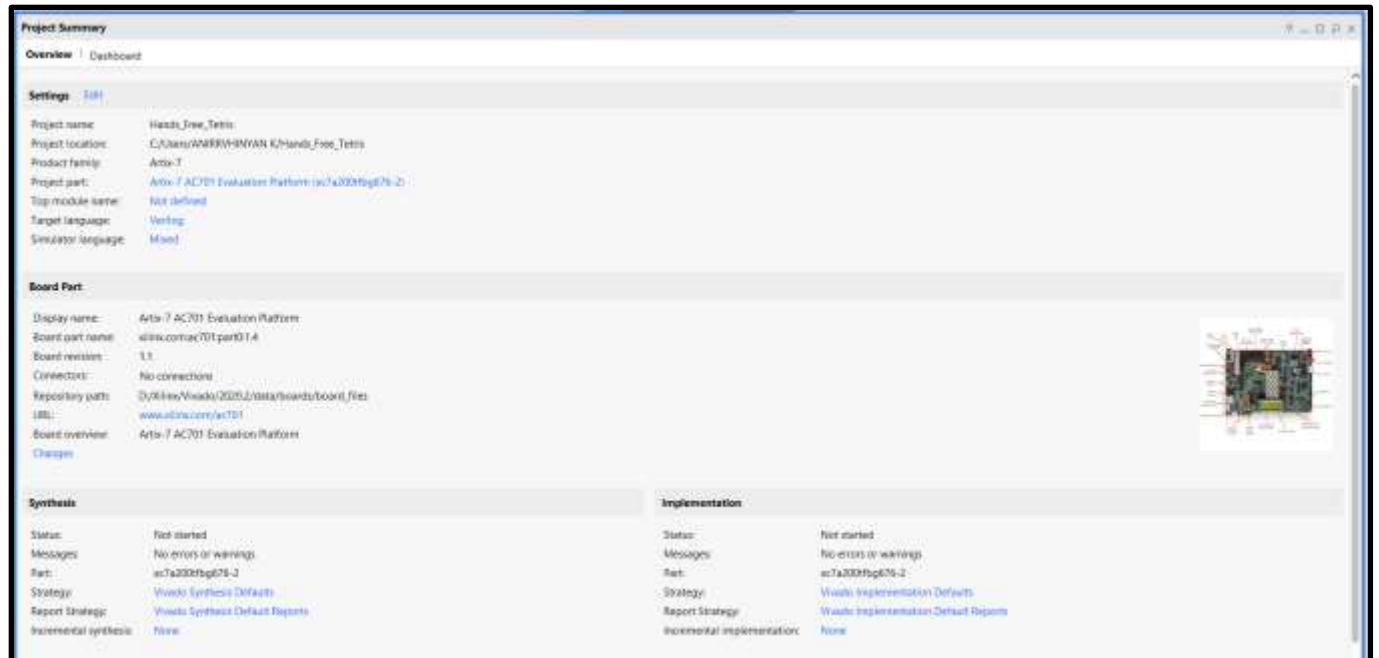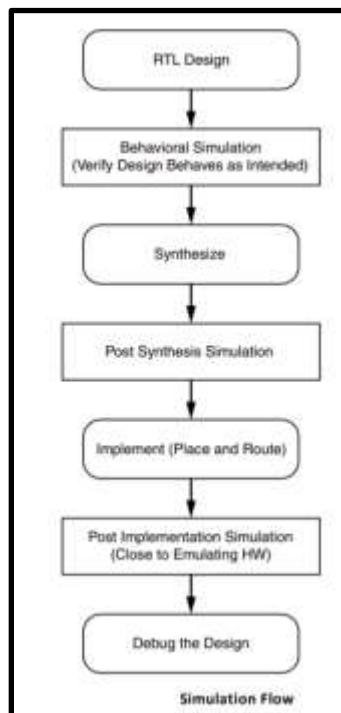# IMAGES

The specifications of Artix 7 FPGA and summary of project are given below:

BITSTREAM GENERATION:

The flowchart below represents steps of simulating the design.

Simulation Flow

MACHINE LEARNING:

The model summary:

```
Model: "sequential"

Layer (type)                    Output Shape              Param #
===============================================================
conv2d (Conv2D)                 (None, 254, 254, 32)      320

activation (Activation)         (None, 254, 254, 32)      0

conv2d_1 (Conv2D)               (None, 252, 252, 32)      9248

activation_1 (Activation)       (None, 252, 252, 32)      0

max_pooling2d (MaxPooling2D)    (None, 126, 126, 32)      0

dropout (Dropout)               (None, 126, 126, 32)      0

conv2d_2 (Conv2D)               (None, 124, 124, 64)      18496

activation_2 (Activation)       (None, 124, 124, 64)      0

max_pooling2d_1 (MaxPooling2     (None, 62, 62, 64)        0

dropout_1 (Dropout)             (None, 62, 62, 64)        0

flatten (Flatten)               (None, 246016)            0

dense (Dense)                   (None, 128)               31490176

dropout_2 (Dropout)             (None, 128)               0

dense_1 (Dense)                 (None, 64)                8256
```

```
dense_1 (Dense)                 (None, 64)                8256

dense_2 (Dense)                 (None, 4)                 260
===============================================================
Total params: 31,526,756
Trainable params: 31,526,756
Non-trainable params: 0

Epoch 1/5
42/42 [==============================] - 54s 1s/step - loss: 0.7635 - accuracy: 0.7441 - val_loss: 0.0074 - val_accuracy: 0.9983
Epoch 2/5
42/42 [==============================] - 53s 1s/step - loss: 1.1122e-04 - accuracy: 1.0000 - val_loss: 0.0085 - val_accuracy: 0.9983
Epoch 3/5
42/42 [==============================] - 57s 1s/step - loss: 0.0124 - accuracy: 0.9941 - val_loss: 0.0259 - val_accuracy: 0.9895
Epoch 4/5
42/42 [==============================] - 53s 1s/step - loss: 6.1079e-04 - accuracy: 1.0000 - val_loss: 0.0224 - val_accuracy: 0.9913
Epoch 5/5
42/42 [==============================] - 55s 1s/step - loss: 1.6783e-05 - accuracy: 1.0000 - val_loss: 0.0209 - val_accuracy: 0.9930
```
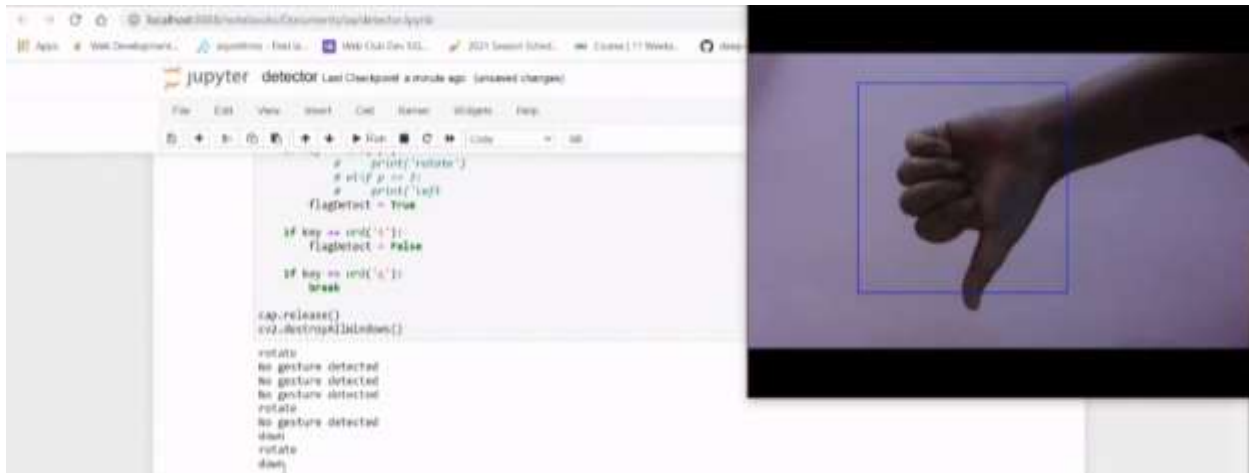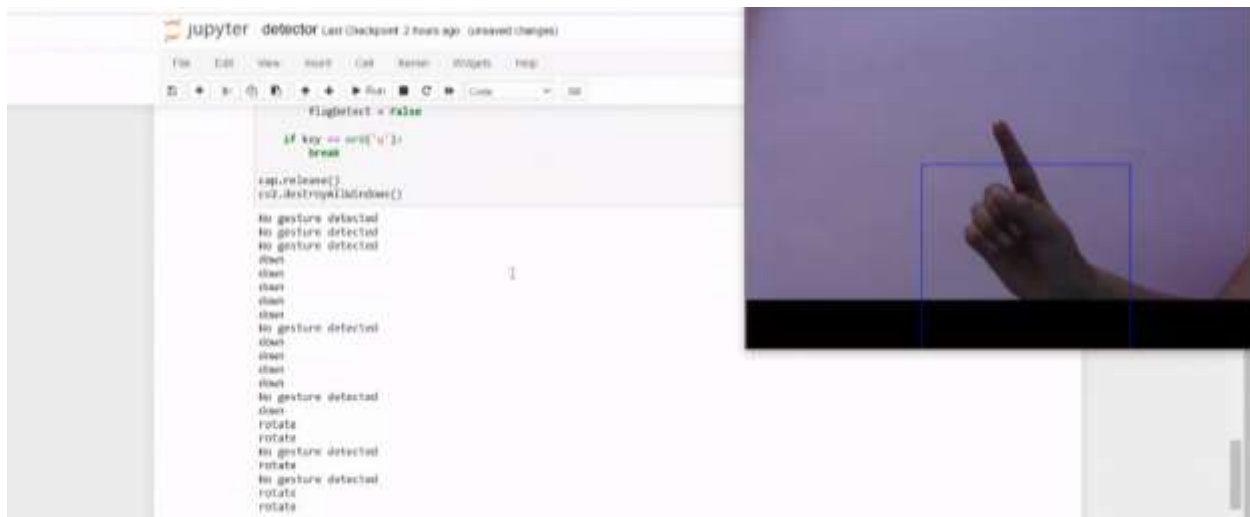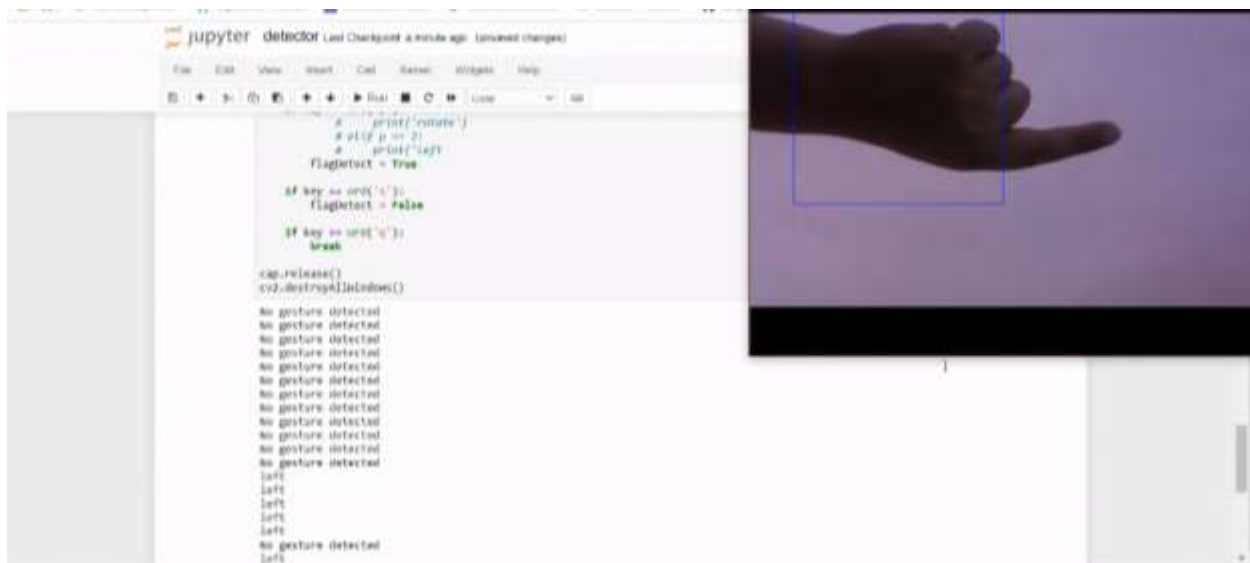
BITSTREAM GENERATION:

The Bit Stream generated by Vivado is given below:

GESTURE DETECTION:

The given inputs are correctly detected. The simulation results are shown below:

File   Edit   View   Insert   Cell   Kernel   Widgets   Help

```
#         print('rotate')
#     elif p == 2:
#         print('left')
    flagDetect = True

if key == ord('s'):
    flagDetect = False

if key == ord('q'):
    break

cap.release()
cv2.destroyAllWindows()
```

```
No gesture detected
No gesture detected
No gesture detected
No gesture detected
No gesture detected
No gesture detected
No gesture detected
No gesture detected
No gesture detected
No gesture detected
No gesture detected
No gesture detected
left
left
left
left
left
No gesture detected
left
```

File   Edit   View   Insert   Cell   Kernel   Widgets   Help

```
right
down
down
down
down
down
down
down
down
right
right
right
right
```

File   Edit   View   Insert   Cell   Kernel   Widgets   Help

```
        flagDetect = False

if key == ord('q'):
    break

cap.release()
cv2.destroyAllWindows()
```

```
No gesture detected
No gesture detected
No gesture detected
down
down
down
down
down
No gesture detected
down
down
down
down
No gesture detected
down
rotate
rotate
No gesture detected
rotate
No gesture detected
rotate
rotate
```