Servo positioning systems

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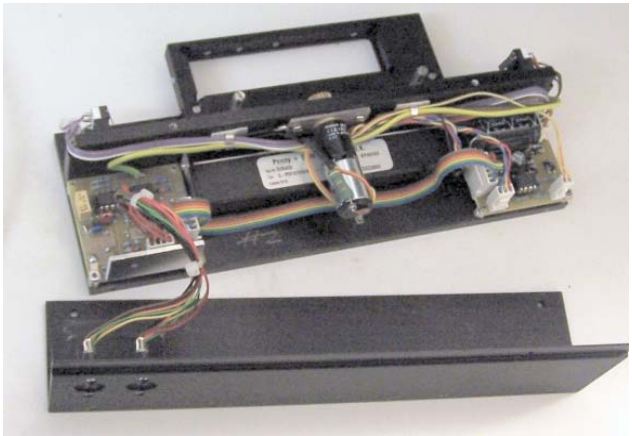
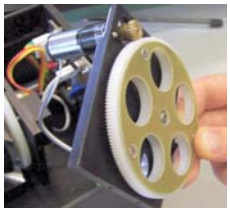
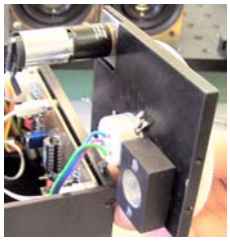
Very often, there is the requirement to insert one of several optical components, e.g. filters, in the light path. The conventional wisdom is to use a stepper motor for this purpose. This approach however requires at least some form of ‘datum’ sensor since the stepper is essentially an open-loop device. Furthermore, the software should be written with some sort of feedback within it to check that the motor has not gone ‘out of step’, so ideally, sensing of individual positions is required. Our experience with these, admittedly low-cost approaches, even when as implemented in commercially-available systems, is that they are not always as reliable as seems at first. Instead, we have opted for very simple analogue servo controllers, which, if engineered reasonably well, have been found to be extremely reliable. The basic idea behind these arrangements is to use a servo-potentiometer to act both as sensor and as a bearing for e.g. a filter wheel, which is belt- or gear-driven by a DC motor. The command analogue input is derived from a resistor chain, which defines the increments of motion; the appropriate set-point is selected by a digitally-set analogue switch and is compared with the actual position sensed by the servo potentiometer. The error signal drives a motor amplifier through a simple proportional-integral-derivative loop and ensures that the motor drives the wheel such that the error signal is minimised. The resistor chain and the feedback sensor are driven from the same reference voltage and thus operate in a bridge-like or ratiometric manner. A generic circuit is presented in the section ‘Useful circuits’. The speed is clearly dictated by the particular motor-gearbox combination and by the feedback loop time-constants. It is straightforward to achieve ca. 200 ms step times and much faster responses (30-40 ms) when the loading (inertia) is constant and optimised.

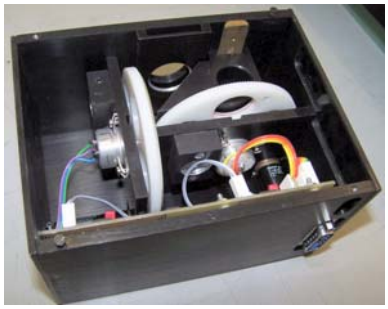
A convenient feature of this type of servo system is that it is readily adapted to cater for linear motions, by substituting a linear sensor/potentiometer for the rotary servo potentiometer. This sort of arrangement has been found useful for constructing e.g. optical zoom systems, which require two or more lenses to be appropriately positioned. Convenient sources of linear sensors (at least up to travel motions up to 100 mm) are conductive plastic audio ‘slider’ potentiometers, such as the range of audio faders provided by Penny and Giles. Another device of this type, intended to position a variable dielectric filter, is shown in the figure below, along with a rotary arrangement.



A linear servo drive intended to move a variable filter, using an ‘audio’ potentiometer as the feedback element







Views of rotary servo drives, used to position optical filters, mounted directly on a gearwheel, itself mounted on a rotary potentiometer acting as the feedback element

Implementations of analogue servo systems in linear (left) and rotary (right) arrangements.

Suppliers of useful components:

Penny and Giles Controls Ltd
Units 35/36, Nine Mile Point Industrial Estate
Cwmfelinfach, Gwent, NP11 7HZ
Tel: 01495 202 000
Fax: 01495 202 006

Maxon Motor UK Ltd
Alberto House, Marino Way, Hogwood Lane,
Finchampstead, Berkshire, RG40 4RF
Tel: 01189 733 337
Fax: 01189 737 472
http://www.maxonmotor.com

Automotion (Int'l) Limited
Saddleworth Business Centre
Huddersfield Road
Delph, Oldham, OL3 5DF
Tel: 01457 82 08 55
Fax: 01457 82 09 55
http://www.automotion.co.uk

Stock drive products
Davall Stock Gears
Welham Green, Hatfield
Hertfordshire, Al9 7JB
Tel: 01707-283-131
Fax: 01707-283-111
www.sdp-si.com

Reliance Gear Company Ltd
Rowley MillsPenistone Road
Lepton, Huddersfield, HD8 0LE
Tel: 01484 601000
Fax: 01484 601001
http://www.reliance.co.uk

Rapid Electronics
Severalls Lane
Colchester, Essex,
CO4 5JS
Tel: 01206-751-166
Fax: 01206-751-188