ECE 544 Final Presentation

Android Controlled Car

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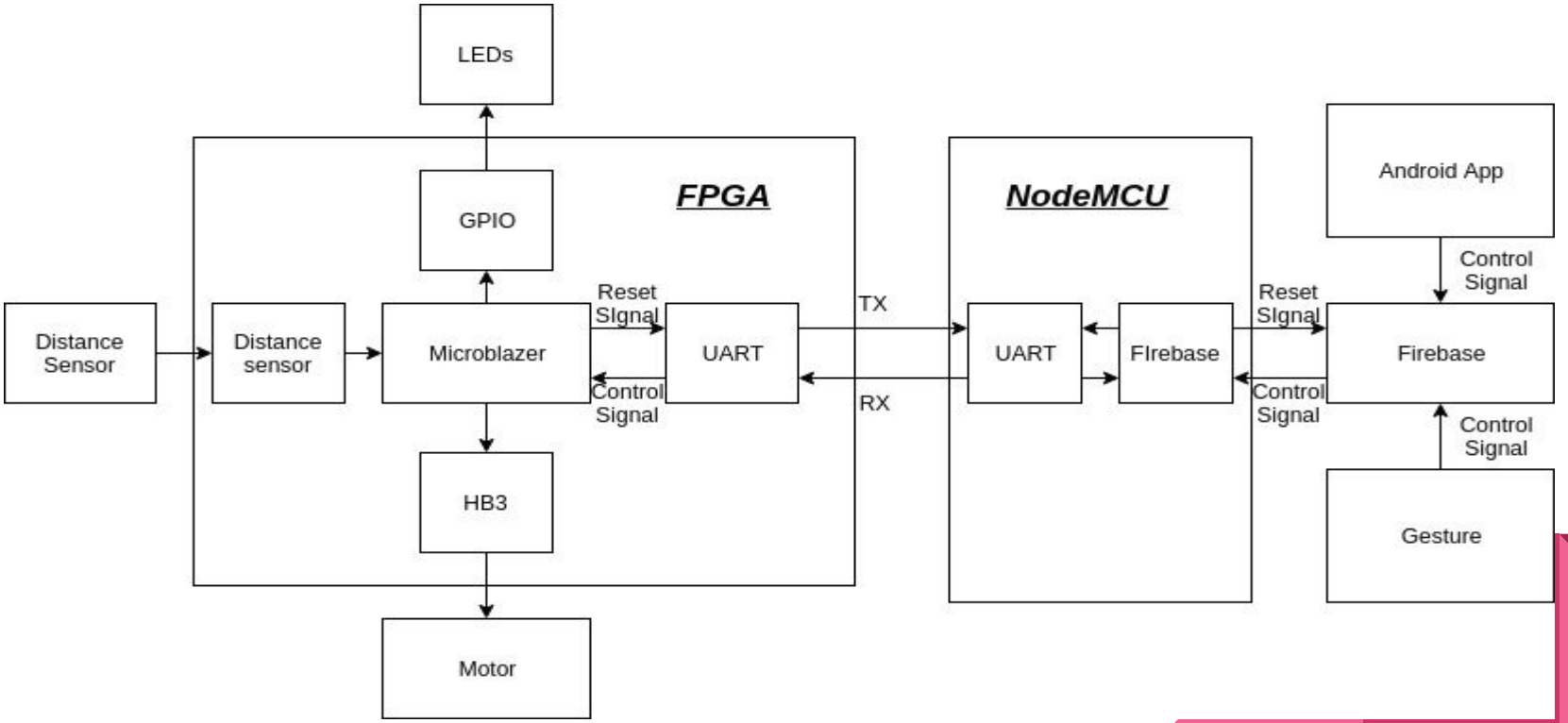
Project Description

For this project, we have designed an android controlled car. This car has 2 motors which are controlled by two PmodHB3 connected to Nexys A7 board. The control signals are given from two sources: Android App or Gestures. These control signals will be transferred to Nexys A7 board by using Firebase and NodeMCU32. The communications between NodeMCU32 and Nexys A7 are achieved using UART. Also, we have two distance sensors connected to Nexys A7 board. The car can't move forward or backward if there is an obstacle within a range of 15 cm. Four LEDs are also connected to the FPGA. So, our car will turn on different LEDs accordingly based on different motions, just like the real car.

System Block Design



Achievements before and after Progress Demo

Before Progress Demo:

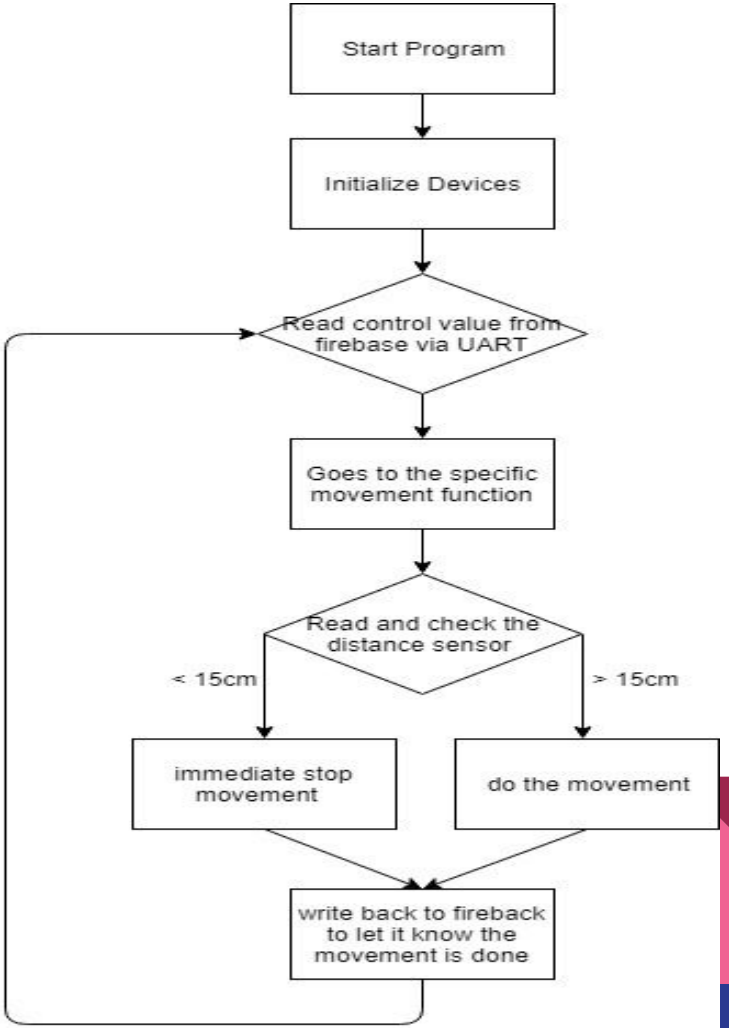
1. Assembled the car model
2. Tested distance sensor code
3. Tested NodeMCU wifi module
4. Tested controlled of the two motors
5. Tested UART communication.

After Progress Demo:

1. Software control code for the car
2. Integrate NodeMCU wifi module with Nexys A7 board and firebase
3. Integrate distance sensor with Nexys A7 board
4. Play alert if there is an obstacle in the range of 15 cm(front and back).
5. Draw a 3D model for our car.
6. Turn on different LEDs based on different motions.
7. Use Android app to control our car.
8. Use Gestures to control our car.

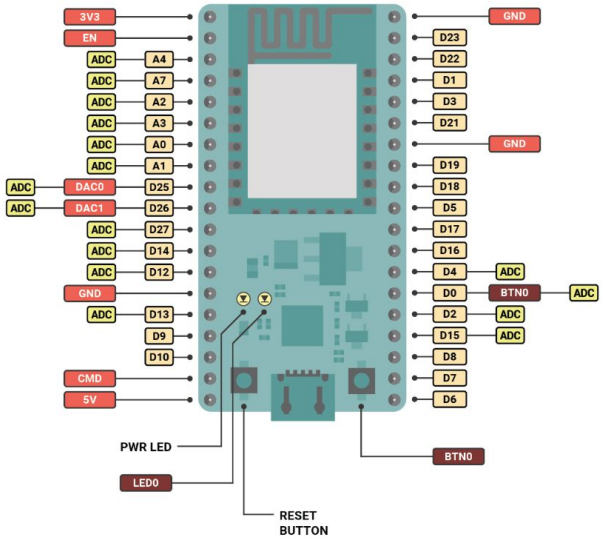
Software Controller.

- Software controls movement of the car
- Listen control signals from firebase, distance from distance sensor
- Send control signal for movement to car



NodeMCU with Nexys A7 and firebase

- NODEMCU ESP32 WIfi module sets up wifi
- Programmed with Arduino IDE
- Listens to update from firebase and Uart
- Sends the Firebase update to Nexsys A7 using Uart
- Receives signal from Nexsys A7 indicating that car is stopped



Gesture Control

Steps Achieving Gesture Recognition

- **Image Generation**
  - Training: 1000 Images
  - Validation: 100 Images
- **Image Resizing**
  - Resize the image to smaller size for better results.
- **Labeling the image**
  - Labeling what each gestures means
  - 1: Fist, 2: Palm, 3: Swing, 4: Peace

→

Fist

FWD

Palm

Reverse

Swing

LEFT

Peace

Right

- **Training: Neural Network(TensorFlow)**
  - CNN: Convolutional Neural Network
  - 7 Layers, 1 Fully Connected Layer
- **Testing**
  - Tested with 100 images for each

Accuracy: 95 Percent

Training and Prediction in Python

Android App Control

- 4 Activities
- Splash Screen(App starts with animating car)
- Option Activity(Option for Gesture or Phone control)
- Phone Activity(Handles the UP, DOWN, LEFT, Right) Arrow presses
- Gesture Activity(Handles all the Gesture activity)

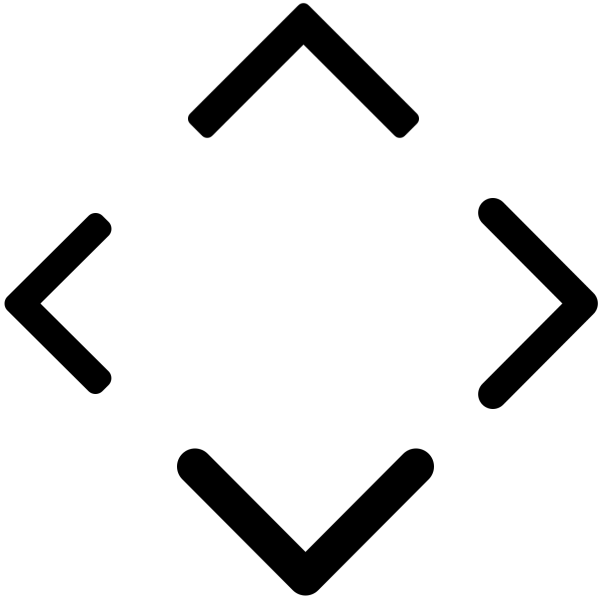
Option Activity:
Provides two modes for the game:

1) Control with Phone
2) Control with Gesture

Gesture Activity:
Listens to the update from firebase and updates the textview with current gesture

Phone Activity:
Listens to the Arrow press and updates the firebase with control signal.

Android APP and Firebase



- Each of these Arrow press, updates the control signal on firebase
- When Gestures is available, it is updated in firebase
- All the gestures and arrows

WD),
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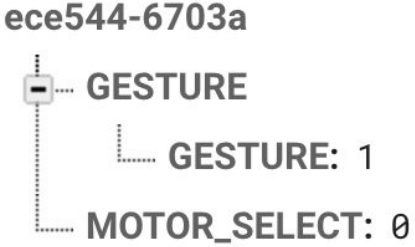


Integrate Distance Sensor and Alert.

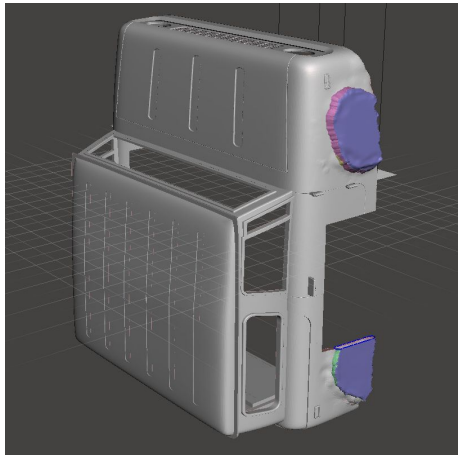
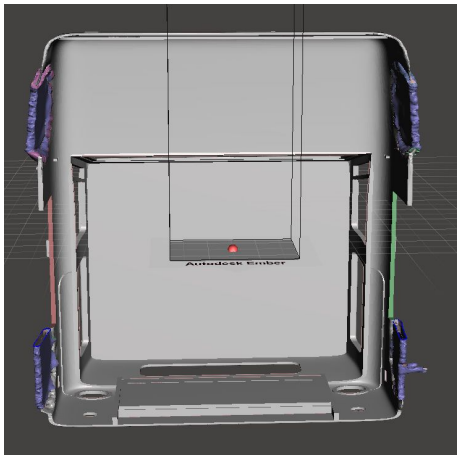
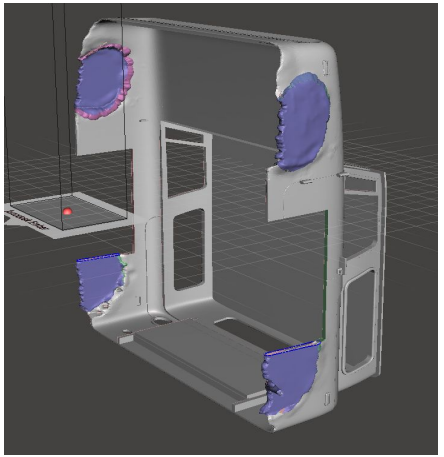
The distance sensor is not working properly when we integrate this with FPGA. The measured distance is not accurate and is not stable. Then, we found we use 100 Mhz clock which is too high. The distance sensor works good after we use 10 Mhz.

For the alert sound, we just find a alert sound which is in format of .wav. Then, we convert this sound to .ceo file and store this into BRAMs of Nexys A7 board. Then we use the on-board amplifier to play this sound when an obstacle is in range of 15 cm.

AUD_PWM: used to play the sound
AUD_SD: shutdown mode. Just give it to 1.

```
if(audio_counter1 >= audio_data1)
    AUD_PWM_I <= 1'b0;
else
    AUD_PWM_I <= 1'b1;
```

3D Model

Length: 230mm. Width: 230mm. Height: 110mm

The size of our 3D model is too big to print by using the printers in EPL and Library. Also, it will cost about 42 hours to print our model. We also don’t have enough time.

Future Work

1. Use built-in camera from phone to recognize gestures.
2. Use 4-Wheel driven car model
3. Try to do the gestures recognition in FPGA.
4. Print our 3D model.

Demo

Thank You!