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A Minor Project Report

On

Visualization of Solar Spectrum

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Abstract

As a responsibility for being the most intellect species on earth, we must keep record and be aware of factors that influence our daily life on earth. Nothing is more important to us on Earth than the Sun. Without the Sun's heat and light, the Earth would be a lifeless ball of ice-coated rock. The solar irradiance warms our seas, stirs our atmosphere, generates our weather patterns, and gives energy to the growing green plants that provide the food and oxygen for life on Earth. Having proper knowledge about solar irradiance will help us make predictions based on deductive reasoning.

This project is about designing a solar spectrometer and measuring solar irradiance using a proper transducer which could simply be a photodiode or an antenna, experimenting with different methods in order to find a precise and efficient way to measure and visualize data. Furthermore, through post analysis of combined collected data, it can implemented for predicting energy generation from solar power plants ,plant growths , weather forecasting and many more.

Table of Contents

Abstract 1
1

1. INTRODUCTION 4
1.1 Background 4
1.2 Objectives 5
1.3 Scope of project 5

2. LITERATURE REVIEW 6

3.METHODOLOGY 7
3.1 System Block Diagram 7
3.2 Description of Proposed Working Principle 7
3.3 Instrumentations/Tools 7
3.3.1 Hardware 7
3.3.2 Software 8

4. EXPECTED OUTPUT 8

5.PROJECT APPLICATIONS 9

7.EXPECTED PROJECT BUDGET 10

8. Bibliography 11

1. INTRODUCTION

1.1 Background

Solar radiation is radiant energy emitted by the sun as a result of nuclear fusion occurring inside the sun. The solar spectrum is close to that of black body with a temperature of about 5800K. The solar radiation spans a range of 100 nm to about 1 mm which is composed of X-rays, ultraviolet, visible light, infrared and radio waves as well. About half of the solar radiation lies in visible short-wave region while rest half lies mostly in near-infrared and some part of it in ultraviolet region of electromagnetic spectrum.

Solar irradiance(SI) is the power per unit area(watt per square metre, W/m^2), received from the Sun in the form of electromagnetic radiation as reported in the wavelength range of the measuring instrument. Solar irradiance is often integrated over a given time period in order to report the radiant energy emitted into the surrounding environment(joule per square metre, J/m^2), during that time period. This integrated solar irradiance is called solar irradiation, solar exposure or solar insolation.

Solar irradiance affect plant metabolism and animal behavior. The study and measurement of solar irradiance have several important applications including the prediction of energy generation from solar power plants, the heating and cooling loads of buildings, solar radiation management and in climate modeling and weather forecasting. Also a large number of solar power systems, large and small, are now being installed worldwide. By measuring solar radiation we can find an optimal solar prospecting location which will maximize the operating efficiency. The device that measure and monitor the solar irradiance are expensive so in this project we plan to design and construct a system for measuring solar irradiance with reasonable accuracy at low cost.

1.2 Objectives

The main objectives of our project are as follows:

- To measure the solar irradiance and visualize the data obtained from solar radiation
- To post analyze the data and realize importance of solar radiations along with its impact at certain places
- To analyze the relationship of irradiance with frequency of solar radiation and time

1.3 Scope of project

The solar irradiance data can be used for weather forecasting as solar radiation plays the most important role in determining the weather conditions on the earth, plant metabolism and animal behavior. The data can be used for solar radiation management (SRM) projects. Furthermore, the data can be analyzed to predict the adequate vegetation at different areas along with suitable places for habitation in terms of solar radiation impacts.

2. LITERATURE REVIEW

SOlar Radiation and Climate Experiment (SORCE), a NASA sponsored satellite mission launched on January 25, 2003 has been providing precise measurements of solar radiations. From last 38 years SORCE has been correlating total solar irradiance (TSI) data with solar measurements of sunspots and faculae which is used to track the passage of sunspots across the solar disk with accuracy of ±0.035% .

In "Statistical Analysis of Solar Radiation Data", a research paper published by E. Yilmaz , Middle East Technical University, Turkey and B.Cancino and W.R. Parra, Pontificia Universidad Católica de Valparaiso, Chile, the solar irradiance data collected from pyranometer and actinograph between years 2000 and 2003 has been analyzed and the total solar irradiance has been calculated. The greatest error frequency in solar radiation range was between 3001 - 4000 Wh/m2, which corresponds to 21.36% days of a year.

Compound Astronomical Low cost Low frequency Instrument for Spectroscopy and Transportable Observatory (CALLISTO), a programmable heterodyne receiver designed in 2006 in the framework of IHY2007 and ISWI by Christian Monstein , measures the solar activities. According to the observation of solar radio burst type III in 2015, solar wind speed was found to be 348 km/s with density 8.4 protons/cm3 and interplanetary magnetic field 13.4 nT. Along with this the X-ray flux data from solar monitor showed the occurrence of strong class flare which is believed to have high temperature due to strong magnetic field.

The solar activities such as solar irradiance, solar burst, solar wind and proton density in solar radiation play vital role in determining the weather conditions and biodiversity of the earth. The analysis of data obtained from solar activities can be beneficial in space research, weather forecasting, biodiversity management and solar radiation management (SRM).

3.METHODOLOGY

3.1 System Block Diagram

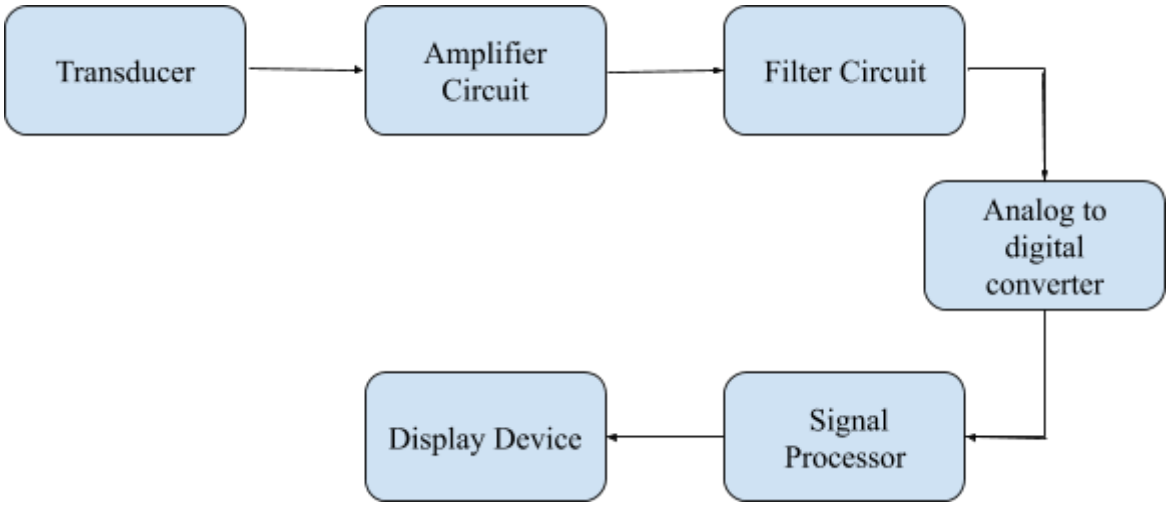

fig: Block diagram of proposed system

3.2 Description of Proposed Working Principle

The proposed system has a suitable transducer to detect solar spectrum. The analog data of solar spectrum received from the transducer is fed to amplifier which amplifies the data which is then filtered using a suitable filter circuit. The filtered spectrum signal is then converted to digital form using a proper ADC. It is then fed to a microcontroller for further processing. Further filtering, if needed, is done by the microcontroller and the signal is then sent to a proper display device.

3.3 Instrumentations/Tools

3.3.1 Hardware

The following is a minimal list of hardware required:

a. Transducer
b. Microcontroller
c. Amplifier
d. Oscilloscope

3.3.2 Software

The following are the software required:

a. Processing

b. Matlab

c. Avrdude(for programming the microcontroller)

4. EXPECTED OUTPUT

The output of the project is supposed to include the following points:

- Detection of EM spectrum of a certain region
- Solar irradiance vs. time graph
- Representation of thermal radiations of different wavelengths from the sun

5.PROJECT APPLICATIONS

The applications of this project are as follows:

- Can be used in weather forecasting and climate modeling
- Can be used for photovoltaic panels to collect maximum direct as well as diffused solar irradiance and calculate efficiency of photovoltaics panels
- Can be used in construction of buildings and spacecraft designs by taking into account the solar insolation

7.EXPECTED PROJECT BUDGET

S.N.	**Title**	**Price (Rs.)**
1	Transducer	2000
2	ADC	500
3	Microcontroller	1000
4	Miscellaneous	3000
	Total	**6500**

Table 1: Expected budget

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