UNIVERSITI TEKNOLOGI MARA

HYBRID EVOLUTIONARY-DOLPHIN ECHOLOCATION PROGRAMMING FOR SIZING OPTIMIZATION OF STAND-ALONE PHOTOVOLTAIC SYSTEMS

ZULKIFLI BIN OTHMAN

PhD

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Zulkifli Bin Othman
Student I.D. No.	:	2014840428
Programme	:	Doctor of Philosophy (Electrical Engineering)-EE950
Faculty	:	Electrical Engineering
Thesis Title	:	Hybrid Evolutionary-Dolphin Echolocation Programming for Sizing Optimization of Stand-Alone Photovoltaic Systems
Signature of Student	:	 ……..
Date	:	May 2021

ABSTRACT

Renewable energy technologies have been the current trend in electricity generation with photovoltaic (PV) systems being one of the promising technologies. PV systems is one of the Distributed Generation (DG) type which is conventionally utilized in remote areas without access to grid electricity. The PV systems that are not connected to the grid are known as Stand-Alone Photovoltaic (SAPV) systems. Despite being used widely as electricity supply systems for rural electrification, a primary issue in SAPV systems installation is the system sizing. When the systems have been designed appropriately; technical and economic performance of the systems are improved. Moreover, sizing becomes computationally expensive when there are numerous models of system components need to be considered in the design. Thus, optimization techniques are frequently incorporated in the sizing algorithms for such systems for the purpose of achieving the best solution. This thesis presents the "Hybrid Evolutionary-Dolphin Echolocation Programming (EDEP) for Sizing Optimization of Stand-Alone Photovoltaic Systems". The objectives are 1) to formulate an iterative-based algorithm for sizing optimization of SAPV and (Hybrid Stand-Alone Photovoltaic) HSAPV systems, 2) to develop a hybrid EDEP technique for sizing optimization of SAPV and HSAPV systems and 3) to formulate a hybrid EDEP technique for determining optimal solar fraction in sizing optimization of SAPV and HSAPV system. Initially, Iterative-based Sizing Algorithm (ISA) which uses the non-computational intelligence-based approach is presented to serve as the benchmark for computational intelligence (CI)-based sizing algorithm. Subsequently, the CI-based sizing algorithm, known as Evolutionary-Dolphin Echolocation Programming Sizing Algorithm (EDEPSA) is formulated to determine the optimal models of each system component such that either Performance Ratio (PR) or Levelized Cost of Electricity (LCOE) of the system is optimized. The system components of SAPV system that need to be optimized are PV modules, batteries, charge controllers and inverters whereas diesel generator is the additional component that needs to be optimized in HSAPV system. Then, EDEPSA is executed to determine the optimal Solar Fraction (SF) apart from the system components such that LCOE is minimized. The results showed that EDEPSA had successfully produced optimal PR and LCOE and comparable with those attained using the benchmark algorithm ISA with much lower computational time. Besides that, comparative studies with other techniques have also been performed to highlight the superiority of EDEPSA. EDEPSA was found to be superior than selected Computational Intelligences (CI) in terms of having lower computational time and lower population size. These findings showed that EDEPSA is capable of sizing the systems under study with accurate and fast computation. Hence, the development of EDEPSA is justified.

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