

Full Length Research Paper

Development of electronic sensors for industries for improving the productivity

M. R. Khare

RDCIS, Ranchi
E-mail: apoorv_raj@yahoo.com

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The newly developed electronic products of Steel Authority of India (SAIL) have proved their supremacy over conventional one in the domain of Process Automation, Dimensional Measurement, Quality control, Safety. Since long time industries are striving for low cost, precise, reliable sensors which can work under extreme heat, flame, water, dust, fume for tracking the metal in their different rolling mills, caster, and furnaces. It is well known that Steel plants are losing good quality of steel as scrap due to lag of accurate, reliable dimensional measuring systems. The paper describes how SAIL has overcome on these problems by developing three different sensors namely SAILPHOS, SAILCHOS, SAILWOS for metal tracking and they are working satisfactorily in process control in different parts of India as well as neighbouring countries. The advance version of these sensors are useful in dimensional measurement for Rails, blooms, slabs, billet, plates and have reduced the wastage of high quality steel. After implementing these sensing and measuring products of SAIL at different places, a total monetary benefit in the tune of several trillion of Rs is worked out.

Keywords: Hot sensor, cold sensor, dimensional measurement, yield, reliability, safety, accuracy.

INTRODUCTION

Photosensors are used to detect luminous and non luminous objects in industries and its outputs controls different mechanisms. Prior to development of these new sensors, the conventional photosensors were suffering from more response time, complex circuit, additional water cooling for electronics, focusing problem, non availability of spares. For sensing cold or hot metal, the method of light interruption was used on the cost of electrical energy by putting high intensity bulb on other side of object. Century old yard stick measurement in different form was carrying out for dimensional measurement of different products in semi finished and finished stages on the cost of production as these products were subjected to stop for measurement

purpose. The relative response of different sensors used for different application is shown in Figure 1.

Development of Sensor

To overcome on above mentioned problems, different sensors namely **a.** SAILPHOS, **b.** SAILCHOS, **c.** SAILWOS are designed and developed and its technology are transferred to different places. For dimensional measurement respective stacks say SAILPHOS-STACK, SAILCHOS-STACK, SAILWOS-STACK are developed along with logic units. The details of irrespective sensors are as follows:

Abbreviation

SAIL- Steel Authority of India Ltd, **SAILPHOS-SAIL-** Photosensor, **SAILCHOS-SAIL-** Cold Hot Object Sensor, **SAILWOS-SAIL-** Wireless Object Sensor, **IR-** Infra Red, **r.f.-** radio frequency

SAILPHOS

It is comprised of two units and normally it needs no cooling due to its unique design.
i. Sensing Unit ii. Output Unit.

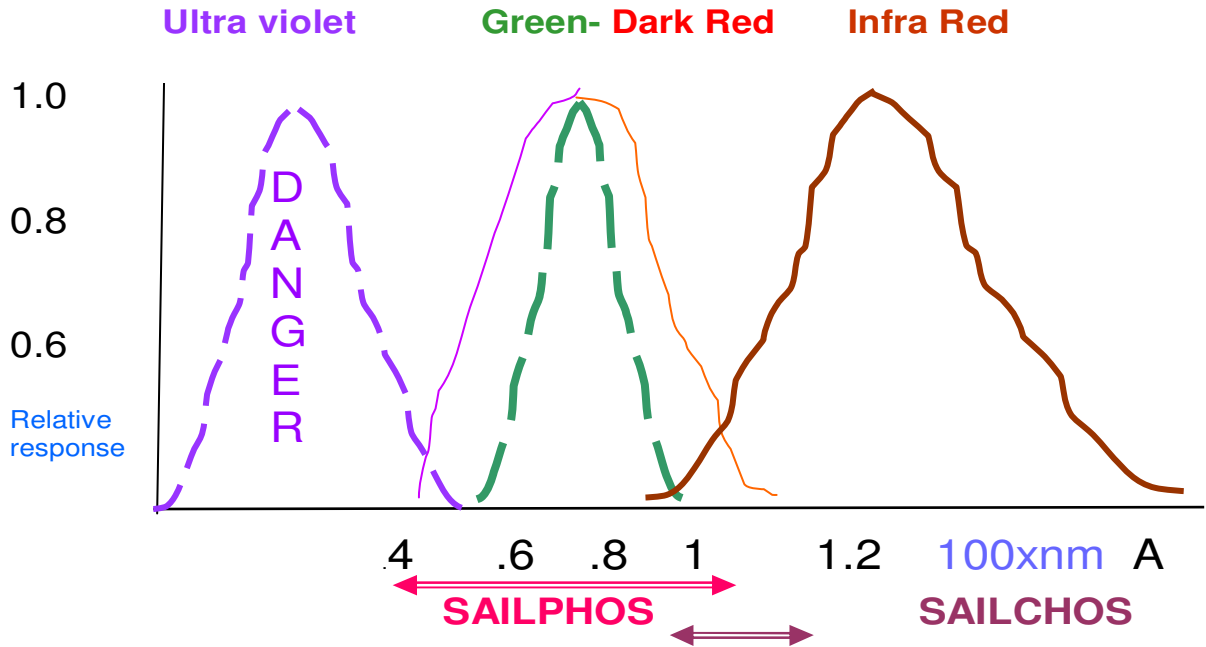


Figure 1. Relative response of different waves.

Sensing Unit

It is sensitive to visible and higher intensity of infra red radiations (John, 2000) as shown in Figure 1. Different indications are present at its top and backside for object sensing. It has target focusing facility and it is adjustable in horizontal plane in 360° and in vertical plane with 300° with an accuracy of 0.5°. It sustains high degree of vibration of 10 mm with 20 Hz and it works up to 85° C environment temperature without cooling, there is provision of cooling jacket but it is experience it is not needed due to its unique design. It has test facility by providing different test points. The focusing hood are of different lengths and cross sections for pin pointing the specially thin objects like wire and are not affected by receiving the radiation of closed neighbouring strand.

Output Unit

It is comprised of power supply and signal processing units and further it is incorporated with Relay output (potential free contacts 2 NO and 2 NC), open collector transistor, opto-coupler, visual indicator, volume control buzzer. The response time is less than 2 ms for relay, 0.3 ms for transistor and optocoupler. It has remote test facility for entire two units along with cable. It has four digit counter with reset facility counting speed is 2.5 KHz) with relay out potential free contact. Preset through Thumb wheel switches. These sensors are working satisfactorily for initiating various equipments like roller table, conveyors, cooling, heating, charging discharging

the metal into and from the furnaces, shears for cropping unwanted product ends in product in semi finished and finished stages. It is also used in detecting cobbles in rolling mills, casters, furnaces, detecting extinguishing of gas in the furnace.

SAILPHOS-STACK used in Dimensional measurement

The measuring range of unit decides the number of sensor while their inter distances are responsible for accuracy of system . The Stack consist of 2,4,8,16,32 numbers of channels and they are tried various places. The system has two versions

- a. Linear displacement
- b. Angular displacement: It is depicted in Figure 2

Safety

SAILPHOS is useful as a Long travel and Cross travel limit switches in different type of cranes, located in door.

SAILCHOS in process automation

- 1. It senses the cold as well hot products. It has different version.
 - Type 1-Single channel ,Type 2-Multichannel,
 - Type 3-Reflection 10m, Type 4-Reflection (3.5 m range),

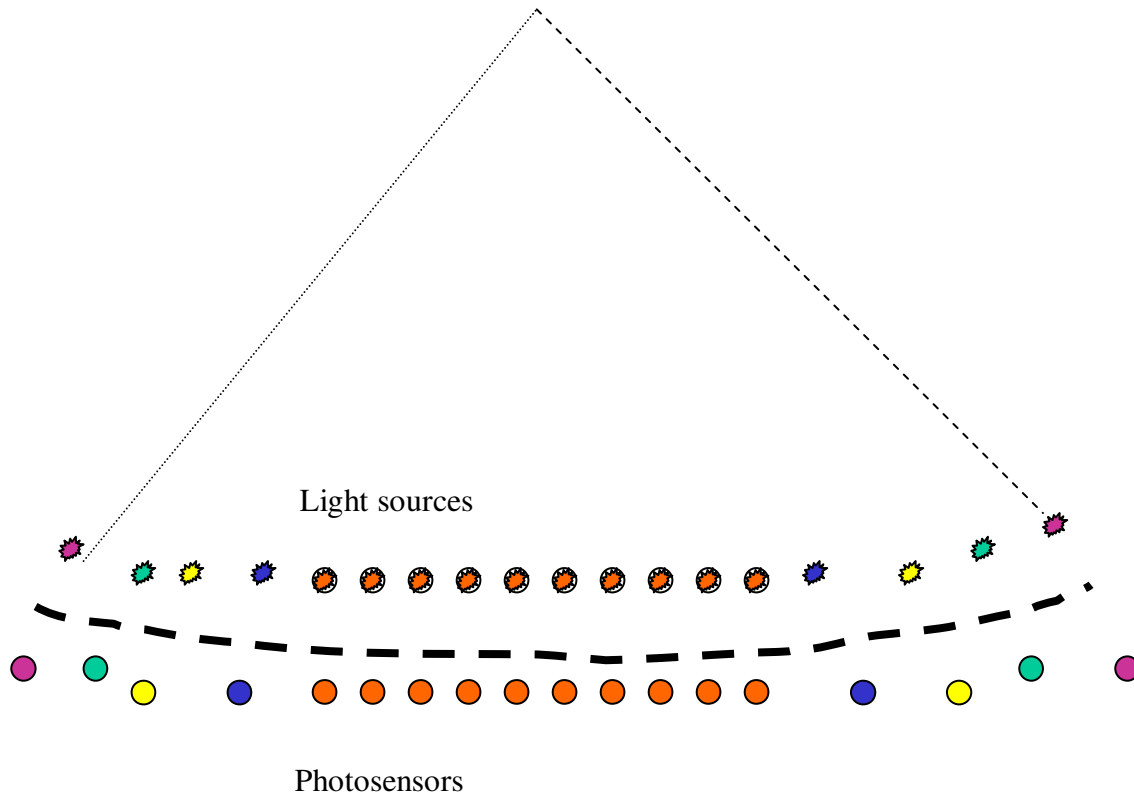


Figure 2. SAILPHOS used for angular displacement measurement.

Table 1. Performance for different temperature for different product.

	Object	Distance		Temp Tested
		V11	U12	
1.	Bloom	3 m	3 m	0-1100 °C
2.	Slab	4 m	3m	0-900 °C
3.	Billet	1m	1m	0-1000 °C
4.	Plate	3m	3 m	0- 900 °C
5.	Rail	1 m	1m	0-900 °C

Type 5-Reflection (2.5 m triangulation), Type 6-Reflection multichannel (2.5 m triangulation)

Table 1 shows its performance for different temperature for different product.

2. Provides an audio / visual Indication / Relay o/p, Opto Coupler , OC Tr.
3. Sensor can be rotated horizon & vertical planes to suit site condition.
4. After 90° C ambient cooling jacket available.
5. Piloting light pinpoint target
6. Counter

Principle of working

It is comprised of IR wave generation, transmission and

IR receiver with code detection circuit. Due to characteristics of alloy of high intensity GaAlAs, it generates pulse in the infrared region after proper modulation over carrier wave and its peak emission response is at 940 nm. IR LED is used to transmit coded invisible light signal, which is detected by a matching IR diode and subsequently decoded in a receiver system at some distance away.

Why IR

IR energy is chosen because in industry light signals from various sources affect the photo sensor. While ultra violet emitters produce signal of lower wavelengths and they are dangerous for living things as their penetration

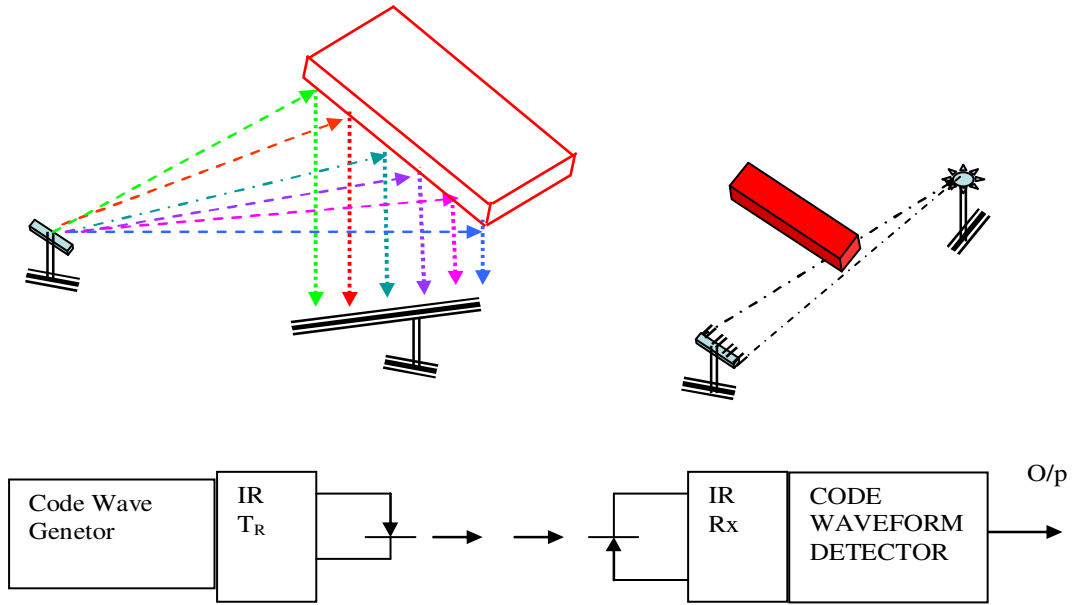


Figure 3. SAILCHOS used for measuring steel product through Reflection/ Interruption.

power is more as shown in Figure 1. IR LED and photo detectors are fast acting devices and the effective range of an IR beam system is thus determined by peak current fed into emitting diode. Infra red radiation is not harmful to eyes as Laser (Laser Speed Measuring, 2008). It is berth mention that the human eye is sensitive to a range of light radiation. It has a peak spectral to the colour green, which has a wave length of about 550 nm is pleasant to retina, but has a relatively low sensitive to the colour violet (400 nm) at one end of the spectrum and dangerous to retina and to dark red (700 nm) at other. Photodiodes also have spectral response characteristics and these are determined by the chemistry used in the semiconductor junction material.

SAILCHOS-STACK used in Dimensional measurement

Dimensional measurement based on IR does not need any calibration as needed in Shaft encoder, doesn't influence due to high luminosity of metal as photosensor. The measuring range decides the number of sensor while inter distance responsible for its accuracy. The Stack consists of 2, 4, 8 numbers are tried at various places as shown in Figure 3. It is much cheaper than CCD line scan cameras (Gopal, 2001).

The system works on sampling principle. For example normal speed of any object is 10 mm /sec. Maximum speed of bloom may be 50 mm /s. Therefore for crossing 10 mm distance, the bloom takes 200 ms. Therefore practical IR beam system need not to be turned ON continuously but only needs to be turned on for short

duration at repletion period of 200 ms . The LED heats up faster than it cools off. On time 25 μs Off time 25 ms and need not operate in continuous mode. At fixed interval a burst say 200 % of peak current is able to drive the IR diode to generate IR pulse .It is used where sensing with close tolerance is needed (George, 1992).

Safety

SAILCHOS is useful in different type of outdoor cranes as a Long travel and Cross travel limit switches. It is used for detecting extinguishing of gas in the furnaces.

SAILWOS

In industries it is difficult to lay conduit cable from sensing unit to control room. After sensing the object by sensing unit either by SAILPHOS or SAILCHOS. the signal is modulated over radio frequencies. The limitation of this sensor is that a power tap near the sensing unit should be available for for feeding power to sensing, processing units.

RESULTS AND DISCUSSION

Developed sensors are working satisfactorily in different places in SAIL plants including Phulshulong(Bhutan), Veer Ganj (Nepal), Dhaka (Bengla Desh), Kanpur, Satana, Raipur, Kolkata, Nagpur, MEL, Hyderabad, Benglore, Patana, Radrapur Utrakhand, Jaipur, Bankura,

Durgapur, Tata, Shobepur (Kol), Dankani, Siligari, Rajkot, Baroda, Jammu, VSL, Noida, Gaziabad, Dadar Nagar Haveli etc and taking care of basic objectives.

CONCLUSIONS AND RECOMMENDATIONS

The developed sensing and measuring system is precise, reliable and does not influence by extreme heat, flame, water, dust, fume. The units are used for tracking the metal in different rolling mills, caster, furnaces. After implementing in different industries, a good quality steel is saved otherwise it would be generated in the form of scrap. Its maximum use in sensing, measuring system is emphasized due its unique features.

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