Toward a New Assessment of Quality

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A convergence of trends is shifting the focus of quality assessment from compliance with system design goals to fulfillment of user needs or expectations in different contexts.

In computing and communications systems, quality is often difficult to define. Attempts to understand this concept date back to Aristotle, who included quality as one of his 10 categories of human apprehension. ISO standard 8402:1986 defines quality as "the totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs," which embraces objective as well as subjective parameters. In practice, however, quality could be compared to the elephant in the famous Indian parable about a group of blind men who each feels a different part of the animal and thus they disagree as to what it looks like.

Under the auspices of the European COST (Cooperation in Science and Technology) framework, Action IC 1003, or Qualinet—the European Network on Quality of Experience in Multimedia Systems and Services (www.qualinet .eu)—defines quality as

... the outcome of an individual's comparison and judgment process. It includes perception, reflection about the perception, and the description of the outcome. In contrast to definitions which see quality as "qualitas", i.e. a set of inherent characteristics, we consider quality in terms of the evaluated excellence or goodness, of the degree of need fulfillment, and in terms of a "quality event" [which is] an observable occurrence ... determined in space (i.e. where it occurs), time (i.e. when it occurs), and character (i.e. what can be observed).[1]

Here we discuss three aspects of quality suggested by this definition—quality of experience (QoE), quality of sensory experience (QuaSE), and quality of life (QoL)—and the challenges quality assessment poses to system designers.

QUALITY OF EXPERIENCE

Until recently, the most commonly cited definition of QoE was a recommendation by the International Telecommunication Union: "the overall acceptability of an application or service, as perceived subjectively by the end-user."[2] Depending on the context, however, one might "accept" an application or service without necessarily being happy or satisfied with it. Thus, Qualinet goes a step beyond and defines QoE as "the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and/or
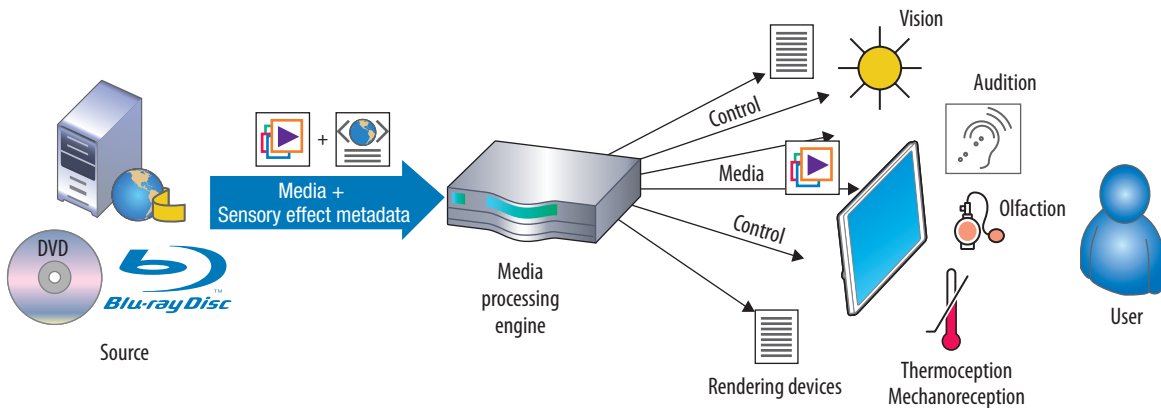
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Figure 1. Providing users with a "sensory experience" that transcends vision and hearing requires annotating multimedia content with additional metadata to appropriately control the technologies capable of rendering multiple sensory effects.

enjoyment of the application or service in the light of the user's personality and current state."[1] QoE is thus determined by various technical as well as social and psychological factors.[3]

QUALITY OF SENSORY EXPERIENCE

Traditionally, QoE assessment is based largely on vision and hearing. However, many emerging forms of content—especially social multimedia—can stimulate other senses including olfaction, mechanoreception, and thermoception that elicit a wide range of emotions.[4,5] As Figure 1 shows, providing users with a "sensory experience" that is both informative and enjoyable requires annotating multisensory media, or *mulsemedia*, content with additional metadata to appropriately control the technologies capable of rendering these effects.[6]

Assessing QuaSE requires a new scientific framework that answers questions such as the following: How do we create, deliver, and consume multisensory experiences? What subjective and objective metrics should we use? How do we interpret the results? In the past few years, many researchers have begun to address these questions.

QUALITY OF LIFE

By including the full sensory experience, we're taking large steps toward assessing QoL, a concept that dates back to the 18th century. Francis Hutcheson was among the first thinkers to explore QoL in a rigorous and scientific way, defining it as the general well-being of individuals and societies. QoL has application in fields as diverse as international development, healthcare, politics, employment, and, more recently, social life networks.[7,8]

As Figure 2 shows, in the area of computing and communications systems, QoL lies at the intersection of three main trends.

First, technologies such as high-dynamic-range and high-frame-rate video, high-definition and ultra HD television, and 3D augmented and virtual reality are delivering richer and more immersive multimedia experiences. Advanced interfaces integrate multisensory input and output—most recently including smells, which can be communicated via the prototype oPhone.[9] These advances, together with faster processing, more efficient content management, and pervasive broadband connectivity, are enabling
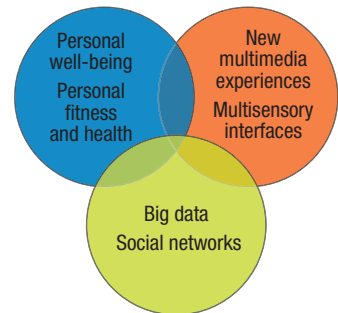

Figure 2. The intersection of current trends will make it possible to move beyond traditional concepts of service or product quality to more broadly assess how a combination of technologies contributes to quality of life.

users to interact with multimedia in novel ways.

Second, affordable wearables such as smart watches and health bands that can sense users' movements, capture their physiological signals (heart rate, respiration rate, and so on), and log physical activity are becoming increasingly popular. These devices can help users better understand themselves to improve their fitness, health, and overall well-being.

Third, the number of sensing devices that can gather and process data from users as well as their environments is rapidly growing. At the same time, social networks that let users share information and experiences are expanding. New data mining techniques can leverage contextual information from these sources to provide specific recommendations that help users make more informed decisions.

As these trends converge, we'll be able to move beyond traditional concepts of service or product quality to more broadly assess how a combination of technologies contributes to QoL. Quality assessment will become increasingly interdisciplinary, requiring expertise from various fields including computer science, medicine, and the social sciences. Unfortunately, insufficient synergy among these disciplines is inhibiting progress.

Our transition from passive content consumers to prosumers—active content creators who share information—has changed the meaning of quality, which can vary considerably according to context. Technologies can no longer be assessed in isolation: a product or service is part of an ecosystem that affects different people in different ways. For example, low-resolution video might be acceptable in circumstances where timeliness and ease of distribution are higher priorities than quality, but not where the sensory experience has primacy.

A convergence of trends—advances in multimedia rendering and interfaces, the widespread deployment of health- and fitness-related devices and apps, and the generation and analysis of big data from sensor and social networks—is shifting the focus of quality assessment from compliance with simple design goals to fulfillment of user needs or expectations in particular circumstances. By integrating research from multiple disciplines, we may be able to go beyond measuring a technology's quality of experience to assessing its contribution to our quality of life. ▣

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