

# Emotionally Reactive Television

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## ABSTRACT

When is an interface simple? Is it when it is invisible or very obvious, even intrusive? From the time TV was created, watching TV is considered as a static activity. TV audiences have very limited choices to interact with TV, such as turning on/off, increasing/decreasing volume, and traversing among different channels. This paper suggests that TV program should have social responses to people, such as affording and accepting audience's emotional feeling with the growth of technologies. This paper presents HiTV, an Emotionally-Reactive TV system using a digitally augmented soft ball as affect-input interfaces that can amplify TV program's video/audio signals. HiTV transforms the original video and audio into effects that intrigue and fulfill people's emotional expectation.

**ACM Classification:** H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

**General terms:** Design, Human Factors

**Keywords:** Emotion, TV, visual/audio amplification, HCI, social responses.

## INTRODUCTION

Television is one of the most popular entertainment resources in the modern life. According to the A.C. Nielsen Co. [1], the average American watches more than 4 hours of TV each day (or 28 hours/week, or 2 months of non-stop TV-watching per year). 99% of households possess at least one television.

TV is a machine actively participating our daily life and providing information in the living room. TV watching is a social behavior in a family house. TV usually occupies the biggest social area in a house, *the living room*, and becomes a center of entertainment. While people are watching TV, they make and share a lot of affective responses such as screams, cheers, or high-fives. However, these responses have no way to feedback to current TV system. Switching to different chan-

nels or turning off the TV is the only way for TV audiences to make affective feedbacks when they don't like the current TV program.



Figure 1: [Top-left] Watching TV is not a sport. [Top-right] An angry TV viewer broke a TV. [Bottom] HiTV provides the emotional interactivity when watching TV programs.

## Interactive Television

In needs of designing a TV system that can reflect some emotional situation happening in front of every television set. Kovsky illustrated ways of gain more control over TV (i.e. TiVo, Xbox, ReplayTV, UltimateTV) instead of the simple ability to turn them on and off [2].

Interactive TV (iTV) [3] is any television with what is called a "return path". Information flows not only from broadcasters to viewers, but also back from viewers to broadcasters. iTV introduces that you could buy a pizza through the iTV. iTV also included the meaning of personalized TV. It enables people to gain control over, and manipulate the TV shows. TiVo[4] is one kind of the iTV. The TV became a media center to store videos. It also monitors every click and ana-

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lyzes this click stream to better understand the preferences of the customers. However, providing Internet access and online content doesn't fulfill the real-time needs and the laziness of their customers when watching TV. The Media-Bed [5] introduced an intelligent selection approach based on affirmations and criticisms. This system used eye-gestures to record if a person is "staring" at the TV or blinking nervously.

Current TV interfaces did not afford and reflect people's emotion other than switching channels. In Nass's studies [6] for human-computer relationship, Nass indicated that *social responses* of machines are fundamentally important. In [7], interactive and personalized TV can turn passive viewers into active participants enhancing their TV viewing experience. However, traditional user interface design (i.e. remote control approaches) struggles to fulfill the experience required by TV viewers. Could a seemly more intrusive interface be both simpler and more enjoyable?

### HiTV

This paper introduces HiTV, an active way of TV watching activity in the living room. TV watching experience is enhanced and more responsive to viewers' emotion. HiTV enables affective interaction and feedback capabilities with TV. HiTV encourages people reacting to the TV contents with affective actions with a soft sensing ball as input interfaces. When watching TV, a person can pick up the HiTV soft ball to toss around or throw the ball to hit the TV when s/he does not like the characters or contents in the show. As the ball hits the TV, the character inside the TV program will get visually distorted and screaming. With HiTV, the interaction and feedback of the TV experience can be greatly enhanced by considering the affective actions of TV audiences and fulfilling their expectation from emotional reaction.

### SOCIAL RESPONSES

How can we create a TV system that affords certain characteristics of social responses? People interact with TV channels for searching TV programs that they are interested in. In [8], Russell suggested that constructing audiences' connectedness is mediated by high involvement while watching the show. SmartSkip [9] demonstrating an interactive picture interface to view and skip videos are using the remote control to interact with the television. But indexing across TV content did not establish much connectedness between viewers and programs. SMS TV [10] demonstrated a new way of return channel to enrich the TV service using other communication channels, ex. cell phone technology.

TV Viewers get better control over the TV program, but the interactivity is still limited to input machine commands. However, there is no way to input affects and emotional reaction so that they can only express their emotion by laughing or yielding on their seats, but can do nothing about the TV program. Although TV surveys make statistics by calling people, there is no such a way that TV audience can react to the TV program simultaneously.

### Expressing Emotions

While watching TV, some people like to hold graspable objects such as a pillow, which can be used to express their

emotions caused from TV contents; some people squeeze the pillow when they are nervous, and some other people use the pillow to block some scary scenes. When people are getting happy and excited, they usually shake objects at hand for cheering. For scary moments, people tend to hold the pillow tightly. When people feel angry and disgusting, they might have more emotional behaviors, such as trying to hit the TV with an object or yielding. For certain annoying moment, people would switch channels or playing objects at hand more frequently.

### A Soft Interface for Pillow Actions

HiTV provides a soft and graspable interface as the affect input interface, like people hold a pillow when watching TV. A soft ball can be used as a graspable object but different from other common objects in a point of that the reactions to the softball affects the TV program and people can interact with TV with it. We found that pillow actions are blocking, touching, squeezing, tossing/throwing, shaking.

### Emotional Reactions

All emotional reactions to the objects mentioned in former section can be used as the input mechanism for HiTV. TV program should equip with user input effects and provide respectful feedbacks for people's action. We develop the interactive techniques for HiTV from the perspective of daily behaviors to reflect how we watch TV everyday and what to expect for people's emotional behavior. Pillow actions will address the physical interaction and visual/audio amplification will demonstrate the response from HiTV system.

From Ekman's six basic categories of emotion (i.e. happy, sad, angry, fearful, disgusted, and surprised) [11], we mapped possible actions and expectation for the TV audience, as shown in Table 1.

Emotion	Pillow Action	Enhancement
Happy	Touching gently	Small disturbing
Sad	Holding tight	Fading out
Angry	Punching/throwing	Visual/Audio distortion
Fearful	Holding or blocking	Lower volume
Disgusted	Shaking	Shaking the TV screen
Surprised	Shortly squeezing	Short flashing light

Table 1: From Ekman's six basic categories emotion, we can map emotions, pillow actions and enhancement.

### AFFECTIVE ENHANCEMENT

HiTV provides extra layers of visual and audio expressions for augmenting existing TV program with user-input affects. When touching, squeezing, or shaking the ball, the pitch and volume of TV audio can be adjusted. At the same time, certain visual effects, for example, ripples, are overlaying on the original video. As the soft ball hit the TV, the accelerometer detects the collision and sends the signal through RF to the signal box connected to TV.

### Visual Enhancement

In [12], Viper demonstrated how visual clips could be re-organized to response to audience-related factors. In HiTV system, a layer of visual enhancement can be added onto the

original TV program’s video signal by considering audiences’ emotional feedback. The visual enhancement may create a positive feedback loop that enhances audiences’ feeling more. For example, when audiences squeeze the ball because of scary themes, scary visual effects, such as bloody skulls, can be added to enhance the scary effects. Audiences can exaggerate scenes and objects appeared in program content that are responsive to their reactions by their references. For example, one can choose make an erupting volcano shown in the original video signal to erupt more according to how strong s/he throws the ball.

**Audio Enhancement**

Sound pitch, sound volume, and audio effect duration are some attributes of audio signals that are worthy to be processed. So when the ball hits the TV, the original audio will be adjusted according to the strength that ball hit the TV, which expresses the users’ emotion to the TV program. For example, when the ball hit the TV strongly, the voice/sound of TV will become sharper and louder. TV users now can play with the ball in other ways, such as squeeze or stretch, which will act as different filters to the voice/sound of the TV. For more subtle interactions, audio signals can be enhanced according to the content. Audiences can use the ball to enhance certain audio effects occurred in the TV programs. For example, one can shake the ball to increase the gunshots sounds in reality show programs.

**SYSTEM ARCHITECTURE**

The HiTV system consists of a soft ball, which is a graspable interface for people to hold, and a signal box to process the TV signals. Sensors in the soft ball can monitor the emotional reactions from people, including patting, holding tight, or throwing the ball to TV. The signal box creates audio and visual feedbacks to people’s reactions, and it can be also connected to the network to share the reactions with others.

**HiTV Hardware Components**

HiTV system contains two hardware components, *HiTV User Emotion Sensing Ball* and *HiTV Signal Box*, as shown in Figure 2. HiTV User Emotion Sensing Ball is the graspable interface of HiTV, which contains the accelerometer and related circuit to detect users’ emotional reactions to TV programs. These circuits and one RF module are embedded into a soft ball. When users shake or throw the soft ball, the accelerometer circuit inside the ball can detect the velocity change and send sensed data back to HiTV Signal Box for further processing via RF module built within that circuit.

TV program signal goes through HiTV Signal Box before connecting to TV. HiTV Signal Box is in charged of manipulating TV program signal according to the users reaction after it interprets data transmitted back by HiTV User Emotion Sensing Ball.

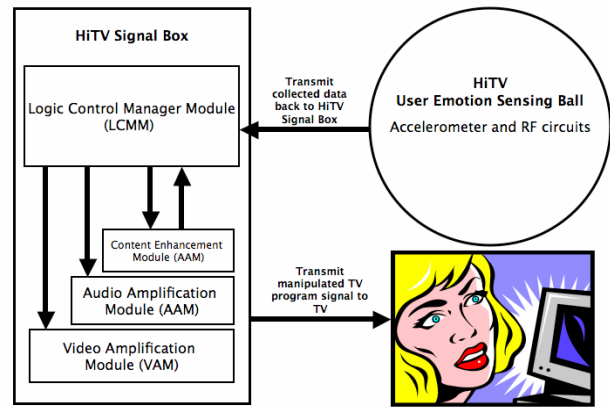


Figure 2: HiTV system architecture consists of HiTV User Emotion Sensing Ball and HiTV Signal Box.

**HiTV software components**

Four software components – *Logic Control Manager Module*, *Visual Amplification Module*, *Audio Amplification Module*, and *Content Enhancement Module* – are running within HiTV Signal Box to accomplish HiTV Signal Box’s tasks, i.e. receiving collected data from HiTV User Emotion Sensing Ball and manipulating TV program signals accordingly.

*Logic Control Manager Module (LCMM)* is the managing component of HiTV system, which receives accelerometer data from HiTV User Emotion Sensing Ball, utilizes Content Enhancement Module (CEM) to identify objects in TV program, and controls Visual Amplification Module (VAM) and Audio Amplification Module (AAM) to manipulate TV program signal at proper time. According to accelerometer data transmitted back from HiTV User Emotion Sensing Ball, LCMM determines what kind of behaviors users are interacting with the ball, which reflects users’ emotions to the current watching TV program. After interpreted users’ emotion by analyzing collected data, LCMM manages VAM and AAM to manipulate TV program signal accordingly.

*Content Enhancement Module (CEM)* utilizes the face tracking algorithm in OpenCV in order to real-time process the video frames and find out where to make visual enhancement. Object inside the TV program can be responsive to our acts.

*Visual Amplification Module (VAM)* is responsible for adding visual effects to the TV program that users are watching. VAM receives information from LCMM and determines which visual effect to use and where the visual effect should apply on.

*Audio Amplification Module (AAM)* manipulates TV program’s audio signal. When users shake or throw the ball, audio effects, such as the change of pitch and volume, are applied to TV’s audio signal according to the data collected by accelerometer circuit because of those users’ emotion actions on the ball.

## Prototype Implementation

Figure 3 illustrates how the HiTV system prototype is implemented and works.

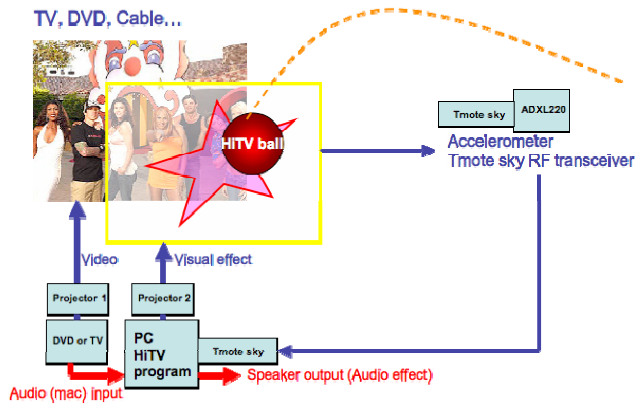


Figure 3: HiTV prototype diagram.

When people shake or throw the HiTV User Emotion Sensing Ball, ADXL220 accelerometer records these different acceleration data and sends them back to Logic Control Manager Module (LCMM) via Tmote sky RF transceiver. A PC is used to implement the HiTV Signal Box in the prototype. Logic Control Manager Module (LCMM) keeps reading data from another Tmote sky RF transceiver hooked up with the PC, which keeps receiving data from ADXL220 circuit in the ball. The HiTV prototype uses two projectors to lower the implementation complexity of Visual Amplification Module (VAM). One projector is for displaying the TV program received from original signal while the other one – connected to the HiTV Signal Box – projects to the same area of the former one and displays contents as what the HiTV Signal Box feeds in. A Flash program running on the HiTV Signal Box forms VAM with the projector connected to the HiTV Signal Box. When the Flash program receives commands from LCMM, it follows the commands and applies different visual effects via the overlaid projector to original TV program. SoundTouch Audio Processing Library [13] is used in Audio Amplification Module (AAM) to manipulate audio signals. Audio signals bypass HiTV Signal Box before reaching speaker. If AMM receives commands from LCMM, it adjusts the pitch of audio signal then sends modified audio signals to play in connected speakers. The duration of both visual and audio effects is determined by the commands issued by LCMM.

## CONCLUSION

This paper suggests that a noticeable, physical interface can be both simple and functional even in its obtrusiveness. HiTV provides an active and multimodal way to create social responses for expressing emotional feeling to TV programs. The future work of HiTV has some possible directions. The first direction is to exchange those local interactions between TVs and audiences among TV audiences who are watching the same TV program. Therefore, audiences will not only interact with their TVs but also other audiences at the same time. Another direction may be to use these affective reactions from audience to guide the TV to switch to popular channels most audiences are happy and excited in. The other possible

direction is to transmit those local interactions between TVs and audiences back to content providers for real-time or off-line contents tailoring.

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