Assignment No. C-1

Roll No:

Aim :

Develop Robotics(stepper motor) Application using Beagle Board.

Software Required :

- Linux Operating System
- GCC Compiler.

Hardware Required :

- Beaglebone Black/ ARM Cortex Processor
- Robotic Arm (Stepper Motor)
- Interfacing cables

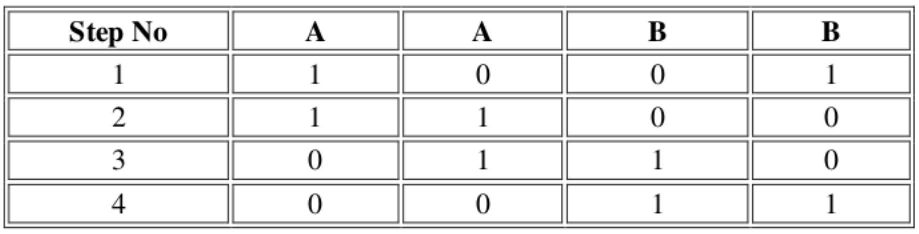
Theory :

Stepper Motor

A step motor can be viewed as a synchronous AC motor with the number of poles (on both rotor and stator) increased, taking care that they have no common denominator. Additionally, soft magnetic material with many teeth on the rotor and stator cheaply multiplies the number of poles (reluctance motor). Modern steppers are of hybrid design, having both permanent magnets and soft iron cores. A stepper motor is made up of a rotor, which is normally a permanent magnet and it is, as the name suggests the rotating component of the motor. A stator is another part which is in the form of winding. In the diagram below, the center is the rotor which is surrounded by the stator winding. This is called as four phase winding.

Unipolar vs Bipolar

nipolar motors use 6 wires and require a unipolar driver. In addition to the A and B phases, there are two extra wires called the common wires, Current



Step No	A	A	B	B
1	1	0	0	1
2	1	1	0	0
3	0	1	1	0
4	0	0	1	1

Figure 1: Stepping Sequence of Stepper Motor

always flows in one direction: from the phases, through the common wires. In addition, only one portion of the motor is energized at a time. Bipolar motors use 4 wires and require a bipolar drive. Common wires are not used. Current can flow in two directions. In addition, two phases can be energized at one time.

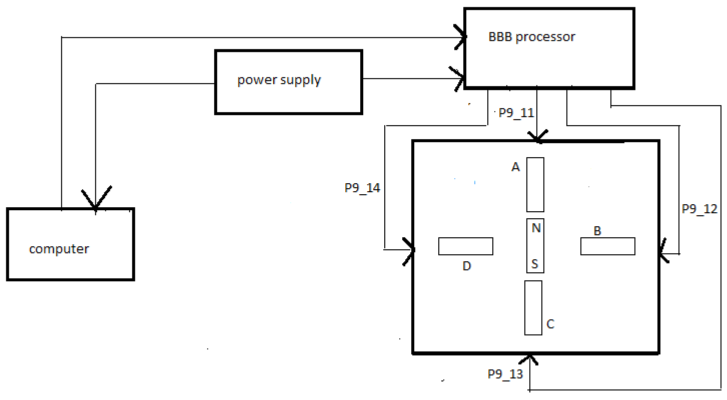
Working of Stepper Motor

The centre tap on the stator winding allows the current in the coil to change direction when the winding are grounded. The magnetic property of the stator changes and it will selectively attract and repel the rotor, thereby resulting in a stepping motion for the motor.

Stepping Sequence

In order to get correct motion of the motor, a stepping sequence has to be followed. This stepping sequence gives the voltage that must be applied to the stator phase. Normally a 4 step sequence is followed. When the sequence is followed from step 1 to 4, we get a clock wise rotation and when it is followed from step 4 to 1, we get a counter clockwise rotation.

Interfacing Diagram



Algorithm

1. Start the Kit with four electromagnets A , B , C , D .
2. Set P9-11 , P9-12 , P9-13 ,P9-14 as output pins.
3. Anticlockwise Rotation

    - First iteration
    - Set P9-11 HIGH
    - Set P9-12 LOW
    - Set P9-13 LOW
    - Set P9-14 LOW

    - Second iteration
    - Set P9-11 LOW
    - Set P9-12 HIGH
    - Set P9-13 LOW
    - Set P9-14 LOW

    - Third iteration
    - Set P9-11 LOW
    - Set P9-12 LOW
    - Set P9-13 HIGH

- Set P9-14 LOW

- Fourth iteration
- Set P9-11 LOW
- Set P9-12 LOW
- Set P9-13 LOW
- Set P9-14 HIGH

Mathematical Model

Let S be a set such that

S={s, e, i, o, f, DD, NDD, success, failure}

s= initial state

e = end state

i= input of the system.

o= output of the system.

f= functions

DD-Deterministic Data it helps identifying the load store functions or assignment functions.

NDD- It is Non deterministic data of the system S to be solved.

Success-Stepper motor rotates in desired direction.

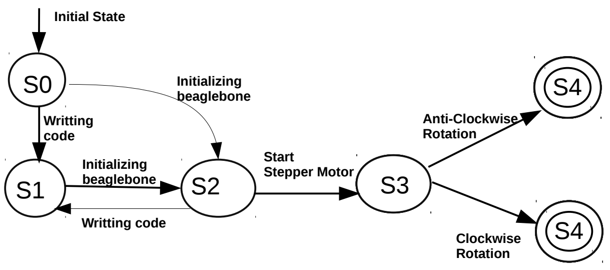
Failure-Desired outcome not generated or forced exit due to system error.

States: { S0 ,S1 , S2 , S3 , S4 , S5 }

S0: initial State (Power supply)

S1: Monitor Display editor (Write and Design application using gedit)

S2: BeagleBone Black



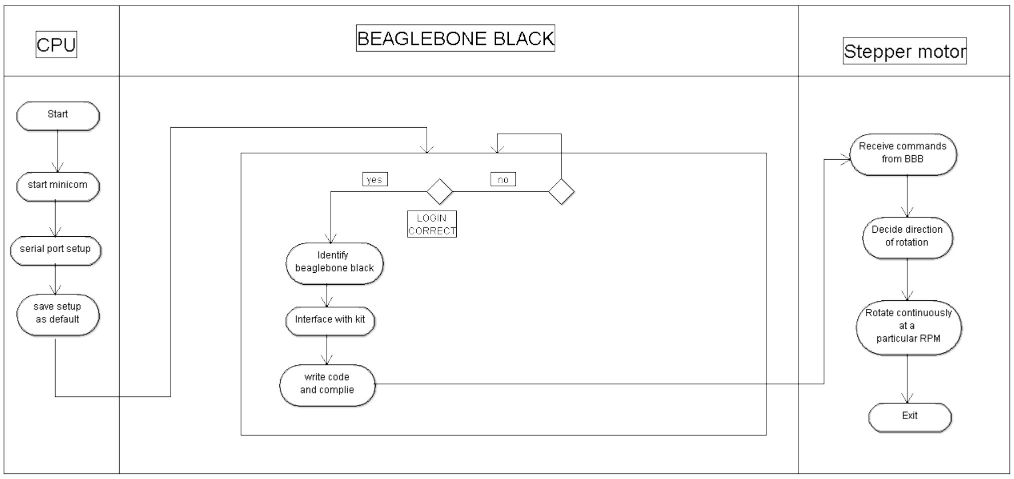
S3: stepper Motor

S4: Final State (clockwise Rotation)

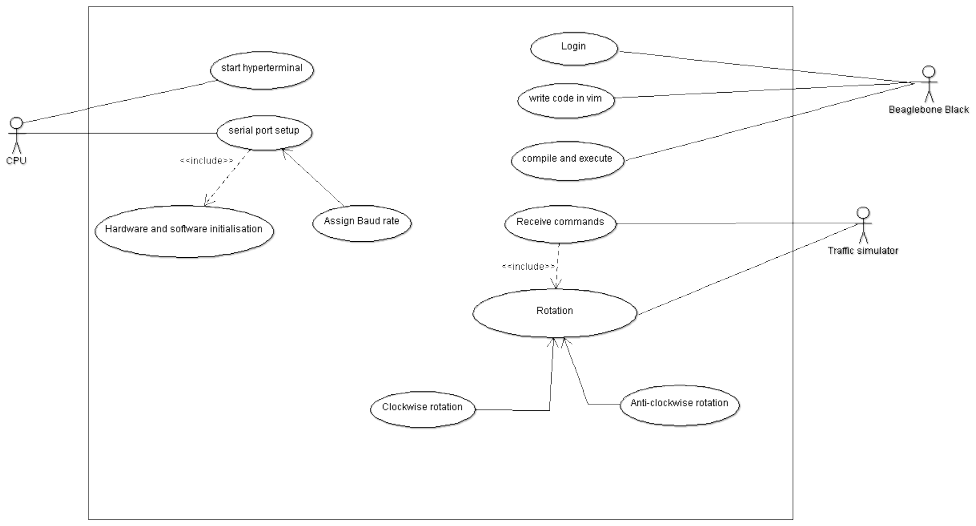
S5: Final State (Anti-clockwise Rotation)

UML Diagrams :

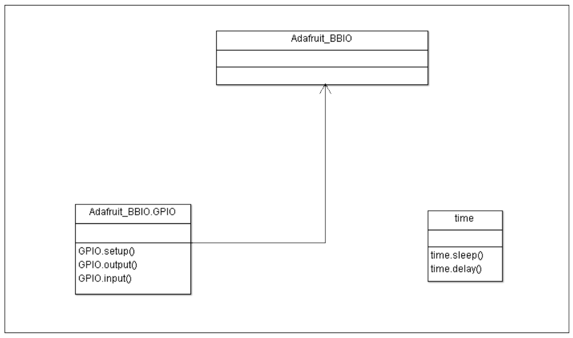
Activity Diagram



Use-case Diagram



Class Diagram



CONCLUSION :

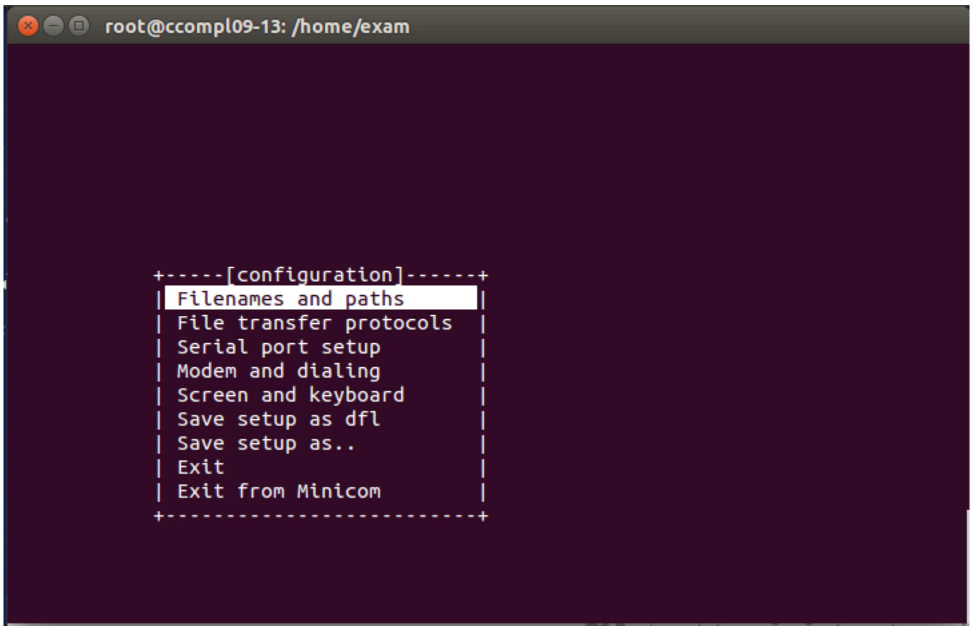
Hence, we have successfully developed and demonstrated Robotic Arm application using stepper motor with Beagleblack bone board..

Course Outcomes :

Course Outcomes	Tick [√]
Ability to perform multi-core, Concurrent and Distributed Programming	
Ability to perform Embedded Operating Systems Programming	
Ability to write Software Engineering Document	
Ability to perform Concurrent and Distributed Programming	

Output (Screenshots)

Minicom Terminal



```
root@ccompl09-13: /home/exam

+-----[configuration]------+
| Filenames and paths      |
| File transfer protocols  |
| Serial port setup        |
| Modem and dialing        |
| Screen and keyboard      |
| Save setup as dfl        |
| Save setup as..          |
| Exit                     |
| Exit from Minicom        |
+--------------------------+
```

Stepper Motor :

0.1 Code :

```
import Adafruit.BBIO_GPIO as gpio
import time

gpio.setup("P9_11",gpio.OUT)
gpio.setup("P9_12",gpio.OUT)
gpio.setup("P9_13",gpio.OUT)
gpio.setup("P9_14",gpio.OUT)

while 1:
gpio.output("P9_11",gpio.HIGH)
gpio.output("P9_12",gpio.LOW)
gpio.output("P9_13",gpio.LOW)
gpio.output("P9_14",gpio.LOW)
time.sleep(2)
gpio.output("P9_11",gpio.LOW)
gpio.output("P9_12",gpio.HIGH)
gpio.output("P9_13",gpio.LOW)
gpio.output("P9_14",gpio.LOW)
time.sleep(2)
gpio.output("P9_11",gpio.LOW)
gpio.output("P9_12",gpio.LOW)
gpio.output("P9_13",gpio.HIGH)
gpio.output("P9_14",gpio.LOW)
time.sleep(2)
gpio.output("P9_11",gpio.LOW)
gpio.output("P9_12",gpio.LOW)
gpio.output("P9_13",gpio.LOW)
gpio.output("P9_14",gpio.HIGH)
time.sleep(2) ;clockwise over
gpio.output("P9_14",gpio.HIGH)
gpio.output("P9_13",gpio.LOW)
gpio.output("P9_12",gpio.LOW)
gpio.output("P9_11",gpio.LOW)
time.sleep(2)
gpio.output("P9_14",gpio.LOW)
gpio.output("P9_13",gpio.HIGH)
gpio.output("P9_12",gpio.LOW)
gpio.output("P9_11",gpio.LOW)
time.sleep(2)
```

```
gpio.output("P9_14",gpio.LOW)
gpio.output("P9_13",gpio.LOW)
gpio.output("P9_12",gpio.HIGH)
gpio.output("P9_11",gpio.LOW)
time.sleep(2)
gpio.output("P9_14",gpio.LOW)
gpio.output("P9_13",gpio.LOW)
gpio.output("P9_12",gpio.LOW)
gpio.output("P9_11",gpio.HIGH)
time.sleep(2)     ; anticlockwise over
```