USING A HOBBY SERVO TO CREATE A METRONOME

ECE 2031 Section L01

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INTRODUCTION

Project Overview

Create peripheral device that controls Hobby Servo

Project Purpose

Expand basic functionalities of Hobby Servo by creating a device that serves a specific purpose

Our Solution

Utilize Servo movement and user-input switches on DE10 to create a working metronome

Requirements

Must adhere to control pulse range between 0.5 and 2.5 ms without reliance on safety device

Implementation

Use pulse width modulation and delay in peripheral to manipulate tempo and angle of Servo movement to produce varying metronome “beats”

TECHNICAL APPROACH

Basic Definitions

- Metronome: Device used by musicians that marks time by producing audible beats at a selected rate
- Time Signature: Number of counts contained within a predefined segment of music
- Tempo: General definition for speed

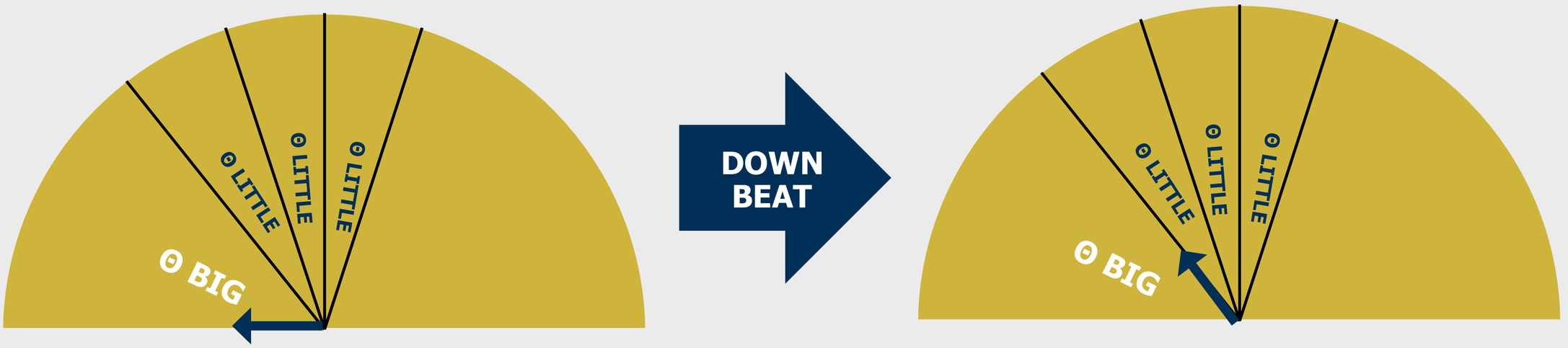
Requirements

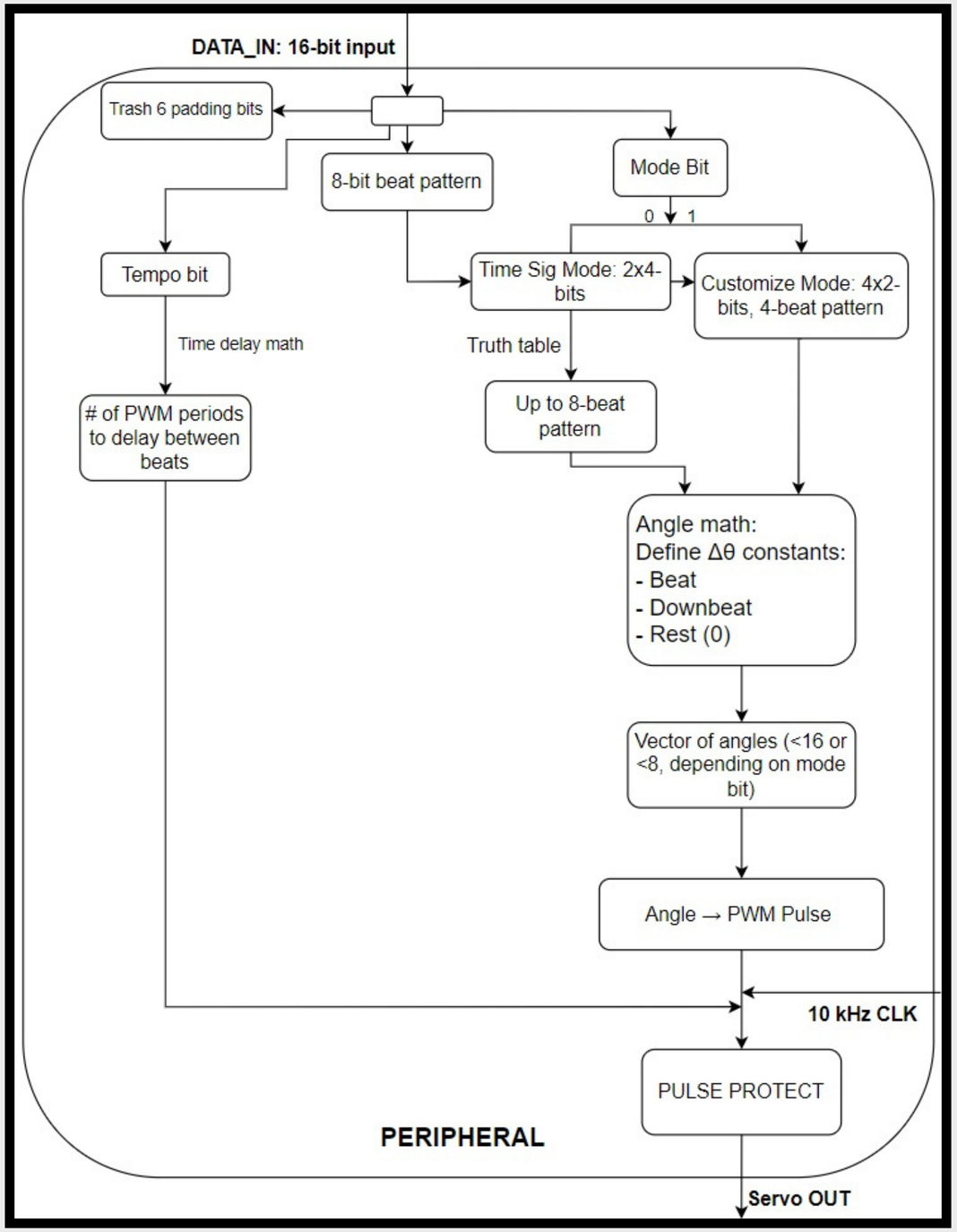
- Take in user input from switches on DE10
- Use binary value of switches to send valid time signature and tempo to servo
- Additional servo functionality:
  - Manipulate angle range of servo movement
  - Larger Δangle produces downbeat
  - Smaller Δangle produces remaining beats
- Ensure pulse is within “safe” range between 0.5 and 2.5 ms

4/4 BEAT EXAMPLE

MODE TEMPO BEAT BEAT BEAT BEAT BEAT BEAT BEAT BEAT

MOVEMENT = BEAT
DELAY BETWEEN MOVEMENT = TEMPO



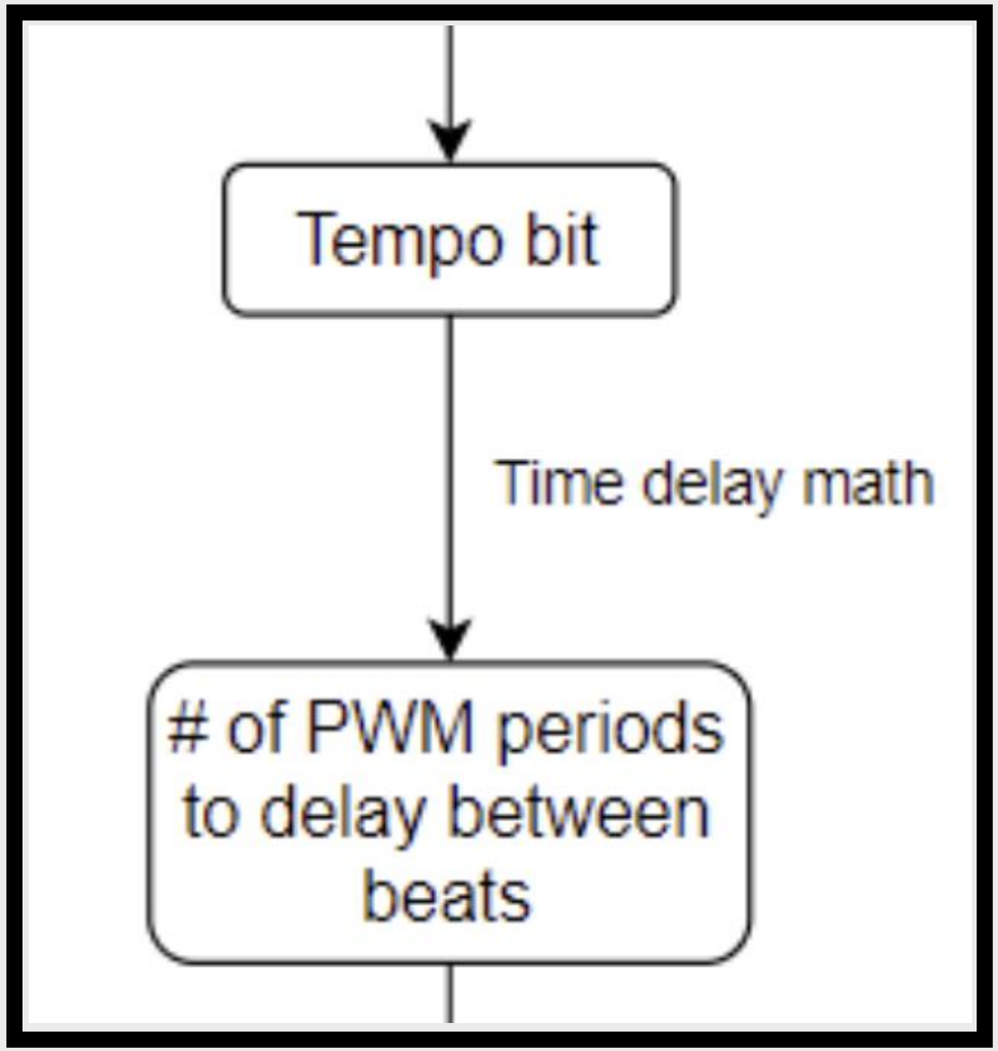


PERIPHERAL FLOW DIAGRAM

Overview of our proposed peripheral device with the following sub-processes:

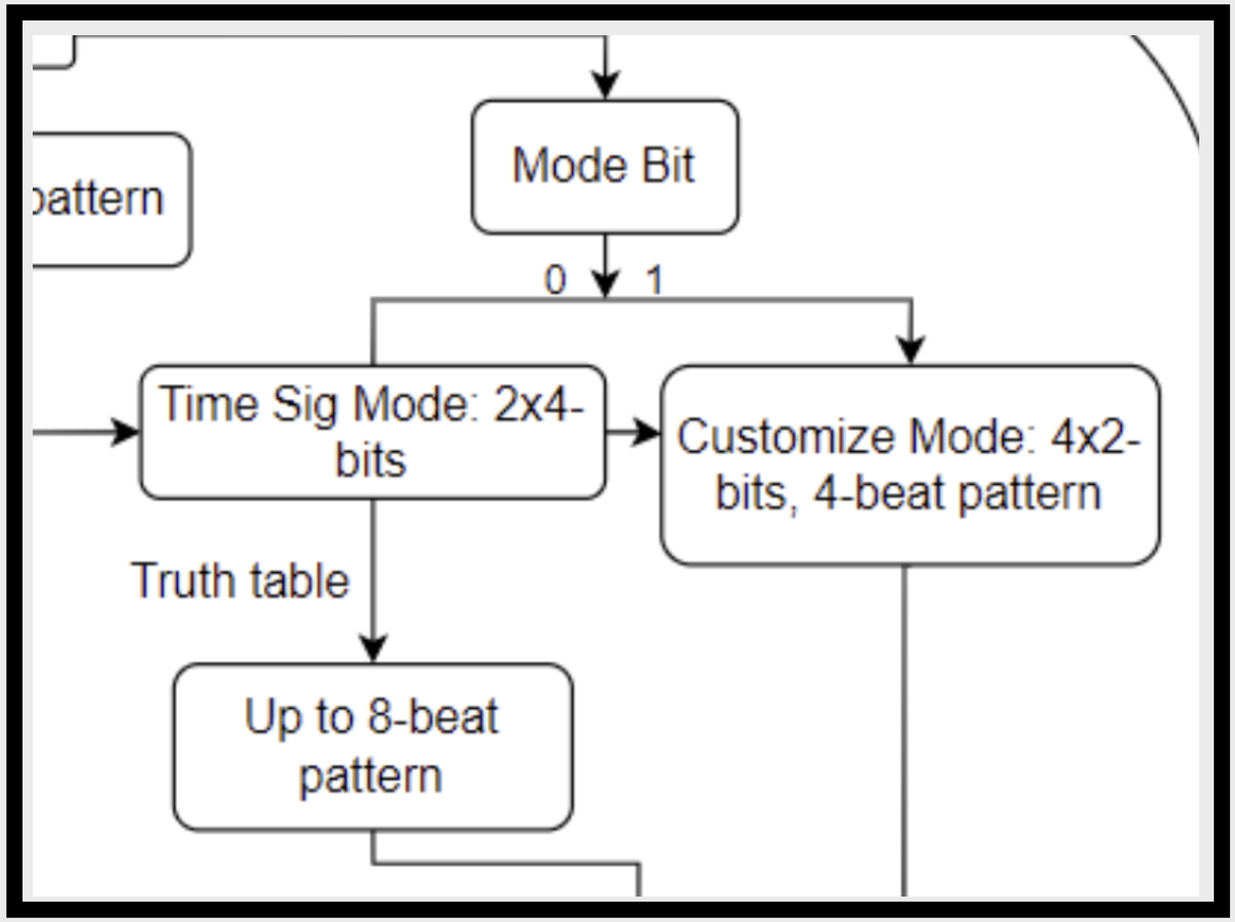
- Tempo manipulated via delay between beats
- Time signature read in as 8-bit pattern
- Time signature beat pattern defined in 8-bits
- Define constants for varying angles and perform “angle math”
- Ensure that pulse produced is within safe range

TEMPO



- 1- bit input from the second switch (S8) on DE10 board
- 2 modes: fast (‘1’) and slow (‘0’)
- Tempo will be maintained by the delay between beats
- Delay is defined as the number of PWM periods with no movement between each beat

TIME SIGNATURE



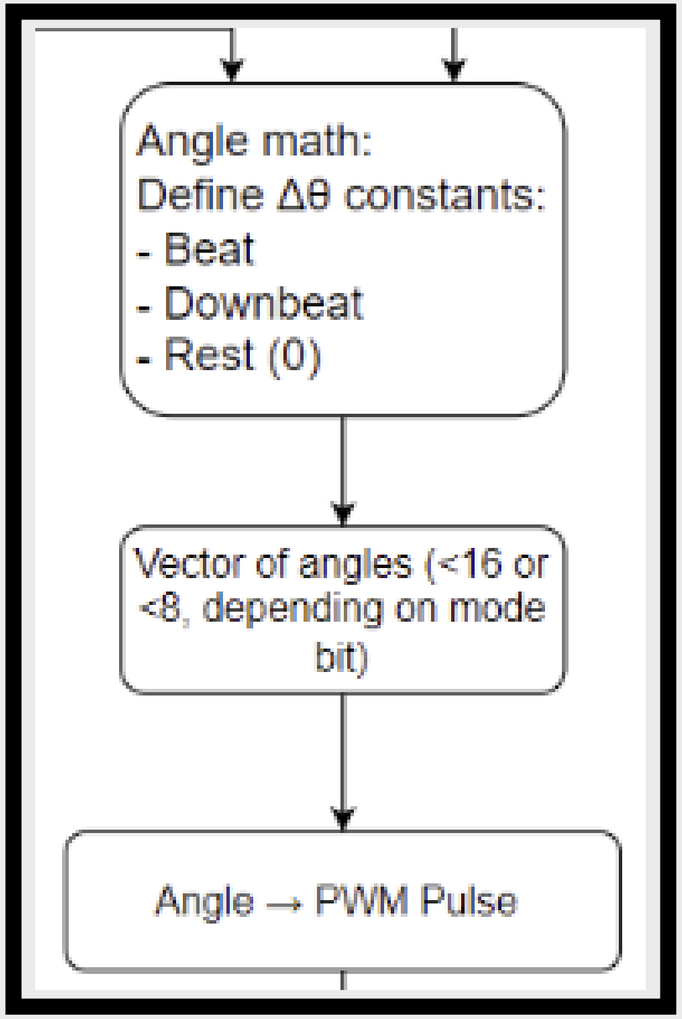
- Determined by the 8-bit switch values (S7-S0) on the DE10
- First 4-bits (S7-S4): Top value in time signature interpreted in binary
- Last 4-bits (S3-S0): Bottom value in time signature interpreted in binary
- Time Signature is then translated to another 8-bits to define the beat pattern

USER INPUT TO TIME SIGNATURE DEFINITION

8-BIT SWITCH VALUE TO 4-BIT/4-BIT BEAT PATTERN:									
1/1 Beats:								Top:	Bottom:
1	1	1	1	0	0	0	1	15	1
1	1	1	0	0	0	0	1	14	1
1	1	0	1	0	0	0	1	13	1
1	1	0	0	0	0	0	1	12	1
1	0	1	1	0	0	0	1	11	1
1	0	1	0	0	0	0	1	10	1
1	0	0	1	0	0	0	1	9	1
1	0	0	0	0	0	0	1	8	1
0	1	1	1	0	0	0	1	7	1
0	1	1	0	0	0	0	1	6	1
0	1	0	1	0	0	0	1	5	1
0	1	0	0	0	0	0	1	4	1
0	0	1	1	0	0	0	1	3	1
0	0	1	0	0	0	0	1	2	1
0	0	0	1	0	0	0	1	1	1
0	0	0	1	0	1	0	0	1	4
0	0	0	1	0	0	1	0	1	2
Patterns:									
1	0	0	0	0	1	0	0	8	4
0	1	1	0	1	0	0	0	6	8
0	1	1	0	0	1	0	0	6	4
0	1	0	0	1	0	0	0	4	8
0	1	0	0	0	1	0	0	4	4
0	0	1	1	0	1	0	0	3	4
0	0	1	0	1	0	0	0	2	8
0	0	1	0	0	1	0	0	2	4
0	0	1	0	0	0	1	0	2	2

8-BIT BEAT PATTERN TO CORRESPONDING 8-BIT HIGH/LOW PATTERN:							
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0
0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0
0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	0
0	0	0	0	0	0	1	0
0	0	0	0	0	0	1	0

ANGLE MANIPULATION

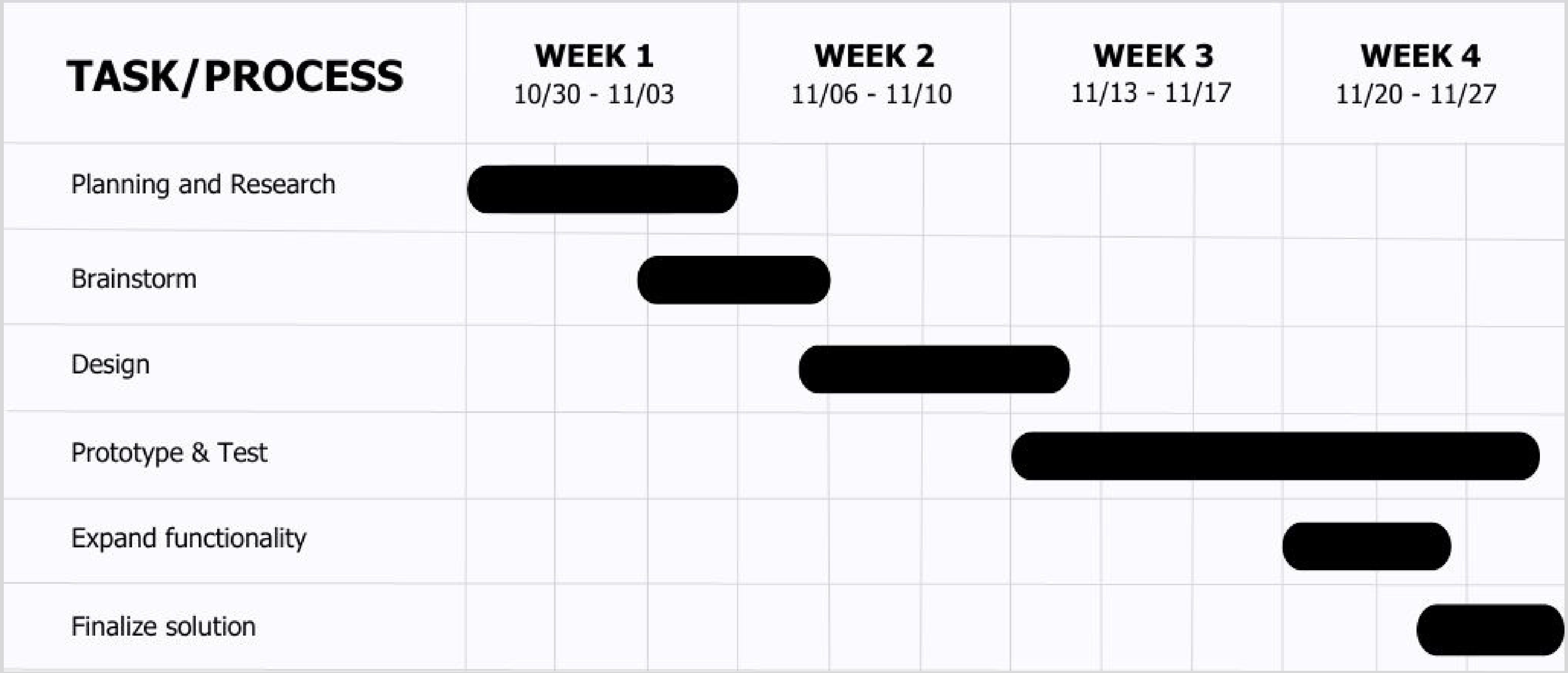


- Control the angle that the Servo moves to
- Each angle is mapped to a PWM high-time value (within range)
- Determine the Δangles (pulse widths) to distinguish two varying beat sounds (defined as Θ big and Θ little)
- Determine # of each beat from beat pattern

- Limitation:
  - Angular resolution of 9 degrees
  - Clock speed

Project Management Plan

GANTT CHART



MANAGEMENT PLAN

Division of Labor

- 2 Parts: Hardware & Programming
  - Hardware: researching how Hobby Servo reads inputs and how to manipulate movement/angles
  - Programming: Assembly/VHDL

  - Shiva and Ishaan: Hardware
  - Rachel, Tania, Anjali: Programming
  - Tania and Anjali: Project Management

Iterative Testing Process

- Contingency Plan
- Start with moving Servo to specific angle and go from there
- Test each part of project at a time before moving on to next part
- Next Step: Time signature VHDL

CONCLUSION

- Project Overview: Creating a peripheral device that will expand on the servo's movement to different angles and read in user input from DE10 switches

- Project Goal: Create a functional metronome
  - Purpose: Utilizes servo movement to generate audible beats for various time signatures to produce a useful, unique tool for musicians of all ages

- Iterative plan: Testing small functionalities before combining the various components

- Progress: Servo movement already tested - final step is debugging state machine VHDL

- Final Functionality:
  - Final Metronome will account for two different tempos, two different modes, and provide beats for 26 different time signatures.
  - Extension: Final Custom Beat Mode will produce a 4/4 beat, at two different tempos, where the user can determine the sound for each individual beat.

THANK YOU!