Tangible Media based on Interactive Technology: iT_Media

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Abstract: Recent paradigm in technology shifts from object-based technology to environment-based technology. Issue here is interaction among humans and the world around humans, which is natural and artificial "space." Holistic interactions based on "Mom (embodiment)" suggest a good starting point for exploring this issue. Soft engineering, "Mom," holistic interactions, tangible space, ubiquitous computing, science of emotion, and interactive media are key concepts in interactive technology. Interactive tangible media "iT_Media" is proposed to explore and synthesize these ideas. Interactive technology initiative (ITI) is an interdisciplinary research group to search for the proper technology and the proper way of implementing technology: "interactive technology" or "soft engineering." Some experimental activities conducted by ITI are presented in this session, "Interactive Technology."

Keywords: Soft engineering, Mom (embodiment) & interactive technology, tangibility, ubiquity, emotional design, interactive media

1. INTRODUCTION

Recent paradigm in technology shifts from object-based technology to environment-based technology. As Mark Weiser once said that the most profound technologies are those that disappear, ubiquitous computing is right now the hottest issue all around the world. Recent interactive revolution tries to advance information technology by newly interpreting "space" surrounding us and interaction with the world around us-natural and artificial [1-5].

According to the recent studies on intelligence, intelligence is thought to be related to interaction rather than as deep but passive thinking. Interactions among human, machines and environment require new interpretations for the space among them. Holistic interactions based on "Mom (embodiment)" suggest a good starting point for this endeavor. Soft engineering, "Mom," holistic interactions, tangible space, ubiquitous computing, science of emotion, and interactive media are key concepts in interactive technology [6, 7].

Soft engineering is a new engineering field to explore proper technology and proper ways of engineering. A new technology paradigm based on soft engineering approach is investigated. Tangible space focuses on embodied interactions among humans and environment, virtuality, and sensation/perception. Science of emotion relies on the notion that emotions allow you to make quick and proper decisions. As emotions are critical to human behavior, they are equally critical for intelligent machines, especially autonomous machines of the future that will help people in their daily activities. By understanding these machines as interactive media we encounter in everyday activities, we can find a proper deign methodologies. So interactive tangible media "iT_Media" is proposed to explore and synthesize these ideas. This is an essay regarding my personal quest for intelligence and intelligent systems.

This essay is about my personal quest for intelligence and intelligent system, bound to be written over and over again. My favorite views on these matters are surveyed and presented with my own views. Until we get better intelligence and intelligent system, I'm presenting ones I like most so far. Let's start our trip to intelligence and intelligent systems.

2. INTERACTIVE TECHNOLOGY

Understanding intelligence as interaction, we reinterpret "space"-natural and artificial-among us and the world around us. First, a historical model of interaction is presented and then our search for an interactive paradigm, interactive technology, is followed.

2.1 A historical model of interaction [8]

Matthew Cahlmers made the observation that computer science is based entirely on philosophy of the pre-1930s. Similarly, much of contemporary cognitive science is based on a rigorous Cartesian separation between mind and matter, cognition and action. However, they have been under continual assault since around the 1930s. This new approach abandoned the idea of disembodied rationality and replaced it with a model of situated agents, at large in the world, and acting and interacting within it.

The development and application of computational technologies is an engineering discipline. It is philosophical in the way it represents the world, in the way it creates and manipulates models of reality, of people, and of action. Phil Agre comments, "Technology at present is covert philosophy; the point is to make it openly philosophical." While any software system introduces some kind of formalization of the world, Human-Computer Interaction (HCI) like Artificial Intelligence (AI) deals with formalizations of human cognition and activity. Debates over philosophical foundations are deeply relevant, because they determine the limits of what can be done and the chances for success of our efforts to have people and computers work effectively together.

Paul Dourish focuses on one particular way in which these philosophical questions have lately arisen in the area of HCI. The context is the historical evolution of the idea of interaction and the technology of HCI.

There are many ways to conceptualize the history of interaction with computer systems. The technological view would recount the history of the input and output devices (that have characterized different stages of interface development), and would describe their computational demands. A political view would consider the movement of ideas from one laboratory to another, while an economic view would consider how user interface development has influenced, and been influenced by, the growth of the high-tech industry and PC economy. Grudin describes the history of interaction as the story of the "computer reaching out," in which interaction moves from being directly focused on the physical machine to incorporating more and more of the user's world and the social setting in which the user is embedded. Dourish presents the stages in the historical development of user interfaces in terms of the different sets of human skills they are designed to exploit, which are characterized as electrical, symbolic, textual, and graphical forms of interaction.

Electrical: When we talk of "computer," we inevitably mean digital devices. Originally, the word "computers" referred to human beings-people whose daily work was the figuring of calculations. Before digital computers came analog computers. Then follows the stored program computer. Even as we made the transition from hardware configuration to digitally stored programs, the dominant paradigm for interaction with the computer was electronic. **Symbolic**: The introduction of programming systems moved computer interaction from an electrical level to a symbolic one. We are all highly skilled at various forms of symbolic interaction; language and communication are largely symbolic in nature, whether these symbols take the forms of icons, traffic signs, flags, maps, or marks on paper. We are generally able to exploit a greater range of skills-visual, cognitive, and so on-as we move from electrical to symbolic forms of interaction. **Textual**: The best-developed form of symbolic interaction with which we are familiar is written language and textual interaction. Textual interaction can draw on our linguistic skills, not by letting us simply "talk" to computers, but rather by drawing on our abilities to create meaningful sentences by combining elements each of which contributes to the sense of the whole. The other significant feature of the textual interface paradigm is that it brought the idea of "interaction" to the fore. **Graphical**: Graphical interaction is characterized by its use of space; information is spread over a larger screen area, so that the locus of action and attention can move around the screen from place to place or can even be in multiple places simultaneously. The task of managing information becomes one of managing space. Moving from one-dimensional to two-dimensional interaction made it possible to exploit further areas of human ability as part of the interactive experience. These included peripheral attention, pattern recognition and spatial reasoning, information density, visual metaphors, and progress.

Graphical interaction remains the dominant paradigm for interaction with computers. In 1981 Xerox's Star was the first PC to ship with the features of a graphical user interface (GUI) –windows, menus, and a mouse-and the Macintosh, three years later, was the first to ship in volume ay an affordable price. Twenty years later, this trend is still true. However, recent research programs have begun to explore new paradigms for interaction and interactive system design.

Working on physical interaction, "tangible computing," has been a particular active topic in the last few years. One general trend of tangible computing is to distribute computation across a variety of devices, which are spread throughout the physical environment and are sensitive to their location and their proximity to other devices. A second trend of tangible computing is to augment the everyday world with computational power, so that pieces of paper, cups, pens, ornaments, and toys can be made active entities that respond to their environment and people's activities. A third topic of investigation in tangible computing is how these sorts of approaches can be harnessed to create environments for computational activity in which we interact directly through physical artifacts rather than traditional graphical interfaces and interface devices such as mice.

The last decade or so has also seen increasing attempts to incorporate understandings of the social world into interactive systems. This **social computing** encompasses a range of different activities. It attempts to understand how the "dialogue" between users and computers can be seen as similar and dissimilar to the way in which we interact with each other.

Phil Agre says, "Dourish's work provides intellectual foundations for the emerging movement that makes people, and not machines, central to the process of design. Dourish's work will only increase in importance as the social nature of computing becomes evident to a new generation of technologists."

2.2 Virtual reality in cyberspace [7, 9]

In recent times, it is difficult to find terms that are more frequently used despite their impreciseness than "virtual reality (VR)" and "cyberspace." As words created by the development of computers and electronic technology, "cyberspace" is sensibly understood as the information space mediated by the vast communication network and high-performance computers, whereas "virtual reality" causes misunderstanding and hinders discourse because of its completely different meaning under different context.

This confusion with "virtual reality" seems to be stemming from the ontological weight of the predicate, "virtual," and the noun, "reality." It is especially problematic in the context of using languages with many root words derived from Chinese character such as Chinese, Japanese, and Korean. Because when written in Chinese character form, the word "virtual" takes on connotations of "fake," "fictitious," "imaginary," or "hallucinatory." Therefore, not only for the intellectual sake, but also to seek an appropriate way of using relevant technology, it is important to clarify the reality of virtual reality.

The "**virtuality**" in virtual reality is not a concept in comparison with the "reality," but with the "**actuality**" part. Virtuality, together with actuality, forms the two ways objects can exist. Virtual things have not yet gone through "actualization" in the space-time but still it subsists somewhere. Once it encounters the right chance in such a state, it is then actualized.

Often things of virtuality are treated as if these are equal to things of "possibility"; this only points to the abundance of possibilities in being actualized, and strictly speaking, it does not mean that the two are equal. Possible things only lack the trait of existence in space-time, but they retain all of the qualities of actuality. In contrast, virtual things do not retain the traits of actuality. The process of possible things gaining existence in the actual world and the process of virtual things gaining existence in the actual world are different. The possible thing is realized without undergoing any change itself, but the virtual thing goes through change according to the given criteria while being actualized.

Virtual reality is a virtualized object, which is sense-able or imagine-able. In this process of virtualization, both the computer's information processing capability and the intentions of humans contribute together. Virtualization is a opposite process of actualization, the dynamic integration process.

Therefore, virtual reality and actual reality do not share the same qualities. It is a changing of form for the quantitative characteristics determined by the spatial and temporal rules of the actual world and the qualitative characteristics. Depending on the level and degree of virtualization, there are several ways to virtualize the actual reality. For example, writing and converting it to text is a type of virtualization. A writer's novel written down is his thoughts (memories) virtualized. The thoughts of the writer evolves into something different than what it was before, and becomes preserved in the form of written text. The readers then read this text in order to actualize the thoughts of the writer. However, the reader's intellectual background and the physical, psychological conditions during reading determine the degree of reader's actualization. The same applies to a wider sense of "text"--in pictures, shapes, and sounds [10]. Hypertext as virtual reality is yet another step of virtualization of many sorts of text existing in the real world.

Specially, computer and communication network based virtual reality exists as an objective entity that corresponds to the perceptive content of each user participating in cyberspace. And even when there is no user participation, it exists in cyberspace as digitized patterns. The reason the experience of virtual reality, unlike the experience of physical objects, is unable to remain fixed is because it is sensitive to the user's mental activities. The fact that virtual reality depends greatly on the physical and mental condition could be a basis for composing a unique realism for virtual reality, but it cannot be an argument against it.

Based on above discussion, it could be suggested that the appropriate Chinese translation for "**virtual reality**" is not "假想現實" ([gasaŋhyunsil] in Korean and [kasougenjitsu] in Japanese) or "虛似現實 ([xunixianshi] in Chinese)" which has the connotation of "fake reality" or "hullucination," but "可象現實" which means "**possible reality**." This way of writing is more in line with the definition of VR, which is the entities, agents, or events within cyberspace. Especially, since this is similarly pronounced as the above one in Korean-[gasaŋhyunsil] and in Japanese-[kazougenjitsu], there would not be much linguistic confusion caused by the correction of the meaning of the term at least in Korea and Japan.

2.3 Mom and interactive technology

Most Korean words describing very important things in life are in one syllable word or single breathing sound. It is necessary to transfer important things and events as quickly and precisely as possible. Things and events fundamental to the lives are more so. There are many one syllable words in Koran language, centered on human "Mom." Words are basically tremors (vibrations) of Mom. This is a process leaving from me alone and entering into the world of us. Mom exists through the process of exchanges and responses. Language is resulting from the combinations of the avoiding and confronting situations to maintain my Mom and other Mom in good conditions. Mom language is the origin of the spoken language. As Merleau-Ponty pointed out, Mom language represents actions and spoken language represents fine actions. Indication aims at tremor of Mom. Language is specific tremor of Mom and meaning of language is Mom's special tremor, Mom's special situations inducing such tremors and Mom's special functioning to maintain Mom in such situations [7, 11, 12].

In Lovejoy's theory of intelligence, human oral cavity has been formed due to standing walk and the changes of dietary life. Repeated sound programming in oral cavity creates human intelligence [7, 11].

In 1681, Dennis Papin invented the first pressure-cooker valve to regulate pressure, as shown in Fig. 1. Since the diaphragm of this device senses the pressure and moves according to the pressure difference, its sensing, control, and action parts are not clearly separated. It reacts easily and efficiently to the pressure changes as a whole piece. These characteristics of embodiment and relativity suggest important virtues of interactions [2].

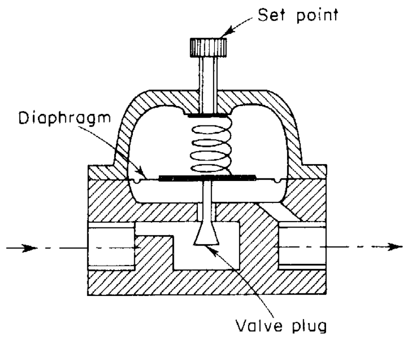

Fig. 1 Self-operated controller.

There is a logical sensation or sensual logic code to interpret nature in human cognition. Like insect's antenna, this is a logic system connected to all cognitive systems and a sensory system required to its survival. The fact that nature's small structure contains its bigger structure is self-similar thus very much connected to the geometric and intuitive world. This is the basic nature of fractal way of thinking [13].

Many present intelligent machines attempt to perceive surrounding environment with complicated sensors and sensor processing systems. However these attempts do not match with the perceptual and reactive capabilities of the insect's antenna.

Advancement in computer technology made real-time interaction possible by processing information from user inputs and sensor data. Problem lies in that, even if the size of data is increasing, approachable user's connection types are limited to the selectively classified ones. This rather shrinks user's intentions into few patterns.

If we follow these clumsy patterns, user's easiness and intentions are greatly damaged. These classifications seem to be only easily possible to the context of Westerners to whom body and mind is separable. Westerners' anatomical body, if necessary, can be always separable from the self. Also, in industrialized countries, characters of body have been being documented. On the contrary, Koreans' embodiment has very instinctive natures. In addition, Koreans treat embodiment and mind as same thing.

To Koreans, body is neither an inferior nor a separable concept to mind as you may see in the words, like "身體髮膚 ([sinchebalbu] in Korean)," "身言書判 ([sinunsopan] in Korean)," "身外無物 ([sinwemumul] in Korean)." Since body and mind to Koreans is connected, Koreans deny the notion that we interface only by classifying body's characters. Koreans in general believe that mind follows body. Koreans like to touch and confirm with hands. This has something to do with the fat that Koreans are familiar to short-distance sensations. Sound and light can travel far away. Multiplication and transportation is also possible. Storage, classification and documentation is possible. On the contrary, relatively short-distance sensations in spectrum of sensations, like touch, taste, and smell, disintegrate the relationship between subjectivity and objectivity. In the countries where subjectivity and objectivity is clearly separated, people tend to prefer long-distance sensations. Short-distance sensations are more persuasive to the people in countries, where subjectivity and objectivity is intermingled.

In this context, we need to have a different view to start a new interaction paradigm, interactive technology, from that of the West. Koreans already have more active environment in interactivity and preferable embodiment to interactivity.

3. SCIENCES OF EMOTION

Science of emotion accounts for the notion that attractive things do work better-their attractiveness produces positive emotions, causing mental processes to be more creative, more tolerant of minority difficulties. Emotions allow you to make quick and proper decisions. As emotions are critical to human behavior, they are equally critical for intelligent machines, especially autonomous machines of the future that will help people in their daily activities. The science of affect and emotion is surveyed, and a design methodology for personal media is investigated.

3.1 Sciences of emotion [14]

Until recently, emotion was an ill-explored part of human psychology. Science knows that evolutionarily more advanced animals are more emotional than primitive ones, the human being the most emotional of all. Moreover, emotions play a critical role in daily lives, helping assess situations as good or bad, safe or dangerous. Emotions aid in decision making. Attractive things make people feel good, which in turn makes them think more creatively. Cognition[*] interprets the world, leading to increased understanding and knowledge. Affect, which includes emotion, is a system of judging what's good or bad, safe or dangerous. It makes value judgments, the better to survive. Cognition and affect, understanding and evaluation-together they form a powerful team.

New research has shown that attractive things really do work better. We don't just use a product, we become emotionally involved with it. Every time we encounter an object, our reaction is determined not only by how well it works, but by how good it looks to us, and by the self-image, loyalty and even nostalgia it evokes in us. When a product is aesthetically pleasing and plays to our ideas about ourselves and society, we experience it positively.

Donald Norman, Andrew Ortony, and William Revelle suggest that human attributes result from three different levels of the brain: the automatic, prewired layer, called the visceral level; the part that contains the brain processes that control everyday behavior, known as the behavioral level; and the contemplative part of the brain, or the reflective level.

The visceral level is fast: it makes rapid judgments of what is good or bad, safe or dangerous, and sends appropriate signals to the muscles (the motor system) and alerts the rest of the brain. This is the start of affective processing. These are biologically determined and can be enhanced or inhibited by the reflective layer and, in turn, it can enhance or inhibit the visceral layer. The highest layer is that of reflective thought. Note that it does not have direct access either to sensory input or to the control of behavior. Instead it watches over, reflects upon, and tries to bias the behavioral level.

The roller coaster pits one level of affect-the visceral sense of fear-against another level-the reflective pride of accomplishment. Everything you do has both a cognitive and an affective component-cognitive to assign meaning, affective to assign value. At the visceral level, people are pretty much the same all over the world. The behavioral and reflective levels, however, are very sensitive to experiences, training, and education. Cultural views have huge impact here.

Whereas emotion is said to be hot, animalistic, and irrational, cognition is cool, human, and logical. At least, that is perceived wisdom. This is nonsense. Cognition interprets and understands the world around you, while emotions allow you to make quick decisions about it. Usually, you react emotionally to situation before you assess it cognitively, since survival is more important than understanding. Emotions are inseparable from and a necessary part of cognition. Our emotions change the way we think and serve as constant guides to appropriate behavior.

Both affect and cognition are information-processing systems, but they have different functions. The affective system makes judgments. The cognitive system interprets and makes sense of the world, whether conscious or subconscious. Affect is general term for the judgmental system. Emotion is the conscious experience of affect, complete with attribution of its cause and identification of its object. The feeling you might experience, without knowing why, is affect. You are angry at something for a reason. Cognition and affect influence one another. Affect and emotion are crucial for everyday decision making. The affective system provides critical assistance to your decision making by helping you make rapid selections between good and bad, reducing number of things to be considered. The emotional system is also tightly coupled with behavior, preparing the body to respond appropriately to a given situation.

3.2 Tangibility: embodiment in tangible space [7]

Natural philosophers have always been interested in the relationship between sensation/perception and external world. Human sensing is dominated by sight, although we are aware of the other four exterior senses-hearing, smell, touch, and taste. We are less aware or our interior senses-our sense of balance, for example, or our sense of body awareness, or proprioception, which is what informs us where our arms and legs are and what they are doing. [6, 7]

We might say that there are two expressions for sensation and perception in Asian countries. If the ability to know what is "out there," rather than just "what is happening to me," is the process of perception[Cohen], the word "感知([gamjee] in Korean)" is close to the expression "sensation and perception," which means that human senses environment first and then knows (perceives) later. On the contrary, "感覺([gamgak] in Korean)" is close to "the ability to feel what is out there" or "instant sensation and perception," which means that human senses and knows (perceives) simultaneously or human feels instantly [7, 11].

External senses can be divided into passive senses and active senses. Passive senses do not themselves affect the environment, but merely capture data provided by it. Sight and hearing both work like this. Active sense-like touch, for example-collect data by interacting with the environment [6].

While sight and hearing seem to closer to the contemplative sensations or "感知([gamjee] in Korean)," touch, taste and smell seem to closer to the instinctive sensations or "感覺([gamgak] in Korean)." In many ways, touch stands apart from the other senses. It covers our entire body surface. While we say that we perceive visual objects, sounds, tastes and smells, we talk instead about feeling texture, heat and pain. Unlike the other senses, touch often carries an intense emotional charge and many studies have demonstrated the positive psychological effects of touch. Tangible cyberspace may be viewed as a touchable space with the sense of reality. This is similar to a space of sight and hearing with a sense of touch added or an "augmented virtual reality" [7, 11, 15].

In addition to these five senses, human has a unique sense, called synesthesia, from Greek *syn* (together) + *aisthanesthai* (to perceive). Synesthesia is the technical name, meaning the simulation of one sense stimulates another [16]. Newborns ride on intermingling waves of sight, sound, touch, taste, and, especially, smell. In time, the newborn learns to sort and tame all its sensory impressions by the age of between six months and twenty-four months, some of which has names, many of which will remain nameless to the end of its days. Those who experience intense synesthesia naturally on a regular basis are rare-only about one in every five hundred thousand people-and neurologist Richard Cytowič traces the phenomenon to the limbic system, the primitive part of the brain. As he says, "synesthesia … may be a memory of how early mammals saw, hears, smelled, tasted and touched" [15, 17].

Synestheisa closely resembles the concept of 法 ([bub] in Korean) in Budism [18] Reconsidering the better way of implementing state-of-the-art technology, the first step toward humanizing technology might be based on technology to properly augment realities in the new form of space and spatial perception. Building tangible space using interactive technology could be one approach to enhancing human conditions.

Emotions in general can be interpreted as different forms or scales in spectrum, as shown in Fig. 2. Sound and light are emotional entities, which only differ in the location in an emotion spectrum scale [13, 19] Sound space is an invisible but a tangible space in a sense that it travels in emotional tremors and stimulates new sensations and perceptions. We experiment such tangible space as a new and proper interactive paradigm.

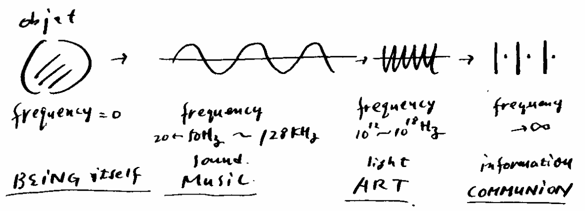

Fig. 2 Waviness in emotions

4. INTERACTIVE TANGIBLE MEDIA

During the distinguished talk for SDForum at PARC, Paul Saffo, director of the Institute of Future, said, "The bubble may have burst, but this really is a about media. Not information, not computing, but media. And lessons from past media forms offer important hints about the trajectory of innovations to come." He also said, "I was surprised when I bought a Mercedez. But I really bought a really is a computer. Yes, this is the present and the future status of cars" [20].

Video game machines are aimed at young males who love excitement and violence. The actual market is much broader. The potential users are beyond young males and the potential uses of videos extend far beyond the playing of games. They could be excellent teaching devices. To break out the traditional video game market, the industry needs to project a different kind of appeal. At the visceral level, the physical appearances of the consoles and controllers need to be changed. The behavioral design of many games evolve around powerful graphics and fast reflexes. The reflective design has to be changed to be an intelligent guide to activities or an aid to learning. The device would serve as tutor and assistant, a cooking aid and tutor, and a reference manual. [Norman]

Saffo once again made statement, "In the near future, you will subscribe a car and services provided to driver will be updated according to subscription fees you pay." This will happen for personal robots soon. Personal robots here are robots providing services for persons' needs [20-22].

Interactive media should possess characters like objects that evoke memories, feelings of self, personality of products. Interactive tangible media are explored and constructed, which include 1) an artificial emotional piece "A Stuffed Ox," which interacts with the audience through breathing, touching, and eye tracking [23, 24]; 2) a composing machine "IFGAM: interactive fractal/GA music," which composes an interactive music evolved genetically from fractal music seed [24-26]; 3) a tangible space "A Room with Sensors," which makes you feel outdoor climate changes and indoor information flow on a sensor chair in the form of vibrations [7, 23]; 4) a sound sculpture "Schwarzwald (Black forest)," which constantly reshapes sound space by interacting with the motions of audience(s) [7, 23, 24]; and 5) an interactive robotic cane "RoJi," which aids blind or visually impaired travelers to navigate safely and quickly among obstacles and hazards faced by blind pedestrian with the help of restructured spatial perception [28-32]. Interactive workspace based on iT_Media is currently being implemented [33].

5. SUMMARY

This is an essay regarding my personal quest for intelligence and intelligent systems. My favorite views on these matters are surveyed and presented with my own views. Interactive technology initiative (ITI) is an interdisciplinary research group to search for the proper technology and the proper way of implementing technology: "interactive technology" or "soft engineering." Some experimental activities conducted by ITI are presented in this session, "Interactive Technology." Three cases based on interactive technology are introduced, which include a new design methodology for personal and emotional robotics: "Emotional robotics based on iT_Media"; and an engineering education and robotics design projects at Pusan National University: "Interactive technology education at Pusan National University" and "Robotics projects at Pusan National University." This is an interdisciplinary effort in investigating a new paradigm of technology [34-37].

ACKNOWLEDGMENTS

The authors gratefully acknowledge the contribution of interdisciplinary research group "Interactive Technology Initiative (ITI)" for special session "Interactive Technology." Also, the authors thank Samsung Electronics for funding this research.

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