FIREBIRD-V HEXAPOD

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The Idea

- The objective of the project is to build **'Locomotion based Hexapod Application'**.
- We wish to do the following :
  - Make the hexapod move fast and smoothly in all directions
  - Make it turn by any given angle
  - Control hexapod motion by a keyboard through ZigBee module.
  - Implementation of code in RTOS environment.
- We want to model the natural walk of a spider in the hexapod by controlling the servo motors on the bot in a coordinated fashion.

Gaits

- A *gait* refers to a particular sequence of lifting and placing the feet during legged locomotion (gallop, trot, walk, run…)
- Each repetition of the sequence is called a *gait cycle*
- The time taken in one complete cycle is the *gait period*
- The inverse of the period is the *gait frequency* (1/period)
- Normally, in one gait cycle, each leg goes through exactly one complete step cycle

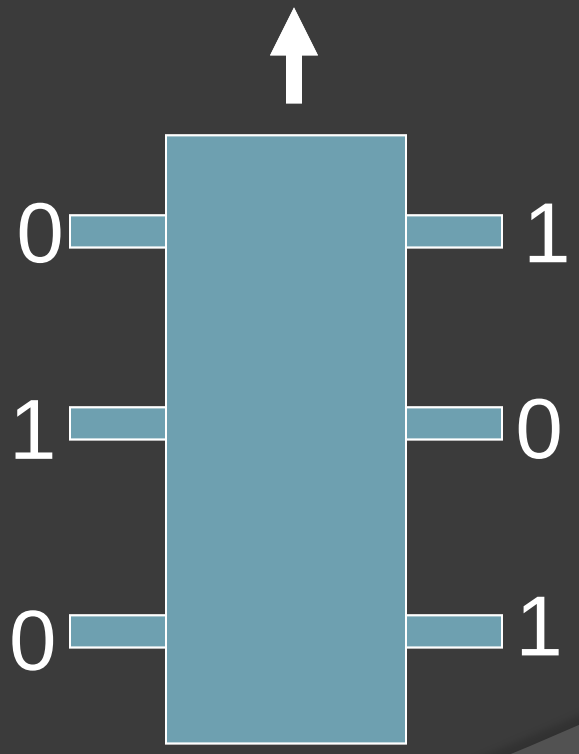
Step Cycle

- In one gait cycle, each individual leg goes through a complete *step cycle*
- Each leg's step cycle is phase shifted relative to the main gait cycle
- The step cycle is broken into two main stages
  - *Support stage* (foot on ground)
  - *Transfer stage* (foot in the air)
- The amount of time a leg spends in the support stage is the *support duration* (& likewise for *transfer duration*)

$$SupportDuration + TransferDuration = GaitPeriod$$

Hexapod Gait

- Most adult insects are hexapods (6 legs)
- For faster movement, most insects use a tripod gait.
- Occasionally, one encounters insects that run on their back 4 legs or even only their back 2 (cockroaches can do this)



Tripod gait

Key Challenges

- Simulating biological movement of a spider is difficult on a mechanical hexapod due to limited degrees of freedom.
- Complexity of movement (due to required coordination) makes the motion slow.
- Battery lifetime. Battery lasts for about 10-15 min and requires 30-45 min to charge.
- Calibration of 18 servos : Different legs move by different angles when given the same movement command
- Speed of the hexapod is limited by the power of the servo motors.

Response

- We will study the motion of a spider and will try to simulate it in the hexapod as closely as possible.
- We will experiment with various possible movements and choose the best from them.

  Some examples for possible movements are :
  - 2 Tripod gait motion
  - Two legged motion
- To deal with battery issue, we will try to get 2-3 buffer batteries (through TA).
- We will take into consideration the speed of motors and various asymmetries during our planning phase.

Additional Hardware

- We would need extra batteries so that we can experiment with hexapod longer.
- Some upgradation of present hexapod might also be useful.

Where can we fail

We might get stuck due to hardware limitations such as

- The hardware incurs a bottleneck on the maximum speed we can achieve. This is because there are 18 servo motors which increase the complexity of motion and as a result, a lot of machine instructions are required to be executed to change a single position. With a fixed value of processor frequency this decreases the speed.
- The power delivered by the motors to the arm limits the speed of arm movement and therefore of the locomotion of hexapod.
- Imprecision in calibration may lead to differences in planning and implementation phase.