SiTek® ELECTRO OPTICS

Non-Contact

1/99

PEOPLE, PRODUCTS & NEWS

SIRRAH - precision sensors for harsh conditions

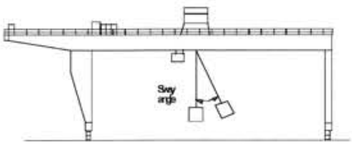
Within the transport sector time usually equals money. Using the SIRRAH from ARCK ELECTRONIQUE S.A. has made it possible to shrink the average transfer time for container handling in ports by 10%. Two major steps were taken at ARCK to modify the earlier manual procedure of positioning of containers into a semi automatic precision operation. The first was to use a SiTek PSD to meet the sensitivity, precision and speed requirements. The second step was to integrate all necessary parts, sensors, electronics, infrared transmitters, etc into a rugged heavy-duty, high-reliability construction intended for such harsh environments as harbours.

Product description

SIRRAH is a sensor that measures the angular positions of a mobile infrared transmitter. The position co-ordinates are given as a deviation from the sensor's optical axis. SIRRAH is waterproof and insensitive to ambient stray light and intended for outdoor use on container bridge cranes or overhead travelling cranes in applications like sway measurement and load positioning. An active beacon is used as BMA for the tracking of the gripping tool or spreader. The beacons mark the points to be tracked and function independently of the SIRRAH sensor. Using a pulse-modulated near-infrared light permits the beacons to function over a large distance.

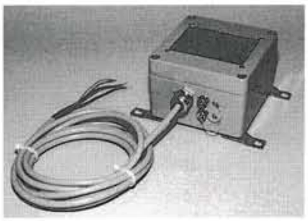
Main applications

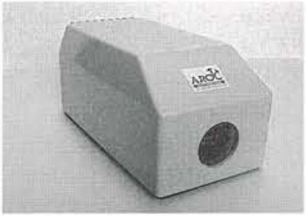
Load position control - sway measurement and skew control of cranes. A SIRRAH sensor mounted on the bridge of a crane trolley detects the x and y position of a beacon located on the hook of the spreader. Any movement (sway) of the load is contained in the sensor's output signal. Thanks to the fast response of the detector it is possible to use the signal as feedback in a sway readjustment loop.



It is also possible to simultaneously measure the position of more than one beacon. This allows for the calculation of - and compensation for - the rotation or twist of the load or calculating the distance to the load. The number of beacons used increases the accuracy of the measurements.

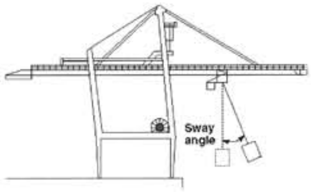
The whole sensor is integrated into a box together with the infrared receiver and the electronics for processing the measured x and y positions of the beacons. A calculator or a PLC can be linked with the sensor through a serial interface.

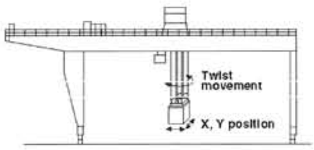




Other applications

SIRRAH can be used for measuring and controlling any moving vehicle i.e. civil engineering power plant, tunnel drillers, moving robots, etc. In these applications the sensor can be mounted on the moving vehicle directed at beacons at fixed locations in the surroundings. If three or more beacons are used it is possible to calculate the x and y position as well as tilt. In some applications involving a vehicle moving along a straight path this scheme may be reversed. The beacons can be mounted on the top of the vehicle and the sensor can work from a fixed position in the surroundings.





Main technical characteristics

Numerical resolution :	1/1000 degree on two axes
Better linearity :	1/100 degree on two axes
Working range :	up to 60 meters
Angle of view :	+/- 6° or +/- 9° (other upon request)
Measurement rate :	200 Hz
Robustness :	for outside use in harsh environment
Interfaces :	RS 422 directly connected to computer

Manufacturer

ARCK ELECTRONIQUE SA, TOULOUSE FRANCE

The company specialises in optical sensors for industrial uses. Its field of activity mainly relates to position and trajectory metering with different types of products to measure angle position as well as distances. SIRRAH products are now in operation from Los Angeles (USA) to Singapore (Singapore), Bremen (Germany) and Durban (Rep. of South Africa).

Report from Salon de la Physique

In the middle of September, "The Electronics and Physics week", took place in Paris. The event consisted of four complementary exhibitions within the areas of physics, sensors, opto photonics and measurement. SiTek exhibited at the "Salon de la Physique" together with Geti Services, our distributor in France. The representives of SiTek assisting Mr. Pierre Godbert, Managing Director of Geti Services were Managing Director Mickey Fukui and R&D Engineer Ulf Kokinsky.

The exhibition went on for three consecutive days and at the same time a conference covering 24 presentations was held. The exhibitions attracted a great number of visitors and the SiTek stand was frequently visited, with about 100 serious enquiries. We showed our components, examples of their successful applications and took the opportunity to giving information about SiTek as acompany.

SiTek also contributed to the conference with a lecture, given by Ulf Kokinsky, explaining the principals of the PSD and examples of some applications. The lecture attracted a large audience and discussions continued after the lecture at the SiTek stand.

We would like to thank all visitors and welcome you to the coming exhibitions SiTek that will attend.

Lars-Erik Lindholm

The new kid on the old block...or was it the old kid on the new block? I guess both statements are true.

After ten years I am back again at SiTek, the company that me and my friend Göran Peterson founded way back in 1976 when we created the first linear PSD. However, the resemblance with the old SiTek that I left is faint as SiTek hasn´t exactly been lounging around over the years. The PSD technology has matured along with SiTek; from "the-two-guys-in-a-garage" into an economically sound high-tech company with a quality stamp written all over it.

Well, who am I?

My name is Lars-Erik Lindholm (usually called "Lars") and I have been a researcher and inventor in the area of Optoelectronics since my graduation from Chalmers Technical University in Gothenburg in 1968. The SELSPOT system - an optoelectronic "camera" using a PSD as a replacement for the film - emerged, among other things, from my research at Chalmers during the 70´s.

The SELSPOT forced me to develop better PSDs to enhance the accuracy of the system. As a result I, together with Göran Peterson, could present the first really linear PSD in 1974. This also inevitably led to the start of SiTek where I spent the next twelve pioneering years until 1988. After this first SiTek period I stayed with the PSD technology - at United Detector Technology in Los Angeles, California. I stayed there for a couple of years until homesickness drove me back to Sweden.

Back in Sweden I worked for some years as the Director of Biomedical Engineering at the Sahlgren Hospital in Gothenburg. My major achievement here was to develop a new method of skin cancer treatment - Photo Dynamic Therapy. This method, that uses red intense light radiation and a special ointment smeared on the tumours, has a curing rate of 98%! After finishing this project I reverted to my own company, Magnolia AB, to work as a consultant within the field of optoelectronics.

Recently I made the mistake of offering SiTek my company's services. It ended with me signing up as an employee of SiTek, because I simply could not resist the temptation of devoting myself to further PSD development. SiTek seems to be the perfect spot for this kind of research with its able personnel, excellent organization and an exquisite high-tech environment. Now I am really looking forward to pushing the PSD technology several steps ahead and to share this progress with all SiTek customers.

Contact possibilities to key personnel at SiTek:

Mickey Fukui	managing director	fukui@sitek.se	+46(0)31 340 03 31
Conny Nordin	production manager	nordin@sitek.se	+46(0)31 340 03 34
Katrin Lindén *	administration manager	linden@sitek.se	+46(0)31 340 03 32
Madeleine Fritzner *	administration	fritzner@sitek.se	+46(0)31 340 03 32
Lars-Erik Lindholm	project manager R&D	lindholm@sitek.se	+46(0)31 340 03 43
Torbjörn Strandberg	project manager R&D	strandberg@sitek.se	+46(0)31 340 03 41
Ulf Kokinsky	project manager R&D	kokinsky@sitek.se	+46(0)31 340 03 42

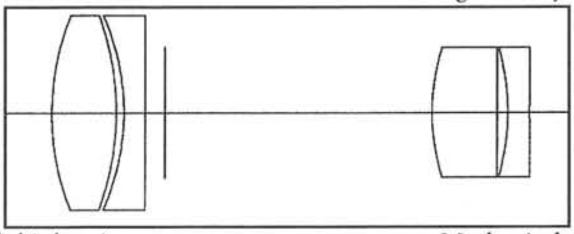
* Katrin Lindén is on mother's leave until September, 1999. Madeleine Fritzner is taking care of administrative issues.

SiTek's PSD-school

SECTION 12 by Lars Stenberg

In chapter 11 we studied a number of different lens types that may be used as main lens when a triangulation probe is to be designed. In chapter 12 we shall study another lens type and then move on to studying the mechanical construction of a triangulation probe.

We concluded chapter 11 by noting that if we wish to keep the requirement that the entry pupil be 15 mm we must introduce a lens system consisting of at least 4 lenses. In this case too, there are several different types to choose from but I have chosen to investigate yet another classic lens design, a so-called Petzval lens. This lens was designed by Joseph Max Petzval in 1840 and frequently comprises two separated achromatic lenses that are corrected so that the image field is flat. Since the lenses are frequently not cemented this lens is very suitable for use in projectors since heat radiation from the projector lamp may otherwise damage the cement leading to destruction of the bond.



The result for a Petzval lens appears from the illustration as well as from table 8.

Image field angles (degrees)	Geometrical spot radius (µm)	Y-position: main beam (mm)	Y position: Centroid (mm)	Difference: (main beam- Centroid)
-5.25	13	-4.326	-4.330	-.004
-2.625	21	-2.114	-2.114	0
0	19	0	0	0
2.625	23	2.035	2.034	-0.001
5.25	16	4.011	4.009	-0.002

Table 8: Petzval lens comprising LAKN12, SF8, LAKN12 and SF4 lenses.

Please observe that we now have spot diameters of the order of 46 mm while the distortion amounts to a maximum of 4 mm or twice as much as for the Cooke triplet according to table 7. On the other hand the entry pupil is 15 mm which corresponds to 2.25 times as large a surface area as for the Cooke triplet.

The performance that has been indicated for the above lens should not be understood in terms of fully-corrected solutions but rather the intention is that the reader acquire a feeling for how great the faults are for the various lens systems. The different suggestions may surely be optimised further. For example, it appears from the size of the spot radii in table 8 that the Petzval lens is impaired by zonal errors since the spot radii for the image field angles +/- 2.625° are greater than for the angles 0° and +/- 5.25°. These errors are fairly easy to reduce. Moreover, it should be possible to reduce the distortion further and increase the entry pupil to 18 to 19 mm for the Petzval lens.

Through using a lens system with even more lenses we can further improve the performance that has been outlined in this section of the PSD school. At the same time, however, we must not forget that costs are also increasing all the time. If for example I were to design a triangulation probe with a very large measuring interval I would choose a so-called double symmetrical Gaussian lens that, in our case, would comprise 6 lenses. In order for the triangulation probe to actually obtain an unusually large measuring interval it would probably be necessary to choose a significantly longer PSD detector that at the same time is significantly more expensive. It is necessary, on a continuous basis, to compare performance with price so that the complete triangulation probe has an end-price that is acceptable to the customer.

Mechanical design of a triangulation probe

My customers frequently ask more questions on the precision of the optical components than on the design of the mechanical parts that determine the optical components. Nevertheless, even if the optical design is very well optimised the finished triangulation probe has a performance that varies between mediocre and disastrous if the mechanical construction is not carried out with due care. We shall therefore study a number of different mechanical design aspects.

Selection of materials

There are many different metallic materials as well as different glass and plastic varieties. Bearing in mind the limited space, I must - for the time being - limit myself to the metallic materials as well as a few different glass varieties. Table 9 gives examples of a few such materials.

Material	Density 10^3 kg/m3	Young's modulus 10^{10} Pa	Thermal expansion 10^{-6}/ K
Aluminium	2.70	6.9	23.2
Brass	8.3 - 8.5	8 - 10	18 - 21
Copper	8.96	12	16.8
Invar	8.1	14.5	2
Iron	7.87	21	11.7
Magnesium	1.74	4.4	25.6
Steel	7.83	20	11-12
Titanium	4.54	11	8.5
Glass with low thermal expansion	2.5 - 5	8 - 10	8 - 10
Glass with high thermal expansion	3.7	8	15
Quartz	2.2	7	0.27 - 0.59
Zerodur	2.53	9	0 +/-0.02

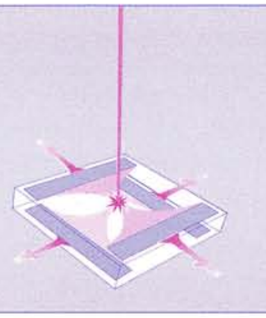
Table 9

Let me first point out that I have only included a small selection of different materials in order to be able to carry out discussions in principle on the material selection. On one occasion, when I visited one of the world's larger manufacturers of optical instruments, representatives of the company said that around 2,200 different metallic materials and alloys were held in stock. To start with, we should go through the different materials and study what they may be used for and - particularly important - which other materials they may be combined with.

Aluminium alloyed with other metals such as copper, magnesium, manganese, lead and bismuth is frequently used in optical instruments. Pure aluminium is very soft and therefore difficult to machine. Examples of such materials are theodolites, binoculars, cameras, video cameras, triangulation probes etc. The most common surface treatment is black anodization. This results in a relatively durable surface but, on frequent occasions, much too high a reflection is produced in order for it to function inside e.g. a lens holder. In this case it is necessary to paint inside the lens holder with a reflex-reducing black paint. In order for anoxidation to produce an even and black surface it is necessary not to choose too hard an aluminium alloy since in that case the surface becomes grey and patchy. It is difficult for parts manufactured in Duralumin e.g. to produce an uniformly even surface. One must be aware that an anodoxation layer, frequently amounting to 5 - 25 µm, has insulating properties. On the one hand, one does not dare to use it as a pure insulating material but, on the other, one must allow for the possibility of being forced to install earthing straps between every anodized aluminium part in an instrument in order to avoid interfering earth currents. It is possible to produce a complete lens holder with distance spacers and threaded lock rings in aluminium but in that case the parts must be anodoxised and provided with a creep-resistant grease before the lens is installed. Otherwise there is a risk that aluminium parts with close tolerances seize when they are installed. To construct moveable aluminium parts that wear against one another must be regarded as bordering on the criminal. If there is an intention to design an optical instrument to function at different temperatures then it is essential to be careful when intending to utilise aluminium, taking into account aluminium's coefficient of linear (heat) expansion but more on this later.

If one wishes to combine aluminium with other materials in order to execute a mechanical function it is rather a question of looking out for the materials that should not be combined with aluminium than those materials that should be. On account of the large electro-potential difference of aluminium and brass it is not recommended to mix aluminium and brass. In a design that I came into contact with it was possible to unscrew the brass screws with the fingers alone from an alloyed aluminium stand where they were originally screwed tight. In this case the stand had been over-rinsed with sea water. It is a good idea to use stainless steel screws in order to screw together aluminium parts but it will not be a good bearing if a steel shaft is to rotate in a aluminium socket e.g.

Brass is easy to finish and it is possible to achieve surfaces with very high lustre. A very good polishing agent for brass is e.g. crushed hazel-nut shells. On the other hand it is harder to provide brass with a cheap black surface coating. Inside ocular and microscopic lens black oxidation or browning is frequently used which gives a dark-brown colour. In order to eliminate interfering light reflections, it is essential to paint with a reflex-cutting black paint of type Nextel produced by 3M. In order to obtain a hard-wearing and beautiful surface a coat of nickel and then one of chrome is frequently applied. Brass may be combined very well with iron and steel. In order to achieve high-quality focusing mechanisms it is e.g. highly advisable to screw a threaded steel lens holder in a brass socket. This material combination is used in camera lenses of the highest quality. If one has a rotating steel shaft it is possible to achieve a very good mounting in bearings by choosing a brass sleeve that comprises sintered small brass balls. Then small cavities are created between the brass balls that may be filled with grease. This is sometimes described as a bearing greased for life. If there is a requirement for large radial loads then it is necessary to use ball bearings instead.
In the next section of the PSD-school we shall continue our study of different materials.



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SiTek Electro Optics, Ögärdesvägen 13A,
S-433 30 Partille, Sweden.
Tel: +46-31-340 03 30. Fax: +46-31-340 03 40.
Website: www.sitek.se
E-mail: info@sitek.se

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