ME 310: Microprocessors and Automatic Control Lab

Fundes: How to run motor?
Encoder interfacing

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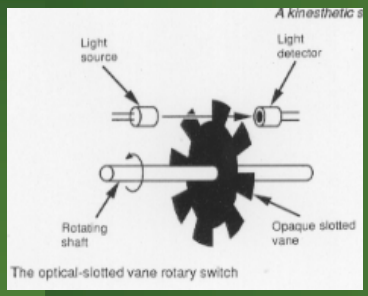
Goal: Feedback control of motor

- What is that we have seen so far
  - Fundes about Flipflop and programing microprocessor interfaces:Digital input output interface, PWM
  - How to run motor using microprocessor
- Q: what we should use as feedback for the closed loop? Any ideas!!
- Position sensing by what means?

Position sensing

- Sensors and interfaces to sense position
  - Potentiometer: interface required ADC
  - Encoder: interface PWM and Digital i/o
- Advantages and disadvantages of these
  - Potentiometer: analog: noisy data, limited range (10 turn)
  - Encoder: digital, clean signal, limited by number overflow but software correction can be done.

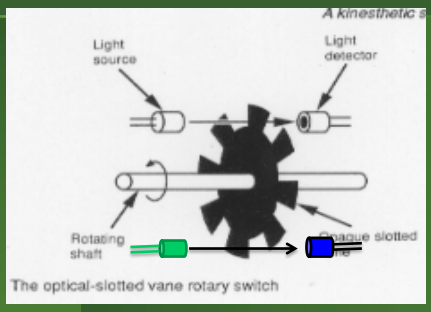
How encoder works?



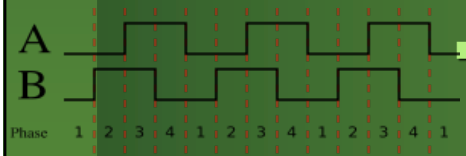
The optical-slotted vane rotary switch

- Source light is cut by the toothed/slits disc
- Signal from photodiode gives pulses that can be counted
- Q: How to detect direction of motion?

How encoder senses direction of motion?



- Two source and detector pair (A and B) are used in such a way that the signals from them are 90 deg out of phase
- Can you see how the direction can be sensed now?



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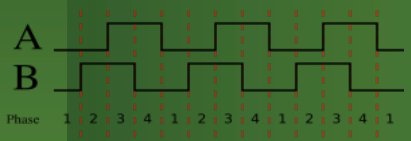
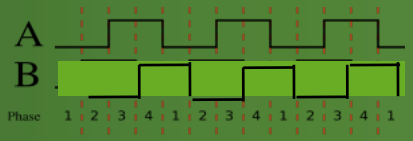
How encoder senses direction of motion?

- Forward and backward direction signals on A and B channels



State	A	B
1	0	0
2	0	1
3	1	1
4	1	0



State	A	B
1	0	0
2	1	0
3	1	1
4	0	1

How to read encoder pulses?

- Interfacing chip HCTL 2017
- Takes input of A B pulses along with some other digital inputs and gives the counted number of pulses as 16 bit digital number

- The MSB and LSB of this number are available on data output pins of the chip HCTL 2017

How to read encoder pulses?

- So data pins of HCTL 2017 can be connected to say PORTB of XEP to read encoder data
- Q: How do we know if MSB or LSB is available to read on the data pins?
- We need to read datasheet of HCTL in detail

Interfacing encoders through HCTL 2017

MSB ← → LSB ← →

- Additional inputs CLK, RST, SEL and OE are given for various purposes
- CLK needs to be given clock
- RST is normally high. Low on this resets the count to 0
- OE and SEL need to be given in a sequence to have proper MSB and LSB available: See the datasheet

Interfacing encoders through HCTL 2017

MSB ← → LSB ← →

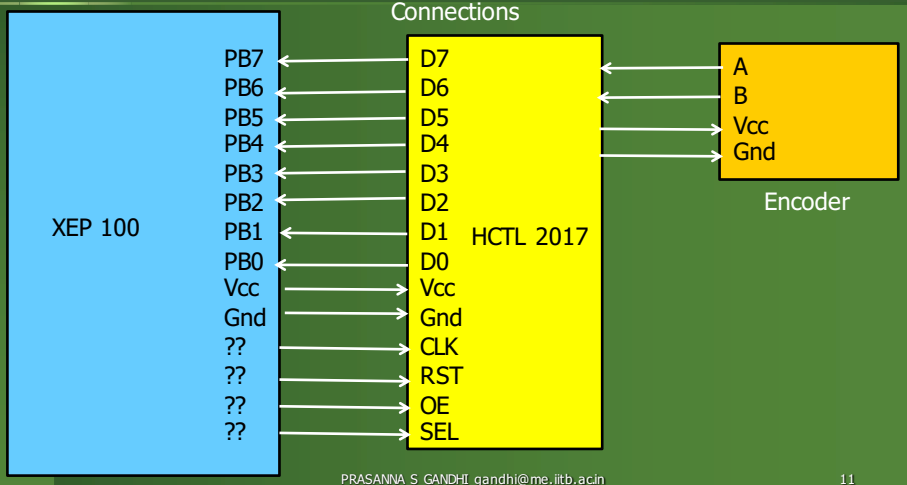
Step	SEL	OE	CLK	Inhibit Signal	Action
1	L	L	Falling	1	Set inhibit; read high byte
2	H	L	Falling	1	Read low byte; starts reset
3	X	H	Falling	0	Complete inhibit logic reset

Figure 10. Two Bytes Read Sequence

- As given above we need to go through these 3 steps in our program to read encoder
- Thus following connections have to be made

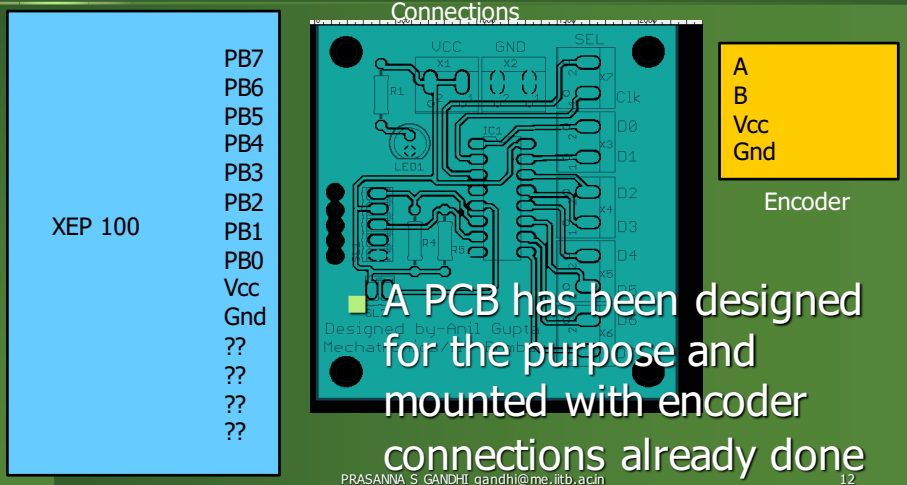
Interfacing encoders through HCTL 2017

Connections



Interfacing encoders through HCTL 2017

Connections



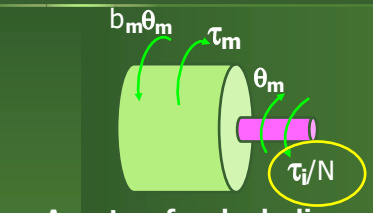
- A PCB has been designed for the purpose and mounted with encoder connections already done

Encoder Motor Gearbox

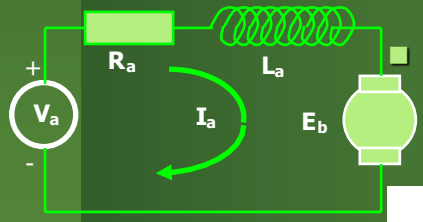
Program

- Clock input to HCTL is provided using PWM signal
- See the program in handout and identify connections to be made
- Follow the handout

Modeling Motor Dynamics



Armature free body diagram



Electrical circuit diagram

- Mechanical $J_m\ddot{\theta}_m + B_m\dot{\theta}_m = \tau_m$
- Electrical $\tau_m = K_t I_a$, $V_a = I_a R_a + E_b$, $E_b = K_b\omega$
- Considering gearbox connected to motor n friction with simplification

$$J_{eqm}\ddot{\theta}_m + B_{eqm}\dot{\theta}_m + \tau_{feq} = K_t\left(\frac{V_a - k_b\dot{\theta}_m}{R_a}\right)$$

Identification of Motor parameters

- Logging the data along with reference for data
- Developing program to clean up data and then plot time vs motor rotation
- Developing program to unwrap the data
- Use commands "diff" and "find" in matlab

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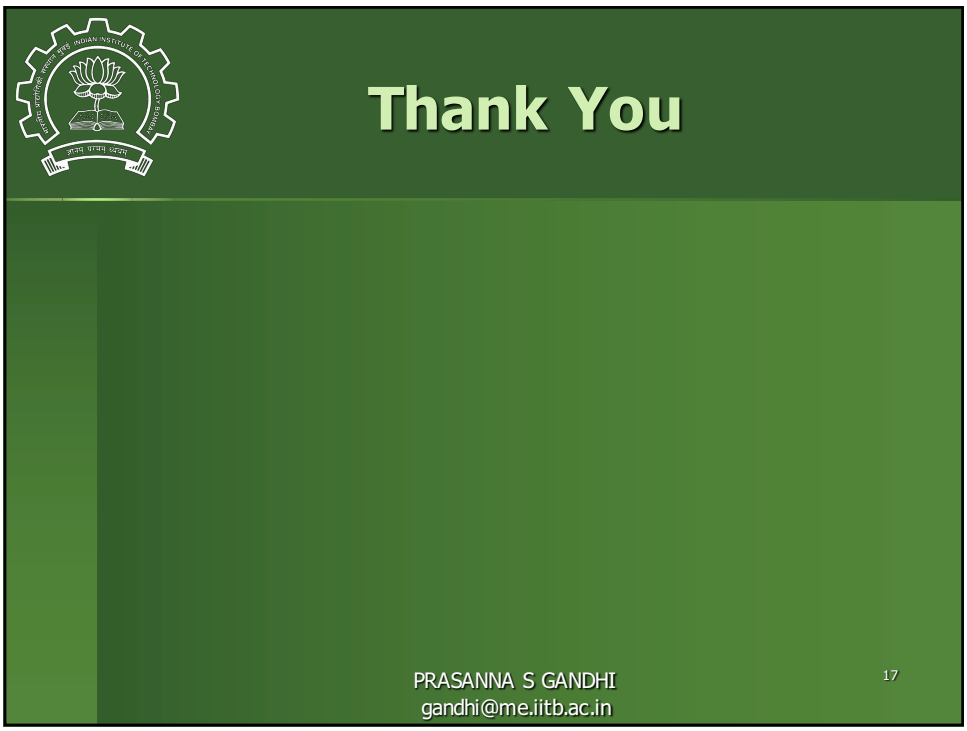
Thank You
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