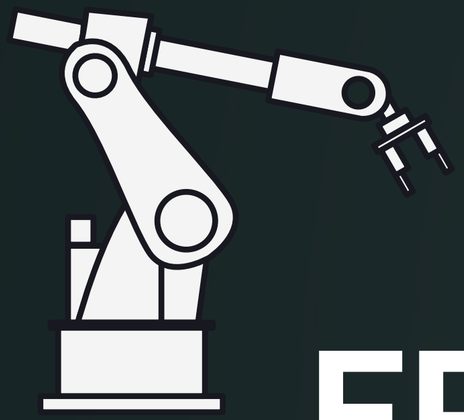

FPGA BASED ROBOTIC ARM MOVEMENT CONTROL

Minor Project

Our Great Team

Talent wins games, but teamwork and intelligence win championships.

-Michael Jordan

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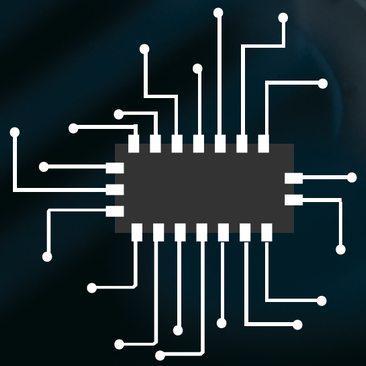
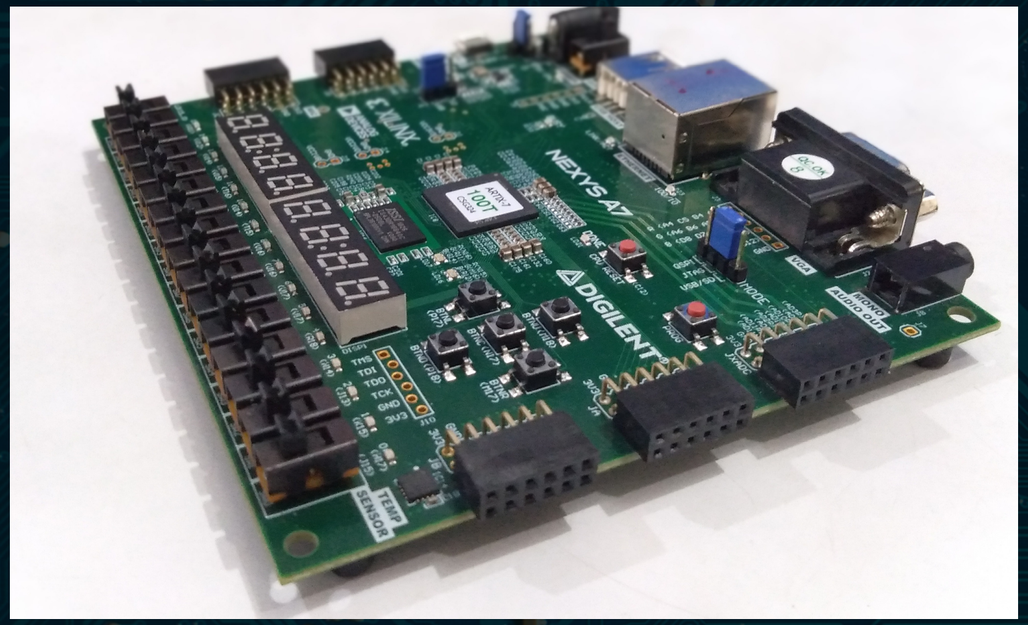
Introduction

Robotic arm is a type of mechanical arm, usually programmable, with similar functions to a human arm; the arm may be the sum total of the mechanism or may be part of a more complex robot. A 3-DOF robotic arm can be built, with servo motors actuating the arm's movement. that can execute tasks either manually or semiautomatically using FPGA.

PWM signals were sent to servo motors individually and in parallel via Pmod connectors on the FPGA board,Using a unique combination of on-board slide switches and pushbuttons distinct PWM signals were sent to the various motors.



Tech Stack



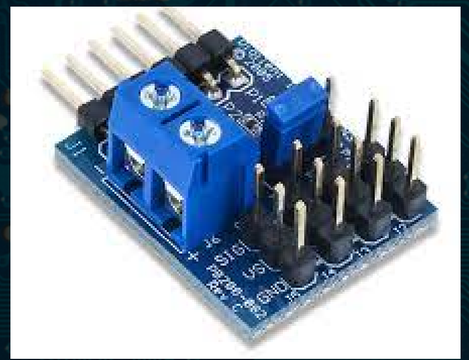
Xilinx Nexys-4 DDR Artix-7 FPGA Board

VIVADO
HLx Editions

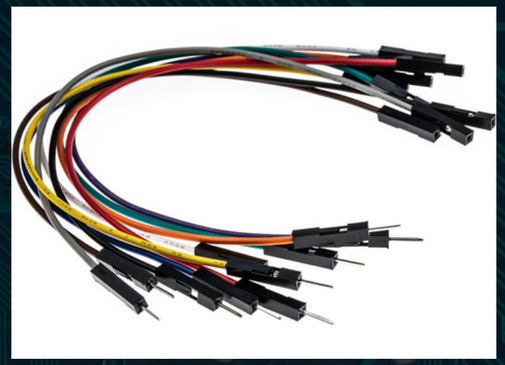
Xilinx Vivado

Ice-Cream Sticks

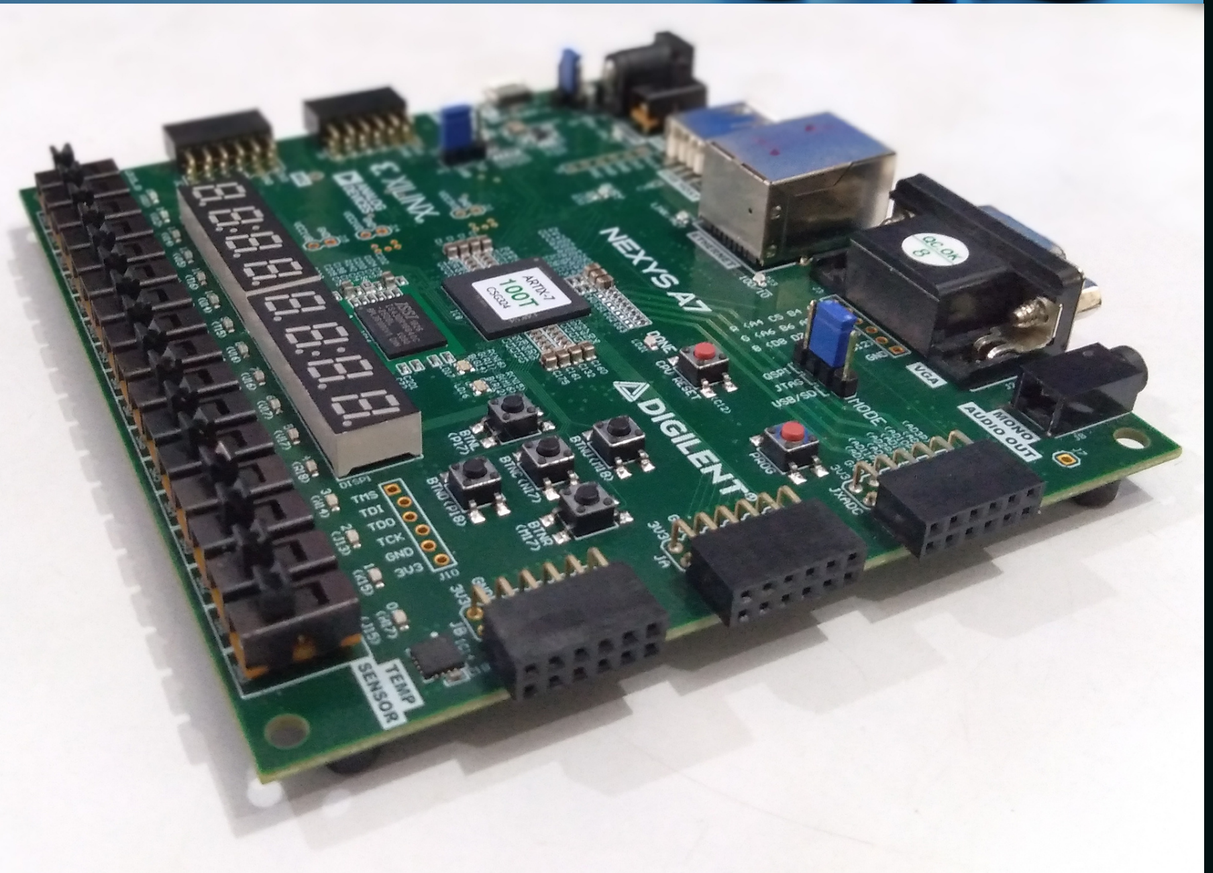
Servo Motor



Pmod CON3 Connector



Jumper wires



Why FPGA?

- **FPGAs are preferred for faster hardware prototyping and validating a design or concept.**

- **For the four servo motors to drive independently and simultaneously, parallel distinct outputs are needed from the FPGA board, for which the FPGA is capable.**

Project Flow

We proceeded in following manner to get our final project

Step 01

To generate PWM signal from FPGA and drive one servo

Step 02

To drive four servos at a time with same angle

Step 03

To drive four diffrent servos with diffrent angles one at a time

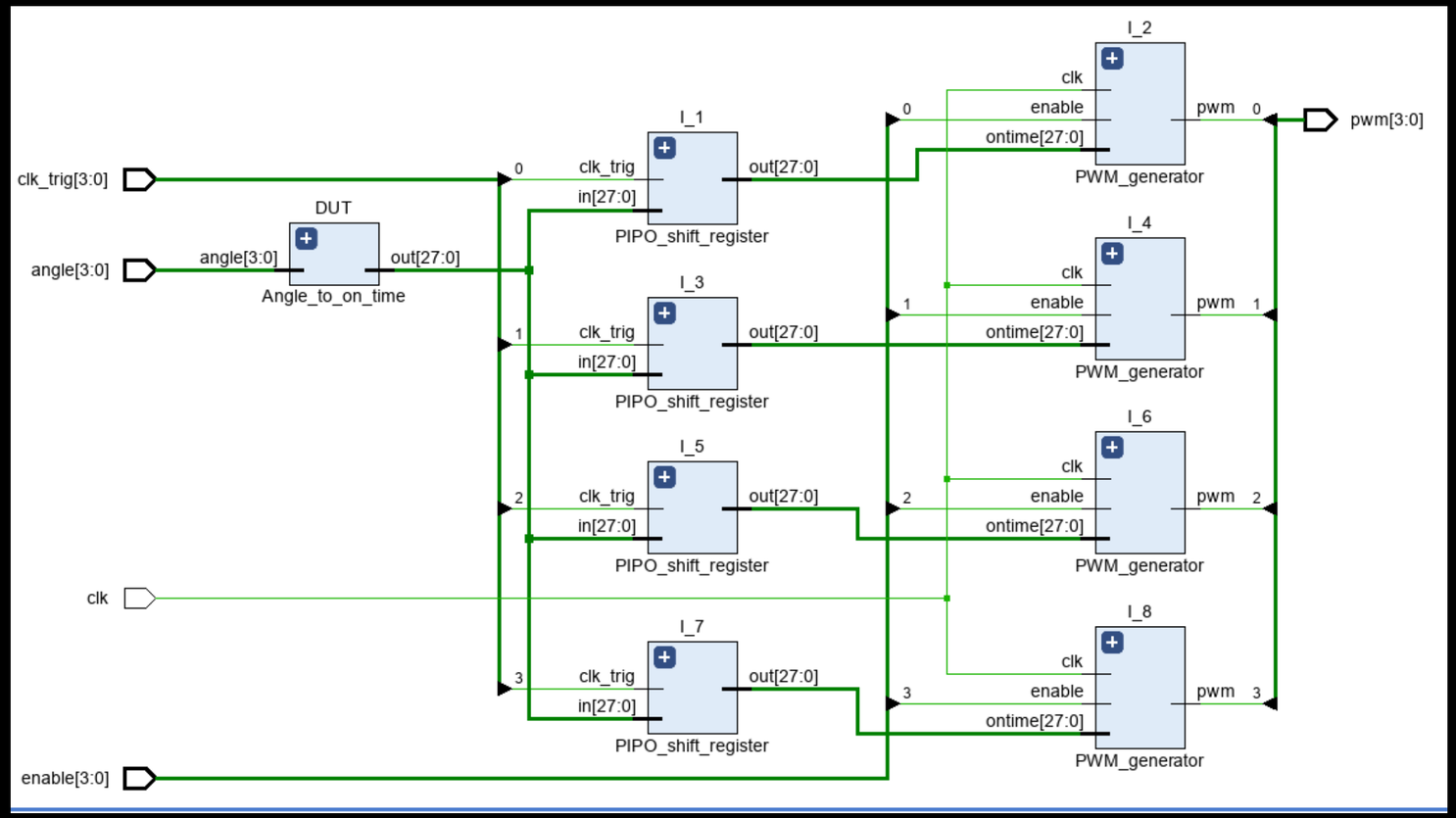
Step 04

To drive all four servos at a time simultaneously and attach to mechanical arm

Design & Algorithm

The whole code was divided into four modules

1. Top Module
2. Angle to on-time
3. PIPO Shift Register
4. PWM Generator



Language: Verilog HDL

Robotic Arm Design

We design a 3 Degree Of Freedom (DOF) Robotic Arm with one joint at the end effector, making a total of four joints. The main job is to pick and place a object from one position to another & job is divided into smaller jobs and assigned to each part and joint.

About the Arm

Base

Base is used to give rotation about the axis perpendicular to platform, its range of angle is 180°.

Elbow

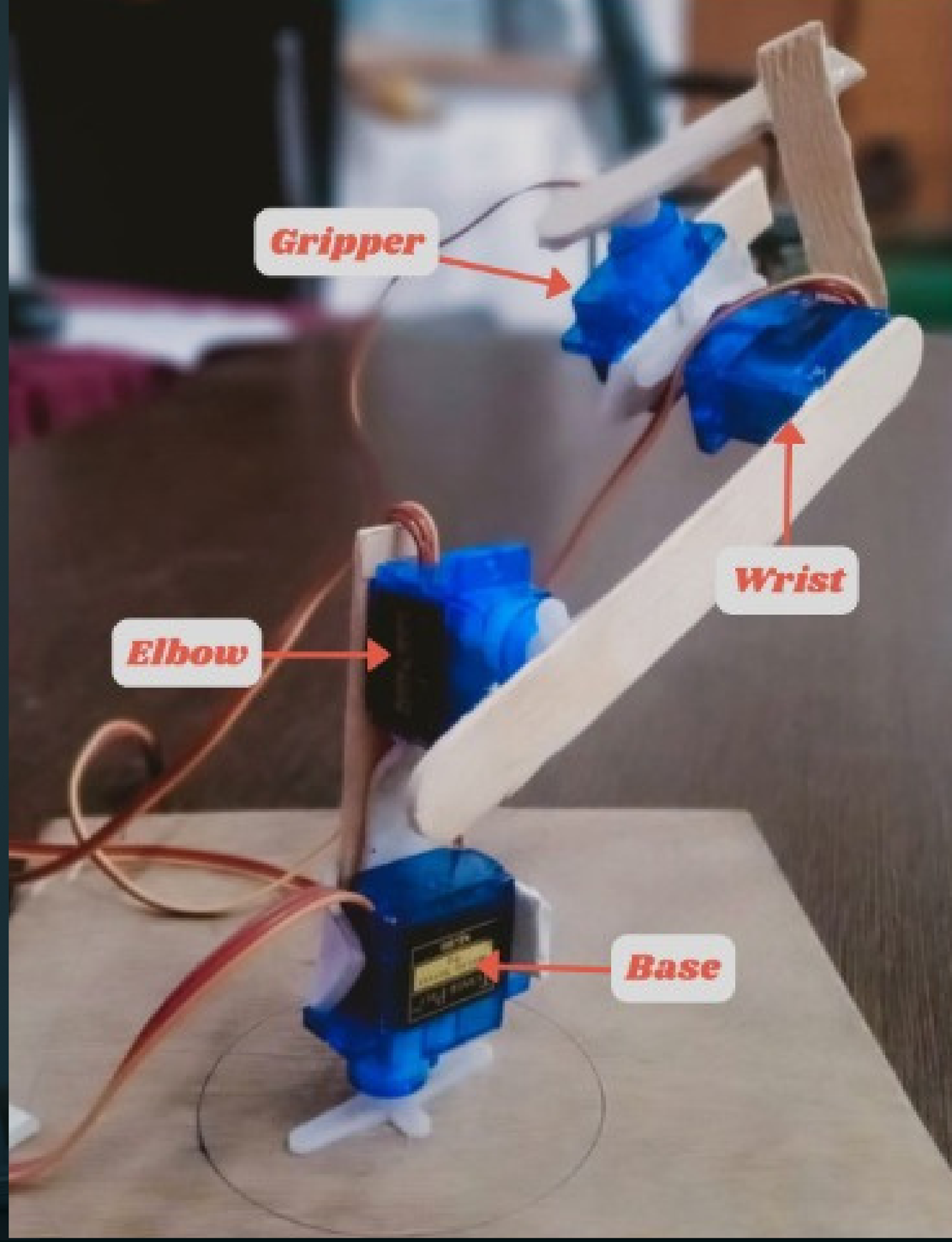
Elbow is to give the arm some more room to move the end effector forward, its range of angle is 90°.

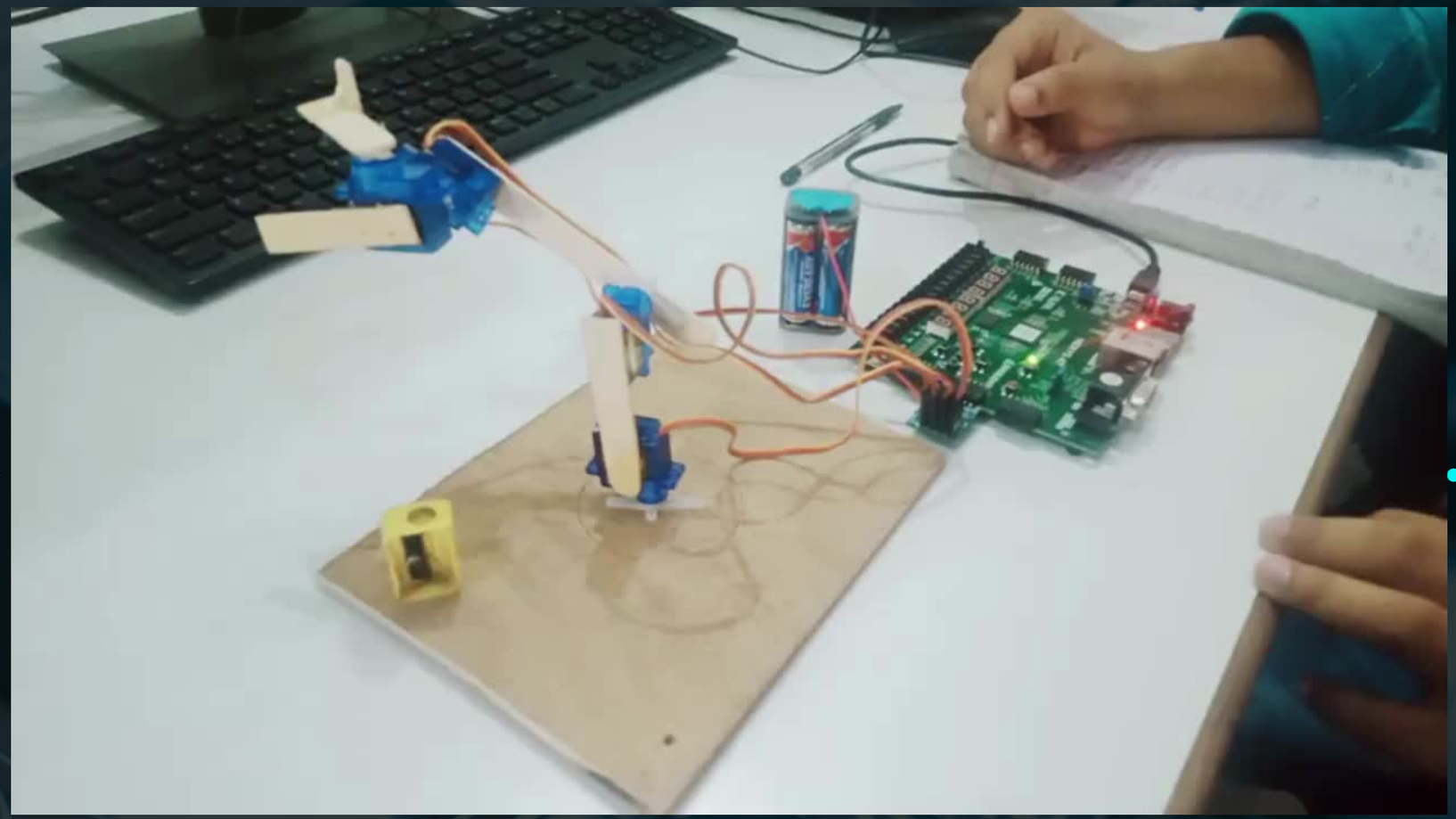
Wrist

Wrist is the area which balances the operation, its range of angle is 90°

Gripper

Gripper is used to pick and place the object, its range of angle is 30°.

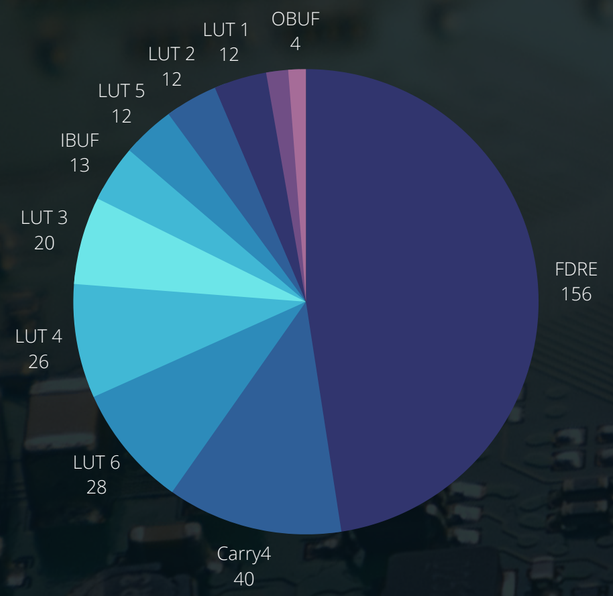




Video Demonstration

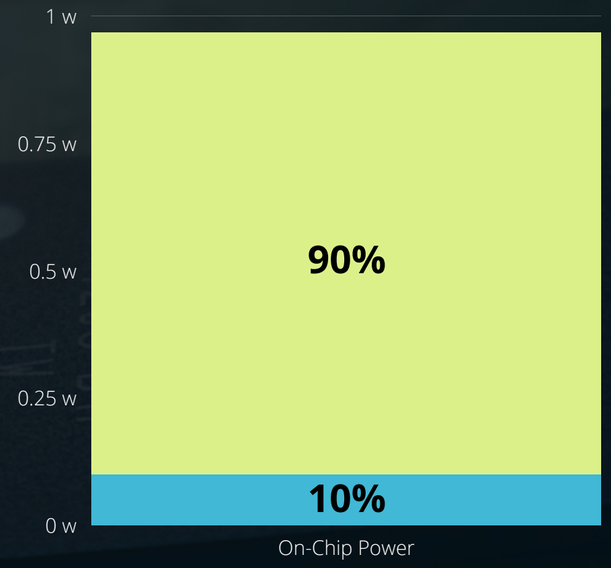
FPGA Resource Utilization

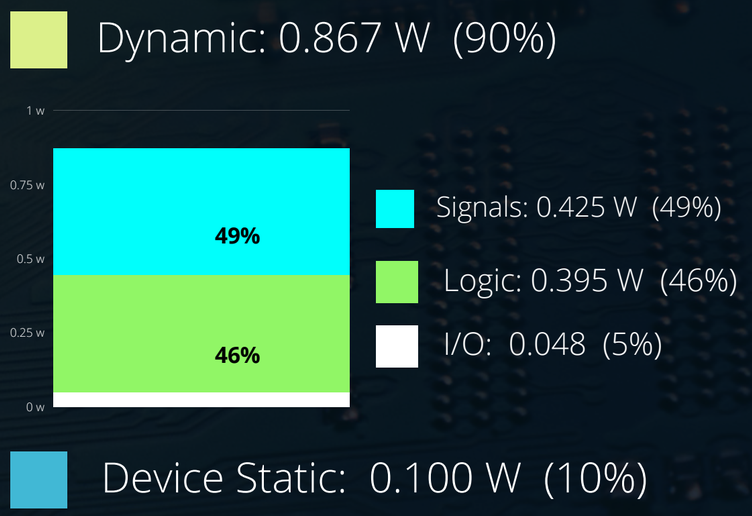
Primitives



- Total slice LUTs= 101
- Total slice Registers= 156

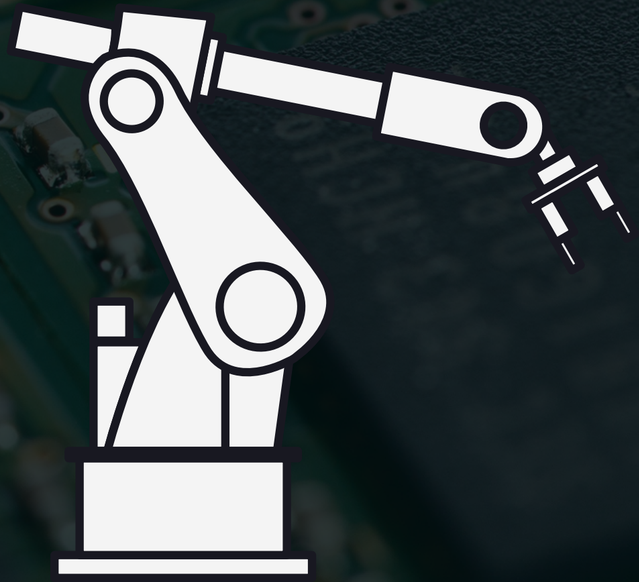
On-Chip Power





Conclusion

we have designed a Robotic Arm and controlled it using FPGA. our major challenges were to design a mechanical structure of the Robotic Arm and implementation of behaviour of the Robotic Arm on FPGA through Verilog. The placement and attachment of servos at the joints of or 3-DOF Robotic Arm was a bit challenging.



Thank You !!

Queries are welcome