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IOT Based Cost-effective Digital Light Meter

Nafisa Anjum[1], Prajjwal Nag[2]

[1]Department of Computer Science and Engineering Future Institute of Engineering and Management Kolkata - 700150, West Bengal, India
[2]Department of Electronics and Communication Engineering, Future Institute of Engineering and Management, Kolkata - 700150, West Bengal, India

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Abstract - *This paper proposes a cheap and efficient, light monitoring system which can be utilized in the industrial and agronomic sector. Our system measures light intensity level using an ESP8266 board the sensor BH1750 from Texas Instrument.*

Key Words: BH1750, Light meter, ESP8266, Arduino, Texas Instruments, IOT

1. INTRODUCTION

A digital Light Meter is a device which is used to measure the intensity of a source of light. Light meter is one in all devices used for several purposes including photography, occupational health, and illumination engineering and agriculture.

Most of the light meter consists of a body, photocell or light sensor, and display. The light that falls on to the photocell or sensor contains energy that's transformed into electric current. Indeed, the measure of current depends on the intensity light that strokes the photocell or light sensor. Light meters read the electrical current calculate the acceptable value, and show this value on its display.

Selecting the most suitable type of light intensity sensor can be a complex process and that too the accuracy and the cost of the sensor play an important part while choosing the best sensor for the desired purpose. It has been observed that there are many light intensity sensors available in the market, but the expense of the meter always restricts the user for its limited usage.

The commonly used choice for light intensity sensors is LDR, which is relatively inexpensive, but they lack accuracy and reliability.

There are different terminologists used in light intensity sensor, such as,

- Lux
- Illuminance

1.1 LUX

The **lux** (symbol: lx) is the SI derived unit of illuminance, measuring luminous flux per unit area. It is equal to one lumen per square meter. In photometry, this is used as a measure of the intensity, as perceived by the human eye, of light that hits or passes through a surface. It is analogous to the radiometric unit watt per square meter, but with the power at each wavelength weighted according to the luminosity function, a standardized model of human visual brightness perception. In English, "lux" is used as both the singular and plural form.

1.2 ILLUMINANCE

Illuminance is a measure of how much luminous flux is spread over a given area. One can think of luminous flux (measured in lumens) as a measure of the total "amount" of visible light present, and the illuminance as a measure of the intensity of illumination on a surface. A given amount of light will illuminate a surface more dimly if it is spread over a larger area, so illuminance is inversely proportional to the area when the luminous flux is held constant.

One lux is equal to one lumen per square metre:

1 lx = 1 lm/m2 = 1 cd�r/m2.

A flux of 1000 lumens, concentrated into an area of 1 square meter, lights up that square meter with an illuminance of 1000 lux. However, the same 1000 lumens, spread out over 10 square meters produces a dimmer illuminance of only 100 lux.

1.3 IOT

The internet of things, or IoT, is a collection of interrelated computational tools, mechanical and digital computers, objects, items or people supplied with unique identifiers (UIDs) and the capacity to transmit data across a network without needing human or human contact.[1]

This specific advancement in the context of new avenues of connection would have an effect on most sectors such as transport and logistics, electricity, healthcare, etc.

2. LITERATURE REVIEW

In [2] using the sensor LDR, an efficient system has been proposed where the author measures the brightness in the surrounding environment and acts according to the darkness.

The authors in [3] developed STM32 based light intensity detection system where the system is small in size and cost effective. But the in terms of development perspective the driver libraries are atrocious and it doesn't have in built Wi-Fi module.

In the present paper, the aim was to develop an ESP8266 based digital lux meter which will be easy, cost-effective so that it can be utilized and commercialized in different industrial applications with a higher degree of accuracy.

The paper has been organized in following sections. In the next section, proposed system has been discussed. In section 4, and 5 block diagram and experimental setup have been explained.

3. OUR SYSTEM

Our System consists of an ESP8266 with a BH1750 sensor together with and 0.96" OLED Display to measure and display the amount of light intensity. Our system is also connected to wi-fi network where we can store the data of light intensity of different environment in the cloud. We are using an ESP8266 because of the following reasons

- It is open source
- It is easy to program and implement
- It is cost effective
- It can be connected to the Wi-Fi

ESP8266 is easily programmed by the java base Arduino IDE (Integrated Development Environment) or Micro-Python. There are several ESP8266 with different versions.

3.1 ESP8266

ESP826 is a low power, self-contained SOC with integrated TCP/IP protocol stack WIFI controlled microcontroller. The ESP8266 uses a 32bit processor with 16-bit instructions. It's Harvard architecture where instruction memory and data memory are completely distinct.[4]

It provides the platform for IOT with ESP8266(LX106) CPU and 128 Kbytes of inbuilt memory and 4 Mbytes of storage capacity.

Fig-1: ESP8266 Nodemcu

Wi-Fi Key Features of ESP8266:

• 802.11 b/g/n support

• 802.11 n support (2.4 GHz), up to 72.2 Mbps

• Defragmentation

• 2 x virtual Wi-Fi interface

• Automatic beacon monitoring (hardware TSF)

• Support Infrastructure BSS Station mode/SoftAP mode/Promiscuous mode

• Antenna diversity

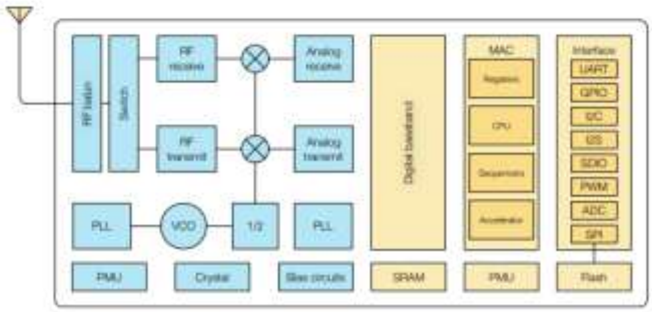

Fig-2: ESP8266 block Diagram

3.2 SENSOR DESCRIPTION

We are using the BH1750 Sensor which is a digital light intensity sensor that has excellent measurement accuracy at very low power. This sensor can accurately measure the LUX value of light up to 65535lx. The BH1750 operates over a large supply range, and is a low cost, low power alternative to competitive solutions in an exceedingly big section of common applications.

We are selecting this sensor for the following feature

- Spectral responsibility is approximately human eye response
- Illuminance to Digital Converter
- Wide range and High resolution. (1 - 65535 lx)
- Low Current by power down function
- 50Hz / 60Hz Light noise reject-function
- Light source dependency is little. (ex. Incandescent Lamp. Fluorescent Lamp. Halogen Lamp. White LED. Sun Light)
- Adjustable measurement result for influence of optical window (It is possible to detect min. 0.11 lx, max. 100000 lx by using this function.)
- Small measurement variation (+/- 20%)
- The influence of infrared is very small. [5]

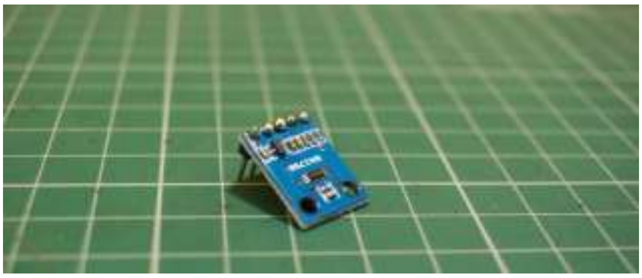

Fig-3 BH1750 sensor

3.1.1 PIN CONFIGURATION AND FUNCTIONS

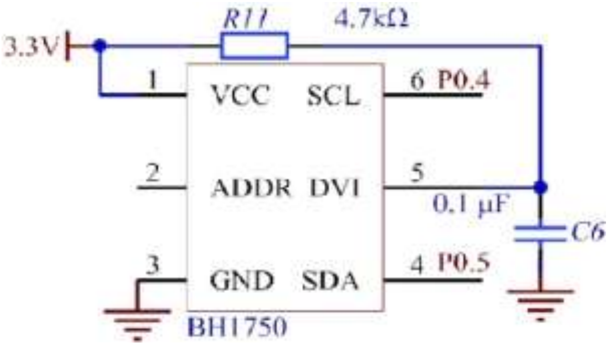

Fig-4: Pin diagram of BH1750

Table -1: Description of different pins of BH1750

Pin Number	Pin Name	Description
1	VCC	Power supply for the module can be 2.4V to 3.6V, typically 3.0V is used
2	GND	Ground of the module, connected to ground of the circuit
3	SCL	Serial Clock Line, used to provide clock pulse for I2C communication
4	SDA	Serial Data Address, used to transfer the data through I2C communication
5	ADDR	Device address pin, used to select the address when more than two modules are connected

3.1.2. LIGHT SOURCE DEPENDENCY

Light source dependency of BH1750 sensor where we can see the dependency is very less and the fluorescent light is set to 1. The maximum light source dependency is for incandescent light which is greater than 1.

3.1.3. MODES

The BH1750 has three modes the H-resolution, H-resolution mode 2 and L-resolution mode. Measurement time for H-resolution mode2 is 120ms and has an 0.5 lx of resolution. H-resolution mode also has the measurement time of 120ms for measurement but its resolution is 1 lx. L- resolution takes 16ms for measurement and its resolution value is 4 lx. H-resolution mode is more beneficial in darkness and it can also easily reject noise.[6]

4. BLOCK DIAGRAM

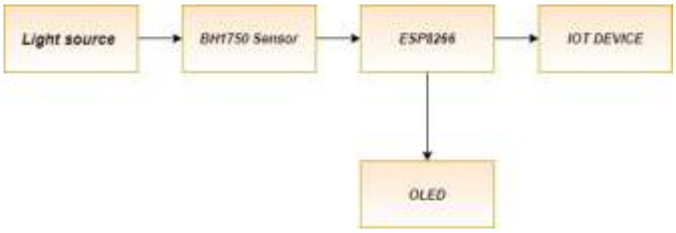

Fig -5: Block diagram of the System

The BH1750 Senses the light intensity and transfer data to the ESP8266 using the I2C Bus then reads the data updates the OLED buffer, which in turn changes the display. The ESP8266 is connected to the IOT device Via Wi-Fi and we can store the measured value in the cloud.

In our system the IOT device will be the smart-phone where we've developed an android app to store the corresponding data of different light sources.

5. CIRCUIT DIAGRAM

The ESP8266 is connected to the BH1750 sensor and OLED display with the I2C port. The I2C port encompass of Vcc, Gnd, SDA, SLA pins of the sensor to corresponding pins of ESP8266. The I2C address required to be changed for each device as the address can vary.

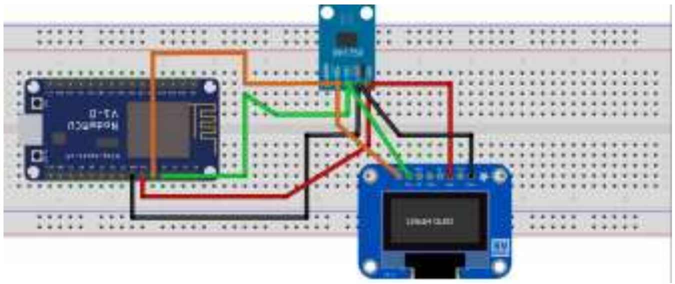

Fig-6: Connection with ESP8266

6. EXPERIMENTATION SETUP

The experimental setup has been shown in Figure 7. A program is coded in Arduino IDE, which is open source software to collect the data using from the serial monitor and shown in the OLED display and stored in the IOT device.

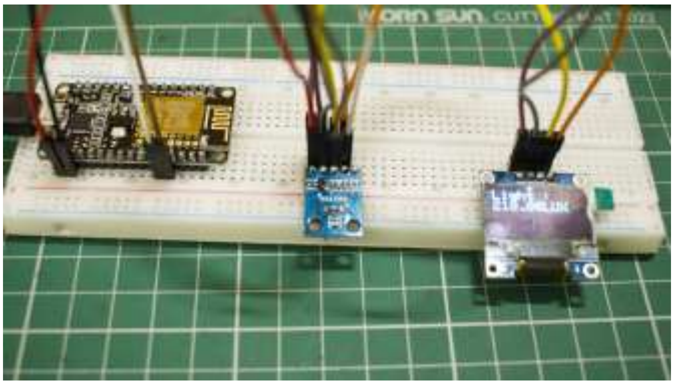

Fig-7: Actual Experimental Setup of the Proposed System

7. CONCLUSIONS

From the results obtained from the proposed system, it has been observed that the present hardware can measure data up to the 2-digit decimal place, which definitely enhances more accurate reading. Considering the cost and size of different parts, the system can be easily transformed into a compact solution with the feature of wireless network sensor. The system can be realized as a handheld mobile device for light monitoring.

Moreover, the total cost of the system is nearly Rs.600/- and the accuracy of ±1.2% makes it cost-effective but efficient to detect intensity of light.

From the market survey, a digital light meter cost around Rs.9000/- with range 200000 and accuracy of ±3%.

An external case can be easily developed and manufactured using additive manufacturing technologies. making the meter economical and efficient as proposed.

The total cost of the meter summarizes as follow

- ESP8266 cost: Rs.250
- OLED display cost: Rs.150/–
- BH1750 cost Rs.150 to Rs.200/–

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BIOGRAPHIES

Nafisa Anjum is currently a Pursing B. Tech student at Future Institute of Engineering and Management Her research interests primarily include Sensors and Actuators, automation and IoT.

Prajjwal Nag has completed his B. Tech degree from Future Institute of Engineering and Management in 2016. His research interests include but not limited to Application as sensor, Instrumentation & measurement, Automation and Digital Fabrication.