INTELLIGENT SUN TRACKER

IST Series

INTRODUCTION

Basic fundamentals about sun tracking should be known. Sun tracking systems have to move with the sun's apparent movement. The movement required is slow, typically 15º per hour, but over a wide range. The sun apparently moves more than 180º in right ascension each day (in summer) and 47º in declination between mid-summer and mid-winter. The sun occupies an angle of about 0.5º, so any efficient sun tracker should have at least this efficiency.

Conventional open loop sun tracker are likely shows inevitable offset error, while the last generation of closed loop sensing trackers are not very accurate. The different tracking techniques are analyzed as follows: Driving the tracker at 'constant speed' is simple but tracks only on one plane and it is troublesome in terms of cable twisting around the device, power consumption and others. While the 'computed position' tracking can work under any weather condition, it always has inevitable offset error, in addition to the high cost and complexity. The 'hill climbing', on the other hand, gives an absolute reference to the sun, but cannot work if the weather condition is changing rapidly, which is a likely prospect. Moreover, the 'non-electrical sensing' is simple, but snail-paced and inconvenient for cold countries. What is more, the 'active sensing' is accurate, but vulnerable to failure on cloudy weather.

Our novel universal series of Intelligent Sun Tracker (IST) performs the operation routine to detect the weather condition and switch to the effective tracking technique accordingly. The methodology used in the design is based on the integration of two tracking techniques in an embedded control system using the micro-controller. On sunshine it operates on 'active sensing' and switches to 'constant speed' on cloud cover. Our series of the IST is accurate, robust and affordable. An outstanding efficiency of ± 0.05º in both planes has been attained. It can stand high wind load, detect the weather condition and the nighttime.. After sunset it turns to the true east & vertical directions and sleeps awaiting the first sunray of the next morning to wake it up. The IST is inexpensive and because it automatically searches for the sun, its installation is so simple. The IST conceptual design is depicted in **Fig. (1).**

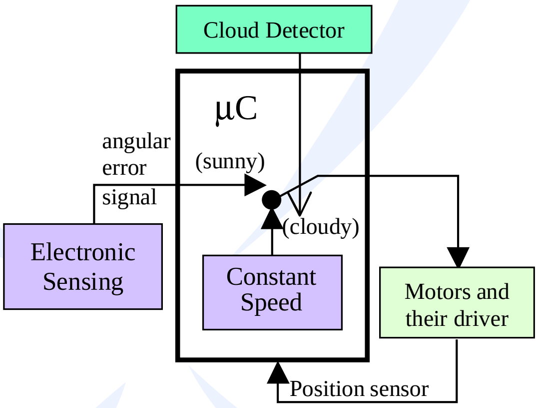


Figure (1): IST conceptual design

THREE SERIES OF OUR IST ARE AVAILABLE:

a. IST–DA1: is our Intelligent Sun Tracker for DNI measurement or Pyrheliometer calibration and powered by 220V AC, 50 Hz source. It is useful for locations where grid power is available.

b. IST–DD1: is our Intelligent Sun Tracker for DNI measurement or Pyrheliometer calibration and powered by 12 V DC source (e.g. battery). It is useful for locations where grid power is unavailable.

c. IST–DPV1: is our Intelligent Sun Tracker for DNI measurement or Pyrheliometer calibration. It is particularly made for unattended operation in remote rural areas. It is powered by 12 V DC Lead Acid Battery (liquid or sealed) that is charged from a small photovoltaic module. The IST-DPV1 is complete with its built-in Intelligent Battery Charge Regulator and PV module.

IST SPECIFICATIONS:

Our IST specifications clearly reveal its ADVANTAGES and BENEFITS. (Specifications are common for all series of IST unless otherwise stated):

1. Outstanding efficiency (Pointing accuracy) of ± 0.05º in both the elevation and azimuth planes.
2. Ability to move 360º in the azimuth plane and 90º in the elevation plane.
3. Equipped with 3 knob screws for horizontal leveling with the aid of bulb balance.
4. Equipped with equator direction guide for setting-up at noontime.
5. Equipped with intelligent 12V-battery charge regulator with temperature compensation and ampere-hour measurement.*(Type IST-DPV1 only)*
6. Detection of the weather conditions (cloud / sun shine / night).
7. Mechanical obstruction (i.e. overload) protection.
8. Reverse polarity protection
9. Scope of vision: 50º azimuth, 54º elevation.
10. Two different tracking techniques are integrate ('active sensing' using photocells + 'constant speed').
11. Auto search for the sun on power up.
12. Unattended operation.
13. Park at the true east & vertical directions after sunset and sleeps (i.e. cut off the power supply).
14. Wake up on the next day by the first sunray.
15. Simple design and cost effective.
16. Complete with the solar photovoltaic module. *(Type IST-DPV1 only)*
17. Weather-proof structure that stands the harsh condition, such as the high temperature, rain and sand storms.
18. Operating temperature -40 to +70ºC.
19. Weight: 10 kg.
20. Power consumption is only 0.4 Wh/equinox day for DNI measuring.
21. Used for both DNI measurement and Pyrheliomenter calibration *(order additional arm)*

IST Mechanism

A superior feature in this structure mechanism, shown in **Fig.(2)**, is that it is self-locked and only allows the movement forced by the motors.

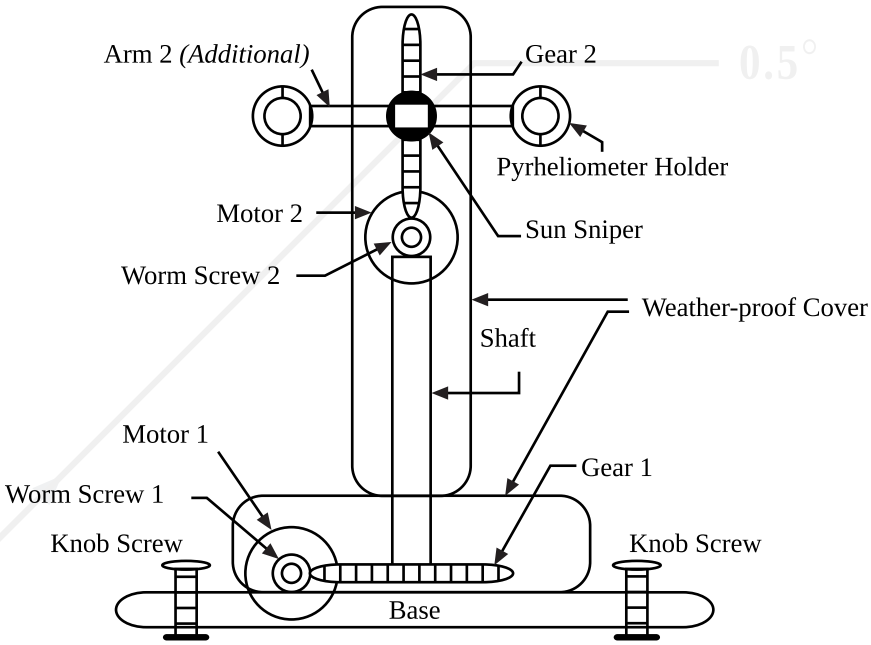


Figure (2): IST Structure Mechanism

CONTROL UNIT

It consists of the sun sniper and the signal-conditioning unit. The control electronic unit is designed on 'current loop' basis thus cancels the cable voltage drop between the sun sniper and the control board. Conventional 'active sensing' trackers are suffering the effect of intensity of irradiance on their angular error signals. This effect has been canceled in our IST and the produced error signal is a mere function of the sun's angular error. The outstanding sensitivity of our IST design is detailed in the graph in **Fig.(3).** The scopes of vision of the head at the two planes is shown in **Fig.(4).**

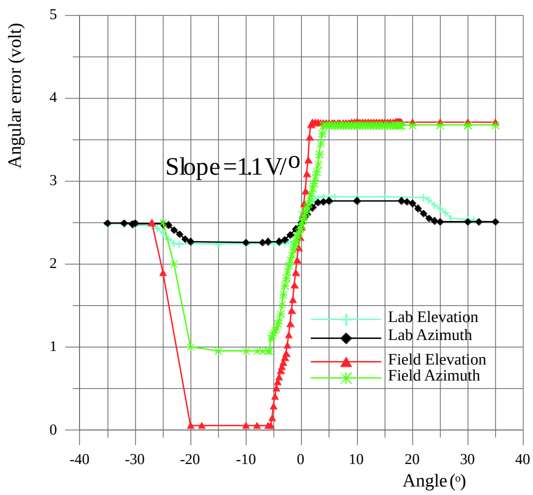
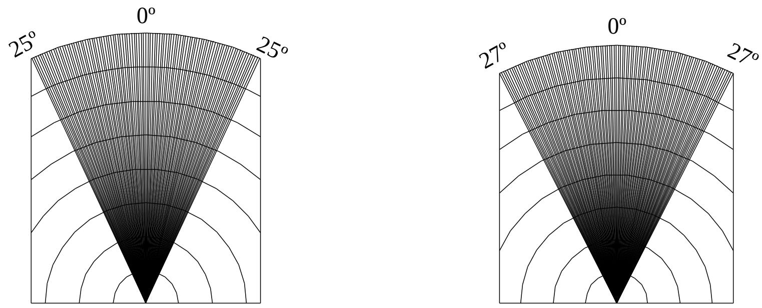


Figure (3): Sun Sniper Performance



(a) (b)

Figure (4): Scope at the Azimuth (a), Elevation (b)

IST INSTALLATION

The installation of the IST is so simple that won't be called "installation procedure", it is rather called "installation on the fly". Installation at noontime is preferred to make use of the noontime guide. However, on sunshine, just orient the IST equipment East-West, as marked on the base, direct it to the equator, level it horizontally using the three knob screws with the bulb balance and switch On. It will then auto-search for the sun and continue tracking it. Equator direction could be confirmed if the noon time at the location of installation is defined. At noontime, just make sure that the shadow projection of the front guide is centered on the line behind it.

In the event of power failure and restoration, the IST will perform the auto-search for the sun automatically until found and then tracks it.

IST LARGER SIZES

Scaling the IST up to drive large AC motors (1phase / 3 phase) is also available (On Order). It is worth mentioning *that larger sizes of the IST will not affect its tracking efficiency* because the gearing (if well made without backlash) and the power electronics for motor driver that are subject to change, do not contribute in determining the IST efficiency. Large sizes of our IST particularly suites the solar concentrators, parabolic or tower, used for solar power stations. our IST has the ability of ”re-adjustment with refrence to the maximum power”. This feature could be included in the system periodic maintenance and thus overcomes the common problem of absorber tube bends due to heat effect over time.

MEET

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