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Efficient Usage of Artificial Grow Light from LED's using Selective PWM techniques for Healthy Growth of Plants

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ABSTRACT: This paper address the problem of agricultural, horticultural and botanical industry for growing indoor flora under the influence of artificial light. The solution removes the usual trial and error method of light adjustment and introduces precision growing using automation from data analysis of plant growth and type. Using this information the microprocessor indirectly controls the light intensity, time of operation and number of LED's switched ON at any instant of time as required by the plant and thus achieving optimum plant growth by avoiding leaf burn or wilting and at the same time reducing the overall power consumption of the system. There are two cases taken into consideration for achieving the set solution. The simulated and experimental results for Open and closed loop system are analyzed.

KEYWORDS*:* component; formatting; style; styling; insert

I. INTRODUCTION

Each day 200,000 more people are added to the world food demand. The world's human population has increased near fourfold in the past 100 years; it is projected to increase from 6.7 billion (2006) to 9.2 billion by 2050. It took only 12 years for the last billion to be added, a net increase of nearly 230,000 new people each day, who will need housing, food and other natural resources. The largest population increase is projected to occur in Asia, particularly in China, India and Southeast Asia, accounting for about 60% and more of the world's population by 2050 [1].

This requirement of food needs decentralized growth of food especially indoors in the cities, one of the major drawbacks of this type of indoor setup is the light, any light cannot be used and all light requirements are different for different plants. Light is the most important factor along with water and carbon dioxide for the plants health and yielding. There is a lot of energy loss and damage to the plants due to unsupervised lighting systems.

II. DEMERITS OF THE CURRENT ARTIFICIAL LIGHTING SYSTEM:

A. Plant Burns due to over lighting

When a plant experiences excess of light for a prolonged duration of time there are chances of leaf burns. The burns might be light initially but with intensity and duration the plant may even end up dying.

B. Plant wilting due to too less light

If the minimum amount of light required is not supplied to the plant, they start to wilt. This will cause their health and yield to deteriorate.

C. Unnecessary wastage of power

A lot of power is wasted if constant light is given t_p all the plants equally, not only does the chances of plant damage will exist but also the amount of power consumed will be a lot more. Lamberts inverse square law prohibits the intensity of light hitting on the leaf surface as the distance increases, this is a large waste of energy as the intensity of light reduces to the inverse square of the distance between the light source and incident surface. Usually the height of the light setup of large scale, medium scale and most small scale systems don't have a height control and this leads to an overall wastage of energy for light generation.

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III. PROPOSED SYSTEM

The proposed system is to control the LED's intensity and duration based on the plants individual light requirements. This system uses a selective PWM based approach so as to control the current entering the led and thus to control the intensity of light. Also this approach allows us to switch on and off the LED's based on the light requirements of the plants. The second component of the system is to use a mechanism to control the distance between the light source and the plant surface so as to decrease the effects of the lambert's inverse square law and effectively increase the penetration of the light to the lower levels of the plant systems. The functions of the system are as follows:

A. Intensity Control:

By controlling the current flowing through the LED using a PWM method we can control the output intensity of the light and thus controlling the amount of light that needs to be supplied to the plant.

B. Duration Control:

The power to the LED Grow light can be cutoff, thus controlling the number of hours the LED is switched ON and OFF.

C. Height Control

The Distance of the led to the top most leaf is measured by a distance sensor and the LED setup moves up in height as the plant grows to conserve the light from scattering

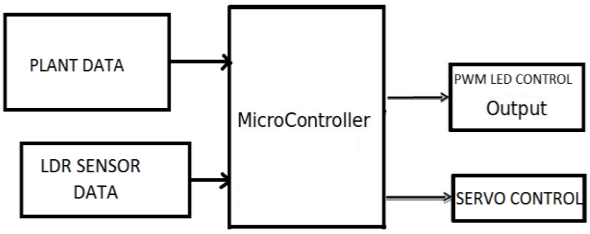

FIG 1. BLOCK DIAGRAM OF PROPOSED SYSTEM

IV. TABLE 1.BENEFITS AND COMPARISON OF THE PROPOSED SYSTEM

Old Conventional System	Current Proposed System
No specific light control	Every plant gets as much light as it needs- No more or No less
Leaf burns possible if unattended on time	Possibilities of Leaf burns are very less
Power consumption is standard and never frugal	Power consumption is dynamic and very economical
Leaf wilting exists if sufficient light is not supplied	Leaf wilting has very low possibilities
No monitoring capabilities	Can be connected to any form of communication for and analyzed after monitoring and controlled remotely
Plant health is average and not confirmed	Plant health is increased drastically

V. SIMULATION

A. Height control

The control system here represents the collective inputs and outputs in the system together with the controller and actuator circuits. The control system consists of an input with a reference set point which measures the error produced by the plant and the controller itself. The plant system consists of the actuator and the process. The controller circuit has primary controlling components which are the PID controller and the actuator controller. The actuator controller consists of a position sensing device and a set point element for the controlling position. The position

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controller is to actuate the position of the stepper motor used in controlling the distance between the "plant" and the light source. The 'Y' element in the actuator controller consists of a motion sensor to detect changes in mechanical rotation of the actuator/stepper motor.

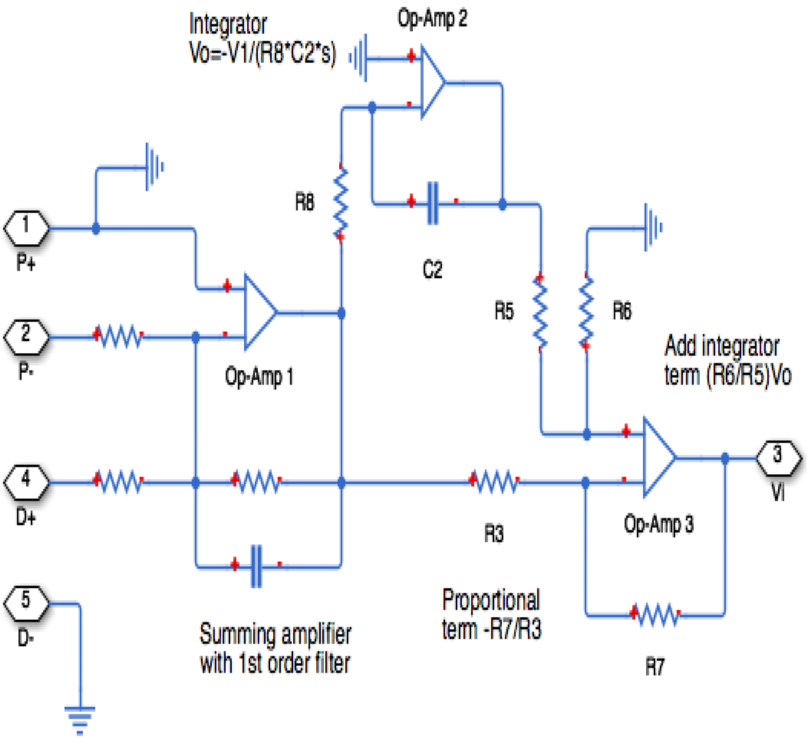
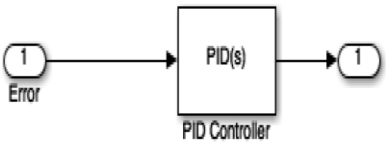


Fig 2. Position controller



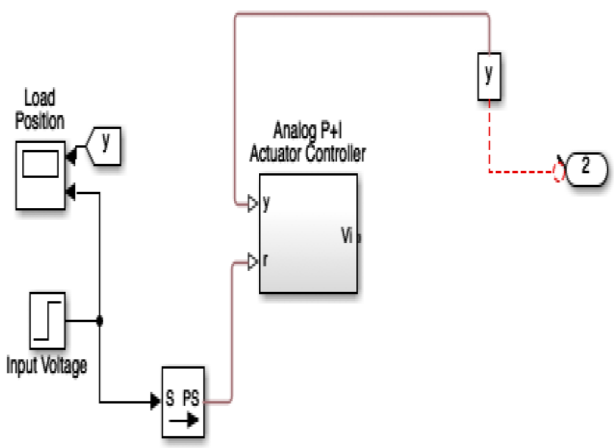


Fig 3. Simulink model

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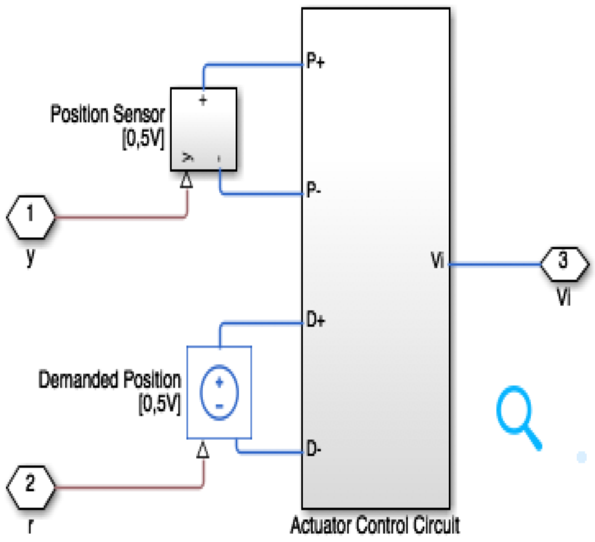

Fig 4. Actuator Control

B. Current control:

Moving on to the plant of the system we have a damped Second order system with a LED driver circuit. This is a LED driver based on a linear current regulator. The scope shows the light and current output of the supply voltage. The output comes into regulation for a supply voltage greater than about 12v.

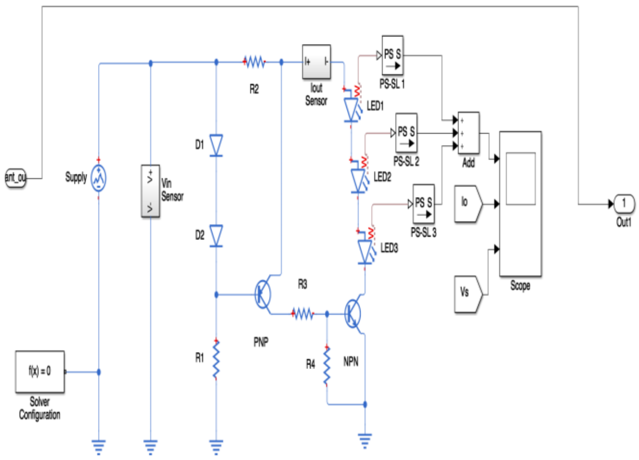

Fig 5. Current control

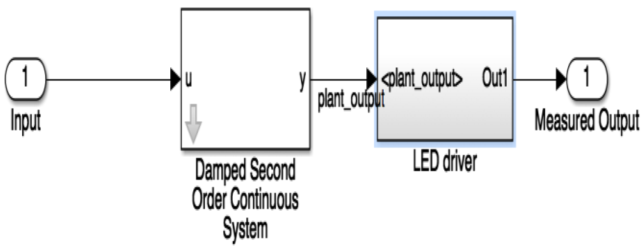

Fig 6. LED Driver

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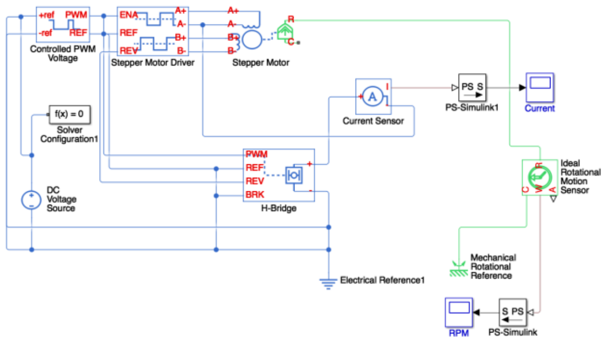

Fig 7. PWM Generator

VI. CONCLUSION

The proposed simulated system proves to be a very good alternative and upgrade to the current system as shown in the closed loop feedback setup, the system is very dynamic and totally controllable based on good references of plant data. A lot of data can be collected and analyzed for future research for a more perfect system by collective iterations from the data of the current system fed to a machine learning algorithm so as to achieve dynamic precision.

VII. FUTURE WORK

To create an automated system for effortless horticulture using a sensor and actuator based mesh network.
To integrate all this data and information using an app based GUI for monitoring from a smartphone
To use the sensor data and create a database of information in a hive mechanism and implement Machine learning. To use the sensor data and create a set of actuators so as to have a perfectly controlled environment.

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