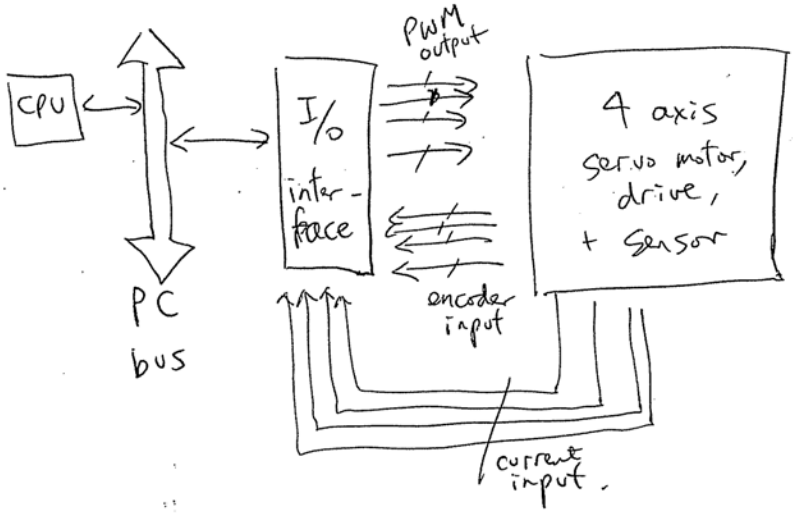
Tutorial 3

Question 5 – Motion Platform and Control

(a) A manufacturing machine has 4 motion axes; all based on DC servo motors with optical encoder feedbacks. The sampling rate is for each axis is 10 KHz and the overall positional accuracy should be better than 0.1mm. It is required to be controlled by a PC computer. Design 3 types of hardware platforms that are suitable for this application. Compare the advantages and disadvantages between the three hardware platforms. (12 marks)

(b) A high-speed linear motion system based on DC servo motor is required to transport goods between two locations. The travel distance is approximately 0.5 metre and the travelling time is less than 1 second. It is presently using traditional PID control. Recently, this linear motion system has been re-deployed to transport goods of different masses. The loading mass variations could be as high as 200%. However, the engineers found that the present form of control cannot cope with the new situation. It will either become unstable, or produce a sluggish response. Suggest a new control strategy for this application. Explain your control method. (8 marks)

(a) Use PC's CPU as the control processor



Advantages

Lowest hardware cost
Expandable structure and flexible
Best utilisation of PC

Disadvantages

Need a real-time OS
May need to program in low level language
Need to write low-level drivers.

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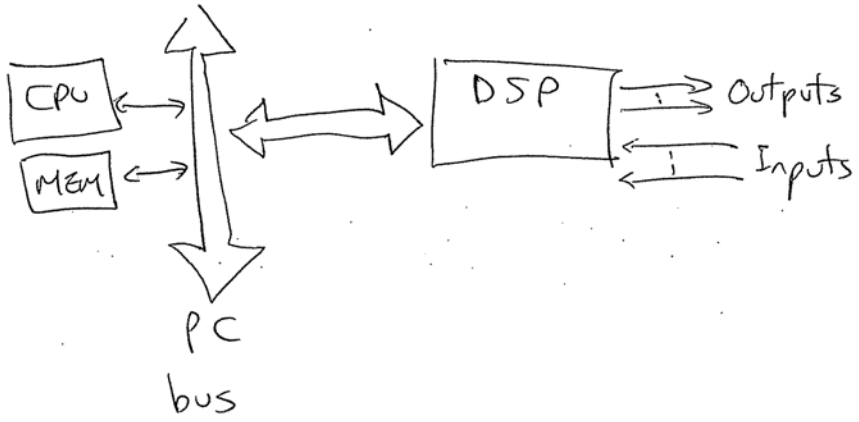
Use a DSP Card for control.

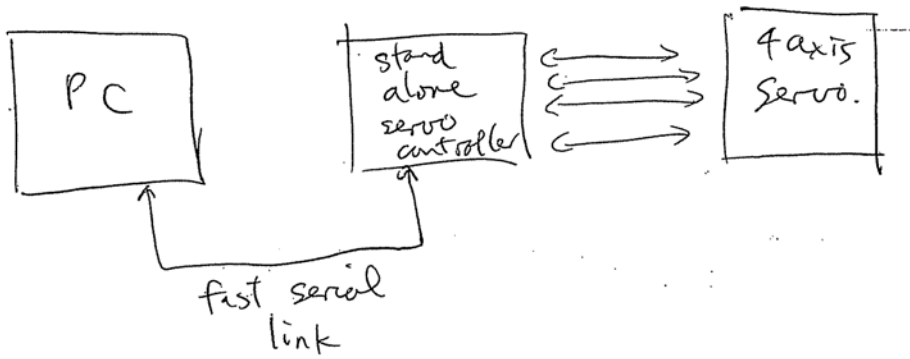


Advantages

- PC can keep the Windows OS
- DSP do the controlling, while PC do other auxillary functions
- High Speed Communicatin btw PC + DSP

Disadvantages

- DSP needs to program in another native language
- Increased cost
- Additional development needed for DSP's I/O peripherals.



Advantages

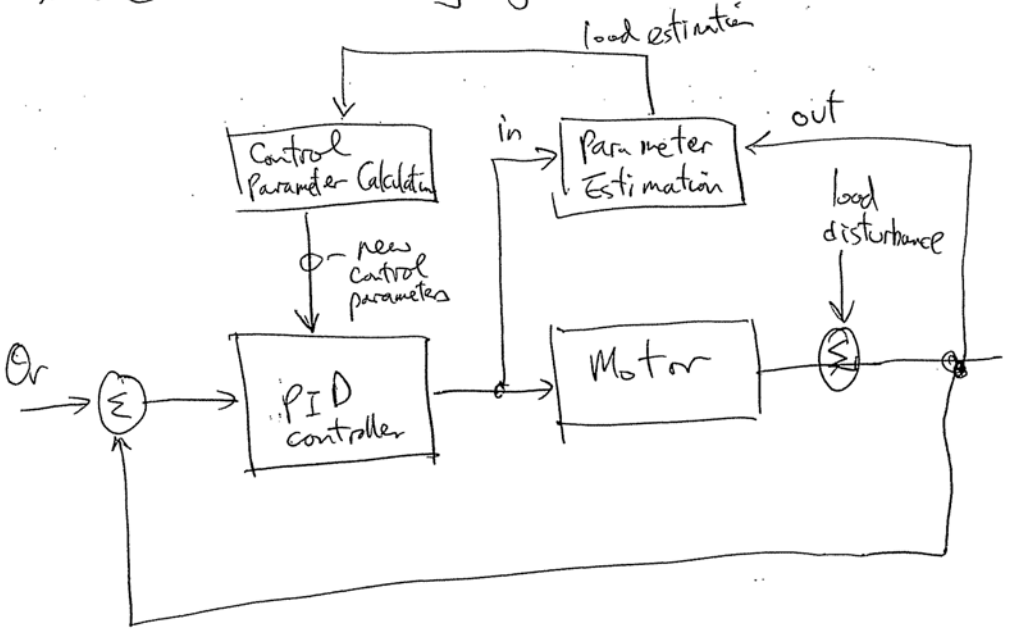
- Complete separation between PC and servo controller.
- Usually come, ready-made
- Can be used for remote operation

Disadvantages

- Least flexible, most expensive
- may pose a problem for multi-channel synchronisation
- Difficult to modify the control algorithm.

Suggested Solution

* Use a self-tuning regulator



* Treat the load variation as a load disturbance

* By tapping the input and ouput of the motor, we can estimate the load disturbance

* The estimation of the load is passed on to the control parameter calculation

* The control parameter calculation block can be as simple as a look-up table for new PID values.

* The output of the "Control Parameter Calculation" block is fed into the PID controller

* Since the load change is not "sudden" and "random" in nature, the updating of PID values can be much slower (>10 times) than the control loop updating rate.