ABSTRACT

In the 21st century mobile devices have made an enormous presence around the world where an estimate of two thirds of the world’s population uses one. Not only has the number of mobile users increased exponentially, so has the features and computing powers of the mobile device. As mobile devices are ubiquitous and have the capabilities to run complex applications, it is possible to incorporate robots and mobile devices together. The opportunities to develop robotic based mobile applications for the public is both welcoming and encouraging. The vision of this project is to develop a mobile robotic system consisting of the Lego Mindstorm NXT and incorporating computer vision through the Apple iTouch camera.

LIMITATIONS OF THRESHOLD

Color Threshold is clearly a great method that can detect piano keys in a fixed environment. While the method is efficient in a fixed environment, Color Threshold has limiting performance with incorporated movement. The first experiment tested the maximum speed the robot can move with acceptable accuracy. The first speed tested was 90 degrees per second. This speed proved to be too fast as the robot was skipping frame in between keys and therefore giving false data. This method is similar to the method used by humans to identify piano keys. The feature on the piano is that there are two sets of black keys, one set on the left and the other set on the right. Base on this feature, the robot will divide the image into seven regions of interests. Since the piano is conveniently colored in black and white, the robot tracks for black pixels in the image. The image is converted to grayscale to give the image pixel values relevant to the color intensity of black. If the region is identified to be black, the value assigned is 1. In the case where the white key may be in between regions, both regions containing the black key will be considered. If both are mostly black, the first region will be assigned the value 1, otherwise 0. The seven regions produce a signal that represents a key and each key has a unique signal assigned to it.

PIANO KEY RECOGNITION

To identify and distinguish the piano keys, the robot takes notice of the placement of the black keys on the piano. This method is similar to the method used by humans to identify piano keys. The feature on the piano is that there are two sets of black keys, one set on the left and the other set on the right. Base on this feature, the robot will divide the image into seven regions of interests. Since the piano is conveniently colored in black and white, the robot tracks for black pixels in the image. The image is converted to grayscale to give the image pixel values relevant to the color intensity of black. If the region is identified to be black, the value assigned is 1. In the case where the white key may be in between regions, both regions containing the black key will be considered. If both are mostly black, the first region will be assigned the value 1, otherwise 0. The seven regions produce a signal that represents a key and each key has a unique signal assigned to it.

KEY LOCATION TRACKING

The robot is able to make intelligent decision regarding the movement it must make to get to the next note. Aside from recognizing which key is being read, the robot must also track which octave on the piano it is currently looking at. Normally on a 61-Key Keyboard, one would first start at middle C or C3. To simulate the same process a human when using a piano, the robot will assume that it would be starting in the third octave. The robot will keep track of the octaves through two keys, B and C. If the robot is moving right and locates a C, the robot will recognize that it has jumped to the next octave, therefore increasing the octave. If the robot is moving left and locates a B, the robot will recognize if it has moved down to the octave below, therefore decreasing the octave.

BLUETOOTH CONNECTION

For the Bluetooth portion, the project will be using the RFComm and HCI protocols from the BTStack Library. The Bluetooth connection is initiated by the iTouch while the Lego NXT is in standby mode awaiting a request from the iTouch. The first set of packets sent are part of the HCI protocol which determine the requirements for the connection. The HCI protocol is used to search for the Lego NXT device and establish the connection between the iTouch and Lego NXT. During the connection process, the iTouch may be required to enter a PIN number which is set to “1234” by default on the Lego NXT. Afterwards the iTouch will attempt to open a channel which will be used to transfer packets to the Lego NXT. When the connection is set, the iTouch will be able to send packets consisting of bytes to the Lego NXT. The purpose of the RFComm protocol is to send the data packets to the Lego NXT. The direct transfer of packets must use the RFComm protocol as required by the Lego NXT Bluetooth capabilities. The packets sent consist of hexadecimal values. For the sake of simplicity the system is design such that only the iTouch sends packets to the Lego NXT which would receive the packets.