Intelligent Control for Voltage Regulation system via DC-DC converter using raspberry Pi 4 Board

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ABSTRACT

A voltage guideline framework for photovoltaic energy sources (PV) is proposed in this research, which uses a Single-Ended Primary Inductance Converter as a DC-DC converter to handle the burdens of dealing with explicit information voltage. The use of MATLAB Simulink as a climate to nurture control order computations as standard PID, PI-Fuzzy rationale regulators is offered for an ongoing reproduction of a regulated voltage framework for solar powered energy sources (PV). Following that, to accept the work, a few consistent re-enactments are treated using control techniques on a low-cost control board: the Raspberry Pi 4 to handle the framework activity as well as acquire the reproduction data. Similarly, and for testing purposes, a few reproductions were treated to check the proper operation of the proposed framework and Raspberry Pi 4 board, which is faster, capable of converting 4K video, and benefits from faster capacity via USB 3.0 and faster network connections via obvious Gigabit Ethernet, opening the door to a wide range of new jobs.

Keyword: - *Photovoltaic system, DC-DC power converters, Voltage Controller, PID controller, PI Fuzzy logic Controller, Raspberry Pi 4 Board.*

1. INTRODUCTION:

In past few years, the use of sustainable energy has grown in importance in a variety of applications, and as a result, specialists' interest in utilizing this resource has grown. Photovoltaic energy creation is thus one of the most unexpected sources that converts light radiation into power; yet, what makes energy recovery difficult is that photovoltaic energy production is directly dependent on various boundaries, namely temperature and illumination level. As a result, the voltage at its terminals is unsteady. It is critical to produce what we call a regulated voltage framework, which is the goal of our effort, when we truly want to supply loads with consistent voltage distinct to ensure their activity Regardless of whether there is a variation in load or a change in the solar source's voltage supply, the regulated voltage framework should provide a consistent voltage in the heap's terminals. For voltage variation between solar sources and loads, DC-DC converters, a power electronic circuit, are used. This type of

static converter is used in a variety of industrial applications due to its low loss impact and excellent effectiveness. [1].

The transformation among source and loads is the principle undertaking of DC-DC converters. This sort of converter enjoys many benefits like low power misfortune and best yield; a continuous reproduction has proposed utilizing two controls strategies, an old style PID and PI-Fuzzy rationale regulatory framework, coordinated on a Raspberry Pi 4 board whose intention is to control the dc-dc converter to keep up with the condition of the voltage load stable, without human mediation, for an ideal given called the set point, per share on a controlled variable [2].

The exhibition of the proposed fluffy tuned PI control conspire is likewise contrasted and the PI and fluffy rationale control plans. The three level AC-DC converters can be utilized as front stages for battery chargers, continuous power supplies and three-level inverter applications. This study recommends that a better fluffy tuned PI voltage regulator with a hysteresis control strategy when contrasted with can accomplish a lower source current complete symphonies twisting of 0.93% in recreations and a THD of 1.351% in explores different avenues regarding a power factor nearer to solidarity [3].

The expansion of number request PI regulators with fragmentary math empowers the control technique to make up for the impacts of the un-demonstrated characteristic nonlinearities related with true dynamical frameworks. For this situation, the ordinary vital administrator is supplanted by a partial request vital administrator. The expansion of a partial request boundary, alongside the two PI regulator gains, expands the level of-opportunity and plan adaptability of the regulator arm is ordinarily disregarded in help converter regulators[4].

1.1 Block Diagram:

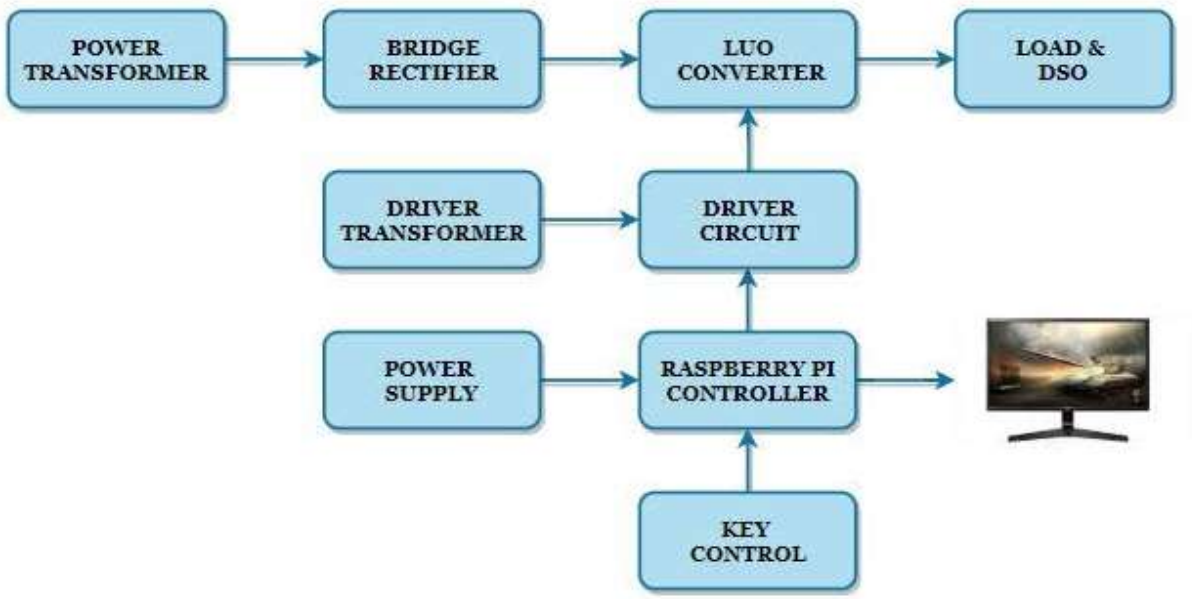

Fig. Block Diagram of Proposed System

Power Transformer:
A power transformer is a static mechanism that switches power from one circuit to the next without interrupting the repetition. A transformer is classified as a static device because it has no pivoting or moving elements. Transformers are powered by an alternating current (AC). The rule of common acceptance governs how transformers operate.

Bridge Rectifier:
For managing large equipment, an AC power source is expected, yet virtually all electronic circuits require a constant DC supply. The contribution from the AC source to the DC voltage is changed over in a basic rectifier circuit demonstrated in this project. To begin with, the AC input from the mains is stepped down to a lower voltage. This AC supply is then passed through a rectifier circuit to remove the AC waveform's negative pattern. The DC yield is then calculated by separating the next sign. The circuit's most important component is the transformer's auxiliary loop, which is made up of diodes and capacitors. The capacitor sifts through the DC part of the circuit while the diodes act as rectifiers.

Luo Converter:
An inductor, the power switch, and two diodes make up the luo converter. In addition, there is a channel for lowering the music of the outcome voltage. When the power switch is turned on, the inductor is stimulated, and the voltage is passed through diodes to the yield capacitor. The voltage across the heap is released by the capacitor. The PIC regulator receives the result voltage. There is both a set voltage and an actual voltage on the PIC. Because the set voltage is constant, the outcome voltage is also constant. The voltage value is set using key capacity.

Driver Circuit:
A driver is an electrical circuit or other electronic component used to operate another circuit or component, such as a powerful semiconductor, in hardware. They are commonly used to control current flowing through a circuit or to control various elements such as different parts and a few gadgets in the circuit.

Raspberry Pi 4 Board:
The Raspberry Pi 4 Model B is the latest version of the low-cost Raspberry Pi computer. The Raspberry Pi isn't your typical device; in its most basic form, it lacks a casing and is simply a MasterCard-measured electrical leading body like to those found inside a PC or PC, but much smaller. With the Pi 4 being faster, capable of decoding 4K video, benefiting from faster capacity via USB 3.0, and faster network connections via obvious Gigabit Ethernet, the door to many new jobs is now open.

2. CONCLUSIONS:

In this study, an intelligent control system for voltage regulation via DC-DC converter is provided, which is regulated by a sporadic source voltage instance of a solar board. The regulatory framework was based on the use of a low-cost expenditure control board: the Raspberry Pi 4, which was used to run the proposed regulatory framework in a MATLAB Simulink environment. Several consistent replicas were dealt with to display the work, ensuring the usability of the provided framework. The obtained results support the acknowledged framework's proper operation, notably in terms of accuracy and consistency. The work might also be reached out to others control framework procedures and calculations due to the superior presentations of the managed board.

3. REFERENCES:

[1] M. Boutouba *et al.*, "Keywords: Voltage control system, Photovoltaic system, DC DC power converters, SEPIC Converter, Raspberry Pi 3 Board, PID controller, PI Fuzzy logic controller.," 2017.

[2] B. T. MOHAMED BOUTOUBA, ABDELGHNAI EL OUGLI, SABAH MIQOI, "Intelligent control for voltage regulation system via DC-DC Converter using Raspberry Pi 2 board," vol. 8, no. April, pp. 41–47, 2017,[Online].Available:https://pdfs.semanticscholar.org/f2ee/6484fa3bb1a5c2ff7194bdb51d67cf93b53e.pdf?_ga=2.167991969.1833433080.1569833197-14590119.1569833197.

[3] J. Gnanavadivel, N. Senthil Kumar, and P. Yogalakshmi, "Comparative study of PI, fuzzy and fuzzy tuned PI controllers for single-phase AC-DC three-level converter," *J. Electr. Eng. Technol.*, vol. 12, no. 1, pp. 78–90, 2016, doi: 10.5370/JEET.2017.12.1.078.

[4] O. Saleem, M. Rizwan, A. Khizar, and M. Ahmad, "Augmentation of fractional-order PI controller with nonlinear error-modulator for enhancing robustness of DC-DC boost converters," *J. Power Electron.*, vol. 19, no. 4, pp. 835–845, 2019, doi: 10.6113/JPE.2019.19.4.835.

[5] F. H. Fudoli, D. D. Vechia, J. P. Bonaldo, and E. G. Bertogna, "Design, simulation and comparative evaluation of both a classic and a fuzzy logic PI controller applied to a DC-DC converter," *Prz. Elektrotechniczny*, vol. 94, no. 5, pp. 27–31, 2018, doi: 10.15199/48.2018.05.05.

[6] S. G. Begum, S. S. Nawaz, and G. S. Anjaneyulu, "Implementation of Fuzzy Logic Controller for DC–DC step Down Converter," *Int. J. Innov. Technol. Explor. Eng.*, vol. 10, no. 8, pp. 109–112, 2021, doi: 10.35940/ijitee.h9251.0610821.

[7] K. Sharma and D. K. Palwalia, "Robust controller design for DC-DC converters using fuzzy logic," *4th IEEE Int. Conf. Signal Process. Comput. Control. ISPCC 2017*, vol. 2017-Janua, pp. 477–481, 2017, doi: 10.1109/ISPCC.2017.8269726.

[8] S. Herrera-aristizábal, J. A. Hincapié-correa, and L. H. Ríos-gonzález, "Visión Electrónica Más que un estado sólido PID-fuzzy of DC motors using Raspberry PI PID-difuso de motores DC utilizando Raspberry PI," vol. 14, no. 1, pp. 86–101, 2020.

[9] S. Winder, "Boost Converters," *Power Supplies LED Drivers*, pp. 61–98, 2008, doi: 10.1016/b978-0-7506-8341-8.00006-2.

[10] H. K. Khleaf, A. K. Nahar, and A. S. Jabbar, "Intelligent control of DC-DC converter based on PID-neural network," *Int. J. Power Electron. Drive Syst.*, vol. 10, no. 4, p. 2254, 2019, doi: 10.11591/ijpeds.v10.i4.pp2254-2262.