research

A Quality of Experience Evaluation of Example versus Procedural Instruction Formats for Augmented Reality Based Procedure Training.

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INTRODUCTION

Augmented reality (AR) is a technology that can enhance the user's world view with computer generated information.

This information can take the form of the domain-specific instructions required for successful completion of novel procedures.

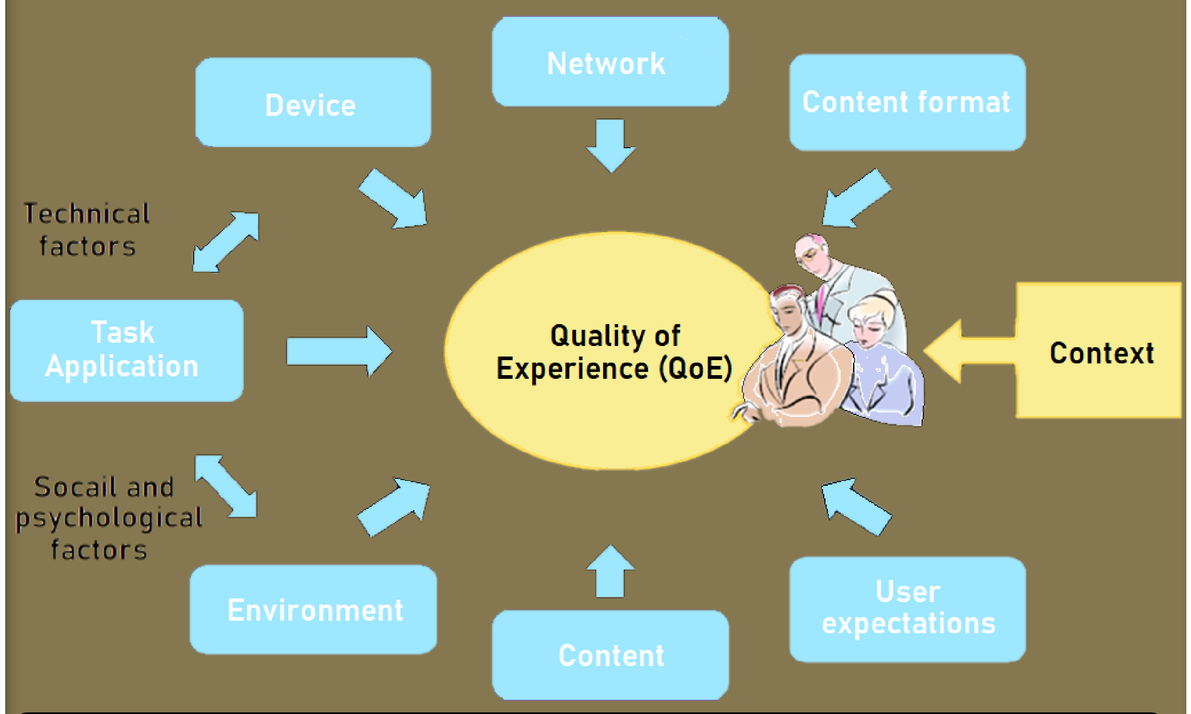
A procedure is a suite of steps that must be followed in strict order for successful completion. A novel procedure is one that is new to the user.

Instruction format is a consideration concerning efficient use of limited power and computation resources on mobile AR devices.

Procedural instructions describe how to complete tasks in a stepwise manner and examples demonstrate how instances of the task are carried out.

Crucial to user acceptability of AR for the procedure assistance role is high quality of experience (QoE). QoE is concerned with the degree of fulfilment of the user's pragmatic and hedonic needs and expectations which will be influenced by instruction format.

This is measured in terms of the user's degree of delight or annoyance i.e., emotional response to stimuli, manifesting as changes in physiology and thought patterns which are measurable using sensors and questionnaires. Although the individual human experience is subjective, it is underpinned by this common physiological mechanism. However, it is influenced by personality, context, technical, social and psychological factors.



EXPERIMENTAL METHODOLOGY

A Rubik's Cube solving procedure will be used for this evaluation.

An AR application will be used to train the participants in a 4 move Cube solving procedure.

Independent samples; Two independent test groups. The main test group will have the benefit of an animated Rubik's Cube model Example instruction demonstrating how to perform each instruction. The control test group will have text only procedural instructions, describing how to perform each instruction.

Objective Task performance:

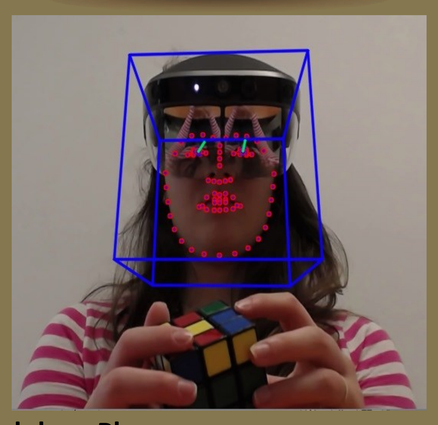
1. Learning evaluated in a post training unassisted demonstration of the Cube solving procedure.
2. Transfer evaluated in post training demonstration of a mental rotation task.
3. Resource consumption of instruction formats on memory and frame rate.

Explicit Experience Questionnaires:

1. Likert scale questionnaire including cognitive load questions.
2. Self Assessment Manikin (SAM) affect questionnaire.
3. NASA-TLX (Task Load Index) questionnaire.

Implicit metrics :

1. Physiological ratings (EDA, BVP, IBI, Skin temperature).
2. Eye gaze. Gaze shift rate, blink rate, scan path, fixation duration features will be extracted.
3. Normal and Micro-facial expressions Via video and Action Units (AUs).



AUs	Full Name	Emotion	Image of AU
AU10	Upper lip raiser	Disgust	
AU12	Lip corner puller	Happy	
AU15	Lip corner depressor	Sad	
AU20	Lip stretched	Fear	
AU26	Jaw drop	Surprise	
Neutral	Lips relaxed and closed	Neutral	

Methodology Phases:

1. **Information sharing** - In this phase, volunteer participants will informed that they will be required to use a Hololens 2 AR headset to learn how to solve a Rubik's Cube using Example of Procedural instruction formats. They will provide informed consent prior to beginning.

2. **Screening** - Participants will be screened for visual acuity and spatial cognition. Spatial cognition will provide a baseline for transfer evaluation.

4. **Instruction** - The participants will be instructed how to wear the AR headset and how to manipulate the Rubik's Cube as required.

5. **Practice** - Demonstration of understanding of the Rubik's Cube manipulation instructions Upon successful demonstration of understanding, the participants proceeded to training.

6. **Baseline** – Begin recording physiological ratings and facial expressions.

7. **Training** – The participants receive Cube solving training in AR under one test condition. Recoding of implicit metrics continues throughout this phase.

8. **Post Training recall** – Participant demos learning during unassisted reproduction of the Cube solving procedure. Recording of implicit metrics continues during this phase.

9. **Questionnaires** – Participants answers all questionnaires and completes a further mental rotation task to evaluate transfer.

Goals

1. Evaluate user QoE of Example versus Procedural instruction formats for AR training.

2. Evaluate resource efficiency of Example versus Procedural instruction formats on the Hololens 2 AR headset.

3. Identify novel implicit metrics of predicative utility of user QoE for real time continuous use of AR for procedure assistance by means of correlation analysis to subjective QoE

4. Evaluate utility of object tracking versus voice command for procedural AR application control.

5. Evaluate any correlation between participant defined affect semantics, Russel's 3D emotion space and SAM responses regarding asymmetrical usage QoE definition.

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