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**RESEARCH ARTICLE**

# Fuzzy-Logic-Based AOF Controller for Non-Linear Load in PV-FED Vehicle Application

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## ABSTRACT

This work presents an electric power train for PV-fed unmanned aerial vehicles that is based on an intelligent fuzzy logic controller (FLC). A tiny LC filter and an H-bridge inverter with a low switching frequency make up the design. The Active Output Filter (AOF) reduces the weight and size of the power transmission network while also significantly enhancing its conversion efficiency by adding a simulated series opposition with the H-bridge inverter to assure excellent quality sinusoidal signal of the line voltage. The non-linear load causes undesired harmonics, which are reduced by the injected voltage across this simulated series resistance. A fuzzy logic controller-based simulation model was created to simulate the proposed system, and a closed-loop feedback control approach was used to assess the system under non-linear load circumstances. According to the computer simulations, the active resistance compensation approach may be able to produce sinusoidal line voltage waveforms of excellent quality with a THD ratio of around 3%. Additionally, the recommended system's study of power losses and conversion efficiency is performed and contrasted with those of a conventional three-phase PWM inverter, demonstrating a 31% reduction in power losses.

**Keywords:** PV system, power train, fuzzy controller, Active output filter, LC filter

# INTRODUCTION

Reduced weight and size of the electricity framework are the main reasons for using an electric-powered power train framework with a frequency of 400 Hz in aviation packages as opposed to a typical small frequency of 50 Hz [1]. Because of their lower energy force compared to the dynamic energy components, regular channels are perhaps the strongest object in electricity transmission frameworks. As a result, shrinking the size and weight of such channels will unexpectedly reduce the size of the power structure and ultimately lower fuel consumption [2]. A long time has passed since the development of the plane's electric energy education systems, and it has gone through several stages before executing fully automated increasing vehicle UAV innovation. The mechanical primarily based velocity drives, for example, Consistent Velocity Drives (CSD) and coordinated IDG is created to provide mechanical connection pointsfor the 400 Hz simultaneous alternator [3]. The mechanical coupling is largely a variable proportion hydro-mechanical drive that coupled the circulated motor shaft to the coordinated alternator through numerous stuff ranges and water-powered chamber block normal to both the siphon and the engine. Notwithstanding, these mechanical factors of interplay have numerous weaknesses, for instance, low productiveness, it requires incessant and exorbitant upkeep, and significant size and weight [4]. Due to their amazing prospective benefits in energy thickness, high transformation skill ability, and need for less preservation, electric frameworks have replaced bespoke mechanical frameworks in cutting-edge Aeroplan's, which are driven by an increasing number of electric motors [5]. In any case, this involves using several frequencies to operate electric loads. Utilizing a variable speed, constant frequency power train framework, each power train's size, and execution have undergone a significant update. A rectifier, a DC interface, and a PWM inverter with latent (L-C) yield channels are all included in the VSCF power train structure to provide a sinusoidal burden yield voltage. The PWM converter generates the necessary pure voltage on a consistent basis. However, VSCF also has certain drawbacks, such as the PWM converter's lower switching frequency in high electricity programs [6]–[7]. Limitations in the inverter's switching frequency cause the LC yield channel's additives to extend farther and produce a superior final impedance. It moreover improves framework performance in instances with delayed burden [8]. A rural-directed UAV that has been used in a wide range of suggestions, including exchanges, reconnaissance, exams, climatic conditions broadcasting, and leading naval sports, has been made possible by the diligent development in aeronautics power train frameworks [9]. Anyhow, UAVs have a number of difficulties, such as their constant need for oil spinoff when visiting to provide the burning engine for plane propulsion and coffee flying perseverance, short flight times, and sporadic flight endurance. As a result, experts have given solar-based powered UAVs a lot of thought.

## MODELLING OF AOF

Figure 1 shows the system under consideration for the power train's implementation. The DC/DC power converter, PV system, power management structure, and battery are the power train's essential components. The six-stage inverter, AOF, and rectifier load make up the AC side. In order to compensate for the rectifier load harmonics, the inverter works at high frequency and injects harmonics. In this article, self-balanced technology is used to increase the DC connection voltage. The voltage waveforms on the DC connection side will be distorted by the current harmonics that the diode bridge rectifier generates. With the aid of AOF, the suggested closed-loop technique transmits the resistance to the harmonics generated by the loads. The main inverter's DC connection voltage and the AOF's common DC link voltage are both taken into account and contrasted. The fuzzy controller receives the error output in order to generate the active compensating resistance brought on by the rectifier load's current harmonics. For the purpose of creating the injected voltage waveforms, the compensation current is multiplied by the line current. The input signal is sent to the AOF with increased switching frequency and a PWM technique after the detected voltage is split with the inserted voltage signals.

## SIMULATION RESULTS

The recommended system's simulation results were produced using the MATLAB/Simulink 2018b environment. Figures 3, 4, and 5 show, respectively, the output voltage of the inverter for the open loop, closed loop, and THD waveforms. Figure.6 presents the DC bus voltage, and Figure.7 shows how to compute the AOF's modulation index.

Figures 8, Figure 9, and Figure 10 show the AOF injected voltage, filter voltage, and nonlinear load voltages, respectively. Figures 11 and 12 respectively show the primary inverter voltages and nonlinear load currents. According on the active filter findings, the suggested fuzzy controller reduces the THD to about 3%.

## CONCLUSIONS

In this paper, a new electric energy production system for solar-powered unmanned aerial vehicles (UAVs) is proposed and investigated. It uses a fuzzy logic controller and a live output filter. Balanced DC-hyperlink voltages for AOF have been achieved via closed-loop management of energetic resistance reimbursement, which provides an injected voltage across it to lower undesirable harmonics caused by the non-linear load. The voltage and current waveforms along with the gathered simulation results demonstrated the usefulness and accuracy of the advised strength era system. The active resistance compensation offered guarantees a super sinusoidal line voltage with much less than 3% common harmonic distortion.

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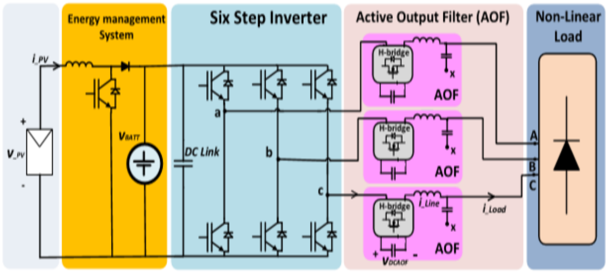


**Figure.1: Modelling of AOF**

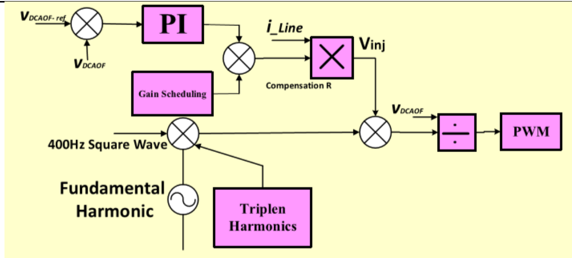


**Figure.2: Fuzzy controller**

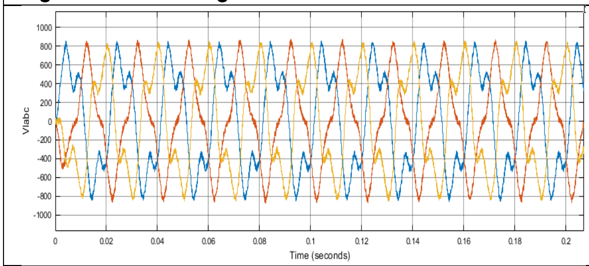


**Figure.3: Output line voltage in open loop control**

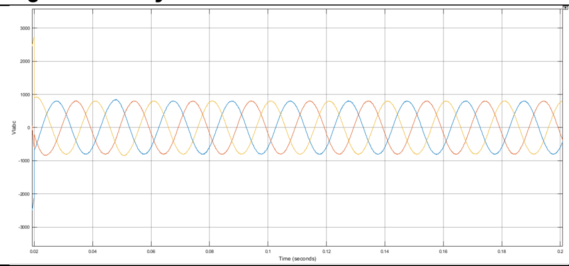

**Figure.4: Output line voltages under closed loop fuzzy controller**

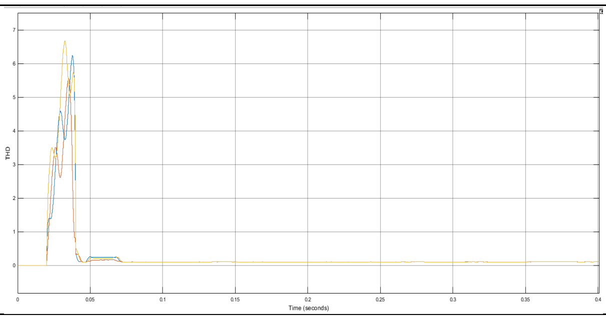

**Figure.5: THD of inverter output**

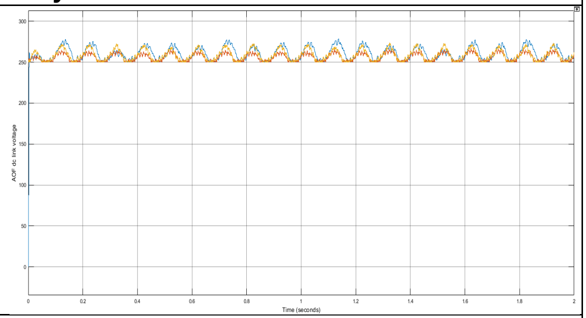

**Figure.6: DC-bus voltages**

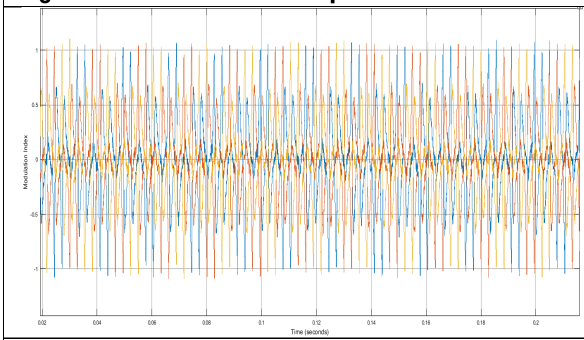

**Figure.7: Modulation index of AOF**

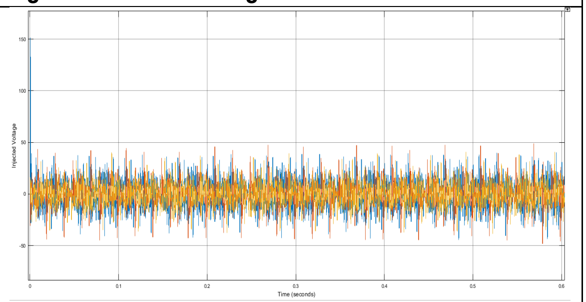

**Figure.8: AOF injected voltage**

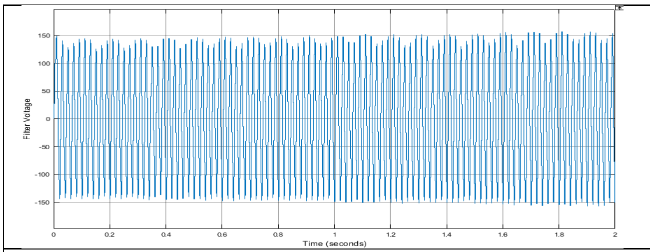


**Figure.9: Filter Voltage**

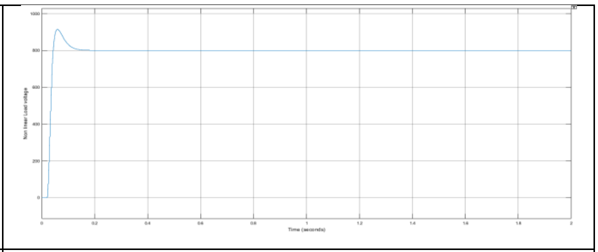

**Figure.10: Load voltage**

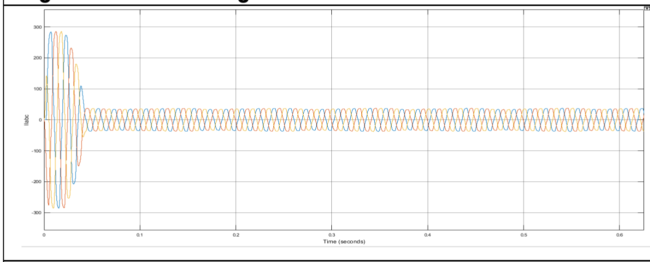

**Figure. 11: Non-linear Load currents**

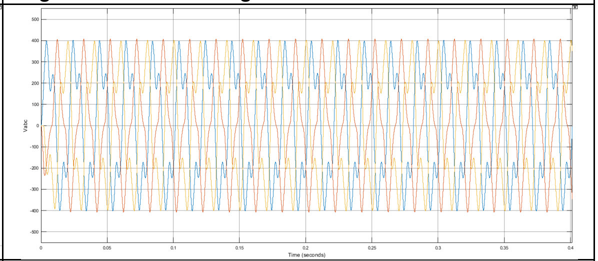

**Figure. 12: Main inverter voltages**