

Gesture Detection

A camera is used to detect gestures made in the camera's field of view using infrared LEDs. Detected gestures will be used to control a music player.

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Motivation/Goals

- The ideal performance case is to be able to use the LED to “conduct” music.
- The program should be able to seamlessly recognize one gesture leading into another.
- A possible extension may include multiple audio streams and the ability to conduct them as if they’re different orchestra sections.

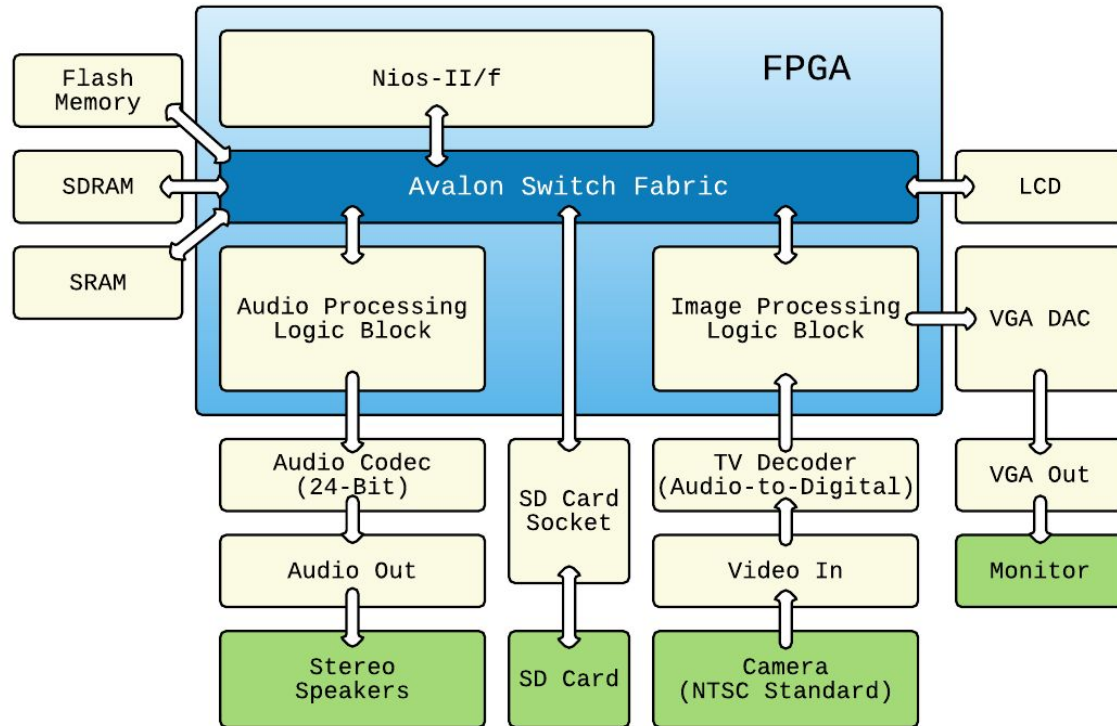


Basic Functionality

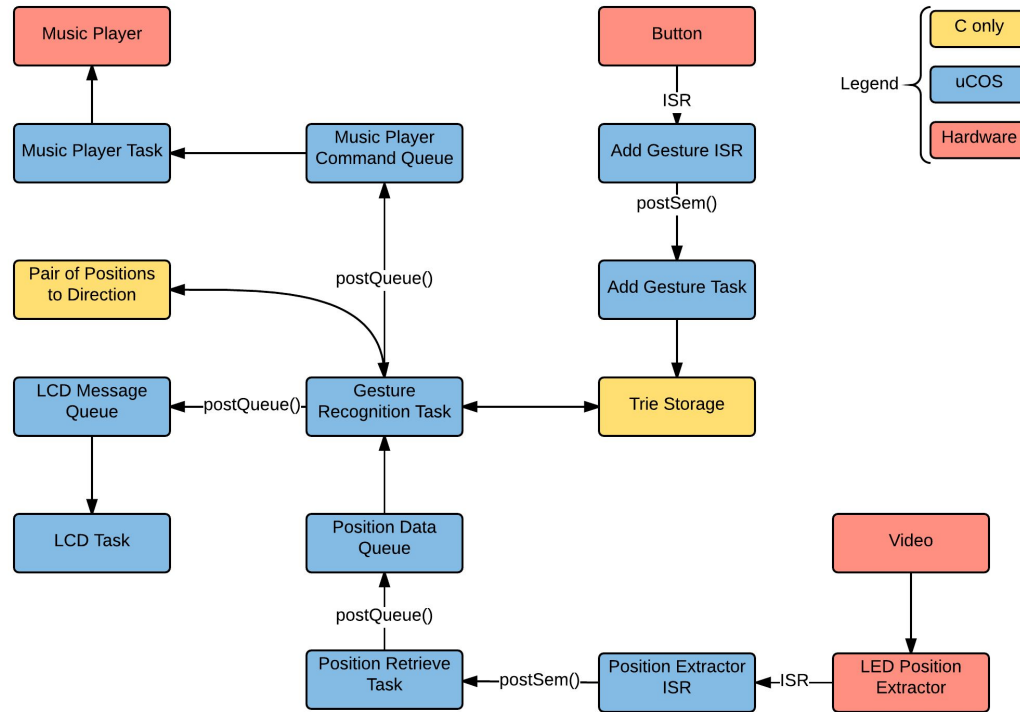
- Gestures are made using an LED.
- A camera is used to track the movement of the LED in an image frame and find the location of the LED in an image frame.
- The stream of location information is compared to stored gestures to recognize the movement of the LED as a gesture.
- Recognized gestures will be used to control music. Gestures will be assigned to play, pause, etc.

Hardware

- LEDs
- NTSC out camera
- Altera DE2
- Monitor
- Speakers



Program Design



Trie Data Structure Pseudocode

```
struct Node {
    int direction;
    struct Node *parent;
    struct Node *children;
    int gesture_code;
};

// Public.
struct Node *getBase(void) {
}

// Public.
// Returns current if at leaf node.
// Returns null if DNE.
// Else returns child with correct direction.
struct Node *nextNode(int direction, struct Node *current) {
}
```

```
// Public.
// Returns -1 if node is not leaf node.
// Else returns gesture_code.
int getGestureCode(struct Node *node) {
}

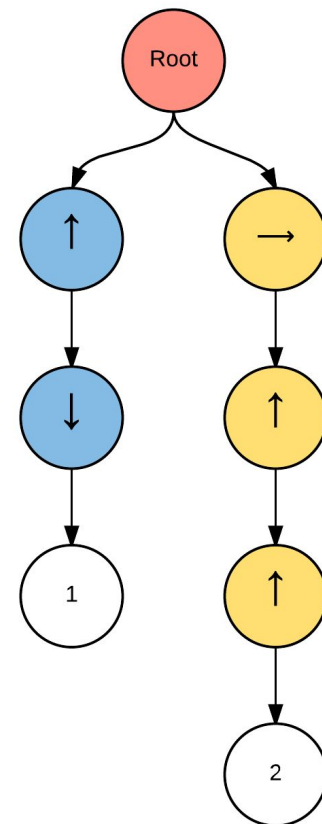
// Public.
int addGesture(int gesture_code, char *gesture_string) {
}

// Private.
void createNode(int direction, struct Node *parent) {
}

// Private.
void addChild(struct Node *parent, struct Node *child) {
}
```

Gesture Recognition

- Gesture recognition will be done using a hybrid trie/graph-like data structure.
- The stream of input position information is at a stable sampling rate.
- A pointer will be moved through the structure as new position information is streamed in.
 - If the input direction cannot be found, the pointer will be reset to root and will begin searching again.
 - If the input direction is found, the pointer will be updated and search will continue.
 - If the input direction is found and the node is a leaf node, the gesture code will be returned.



Performance

- The biggest bottleneck is processing input frames.
- Processing input frames will be done on a stream rather than storing anything to memory.
- All image processing will be done in hardware to get the best performance.
- Audio modulation will also be done on hardware.
- Software will be relegated to relatively straight-forward tasks and used as a controller rather than a processor.

Test Plan

- Testing will be done in modular pieces and with incremental testing.
- LED detection was prototyped using a MATLAB program and will be tested independently of other modules by printing position information to LCD and using video out.
- Gesture recognition can be tested independently using a mocked C program and dummy LED position data. It will also be tested with actual LED position detector output.
- Audio modulation can be prototyped in MATLAB as well. It will be tested using mocked commands and while connected to the other modules.

Questions?
