Gestural Remote Control Using FPGA

Table I. Final checkoff checklist.

Deliverable	Functionality	How it will be demonstrated	Priority
RGB to HSV module	RGB to HSV conversion	This is a data-centric module and will be demonstrated via a testbench.	if needed
Center of mass module	Calculate the center of mass of left/right hand.	This module operates in sync with actual hardware and will be demonstrated in the labkit, showing a crosshair on an XGA monitor.	required
Gesture recognition module	Recognize specific gestures based on the user's hand positions.	This is a high level functionality that can be easily demonstrated once the system is integrated. In case of trouble, we can use two digits from the labkit hex display to indicate the current state and the ID of the recognized gesture.	required
User input & control module	Mapping of recognized gestures to specific IR commands and audio files.	This is a high level functionality that can be easily demonstrated once the system is integrated.	required
IR subsystem	Sending IR commands to the controlled device using the Sony Infrared Command protocol.	Controlling the TV set available in the lab (volume, channels, power, etc.)	required
Audio subsystem	Sends audio files from the flash memory a byte at a time to the ac97, and then plays appropriate portion through external speaker.	whenever this module receives a recognized gesture and start pulse, you will hear audio feedback that will say whatever command is being sent to the TV.	required
Audio file conversion	Converts audio files in the wave (.wav) format to the format used by the AC97 codec.	This is a Matlab script that can be demonstrated on the PC.	required
Audio file transmission	Sends audio files from the PC to the labkit using USB.	This functionality comprises a Python, a USB FIFO module, and the custom hardware in the FPGA to process the received data. It can be demonstrated with the logic analyzer or by playback of the transmitted audio file.	required
Flash memory write module	Receives audio data from the USB module and writes to the flash memory chip on the labkit.	This module operates in sync with actual hardware and will be demonstrated in the labkit. It can be demonstrated by playback of the transmitted audio file.	required
Audio playback	Playback of specific audio files using an AC97 codec and an external speaker.	This is a high level functionality that can be easily demonstrated once the system is integrated by playing back an audio file.	required
Gesture recognition - one hand	Gesture recognition with only one hand/color.	This is a high level feature and can be easily demonstrated when the system is integrated.	required
Gesture recognition - two hands, one at a time	Gesture recognition with two distinct hand/colors, using only one hand per gesture.	This is a high level feature and can be easily demonstrated when the system is integrated.	if time permits
Gesture recognition - both hands, simultaneously	Recognition of complex gestures using both hands simultaneously.	This is a high level feature and can be easily demonstrated when the system is integrated.	stretch goal
Audible instructions for the user	System gives instructions to the user using recorded audio files.	Actual playback of the instructions.	stretch goal
Learning of new IR commands	System is able to record new IR commands from an actual remote	This is a high level feature and can be easily demonstrated when the system is integrated.	stretch goal

Complex gestures (e.g., individual numbers)	Elaborate gestures to increase the number of supported IR commands.	This is a high level feature and can be easily demonstrated when the system is integrated.	stretch goal

List of Recognized Gestures

The following table lists the gestures and commands recognized by the system. Table III shows additional commands and more elaborate gestures that will be added on a time-permit basis.

Table II. Minimum list of gestures.

Gesture	Description	Function
Waving to the camera	Moving right hand from left to right and back several times	TV power
Right swipe	Moving right hand horizontally from left to right across the field of view (FOV)	Channel +
Right/left swipe (right hand)	Moving right hand horizontally from right to left across the field of view (FOV)	Channel -
Holding right hand up	Moving right hand vertically from the bottom of the FOV to the top, and holding in in place for a few seconds	Volume +
Holding left hand up	Moving right hand vertically from the bottom of the FOV to the top, and holding in in place for a few seconds	Volume -

Table III. Additional gestures (if time permits).

Gesture	Description	Function
Drawing an 'M'	Upwards swipe, ↘ diagonal, ↗ diagonal, downwards swipe	Menu key
Drawing an 'L'	A down swipe followed by a left swipe	Enter key
Right/left swipe (left hand)	Moving left hand horizontally across the field of view (FOV)	Arrow keys ◄ and ►
Up/down swipe (left hand)	Moving left hand vertically across the field of view (FOV)	Arrow keys ▲ and ▼
Drawing a 'T'	Start with both hands together at the bottom of the FOV, move them to the top, and spread them horizontally	Mute key
Drawing numbers 0-9	Draw the approximate shape of a number with the right hand	Number keys