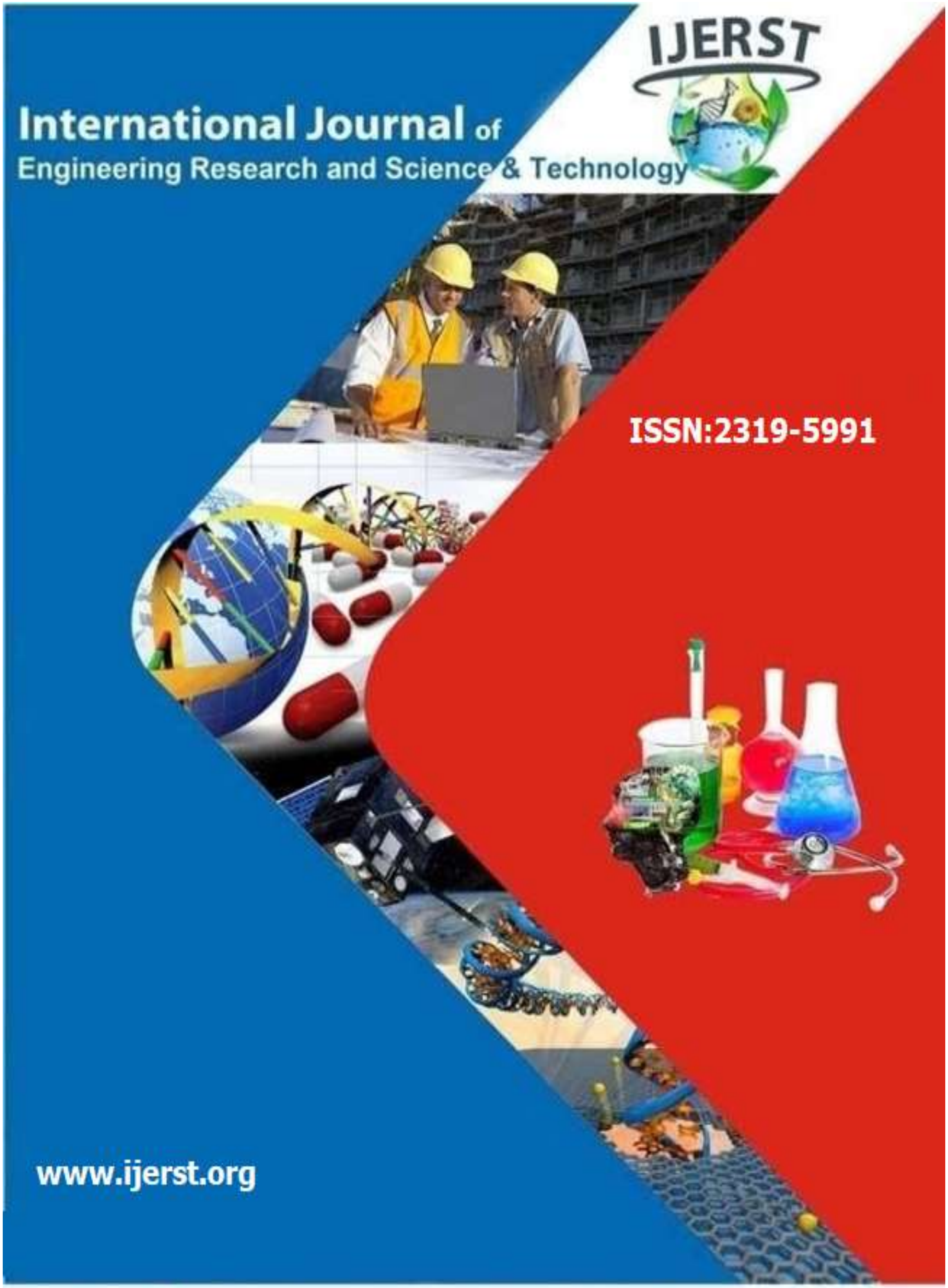

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STANDALONE DUAL AXIS SOLAR TRACKING SYSTEM WITH BATTERY CONTROLLER AND MICROCONTROLLER

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Abstract:- This Project introduces a novel mathematical approach to significantly enhance dual-axis solar trackers' Solar Reliability Factor (SRF) by developing and implementing an advanced Online Built-In Self- Test (OBIST) architecture. This innovative architecture is designed to efficiently address and correct single bit-flip errors within the system's microcontroller unit (MCU), a common control unit in contemporary solar trackers. By employing an improved diagnostic scheme based on extended Hamming codes, our OBIST architecture identifies and autonomously corrects all detected single bit-flip errors, reducing the fault coverage. This capability marks as significant advancement in the field, directly contributing to a substantial increase in the SRF. The study meticulously analyzes the potential fault domain influenced by environmental factors such as prolonged sunlight exposure and varying weather conditions, which are critical in the regular operation of solar trackers. Furthermore, we introduce a probabilistic model for defining and addressing stuck-at-faults, enhancing the system's overall reliability. The successful application of novel fault coverage-aware metrics demonstrates the OBIST architecture's effectiveness in improving solar tracker reliability, significantly contributing to the photovoltaic (PV) systems domain. This research presents a groundbreaking approach to enhancing solar tracker reliability and sets the stage for future advancements in the maintenance and efficiency of renewable energy systems

1. INTRODUCTION

1.1 GENERAL

The growing demand for sustainable energy has made the reliability of photovoltaic (PV) systems, particularly solar trackers, a critical research focus. While static and mobile PV panels have advanced significantly, their fault diagnosis remains complex, often requiring costly and resource-intensive testing methods. Existing techniques—such as those using Artificial Neural Networks (ANNs)—offer effective fault detection but involve high computational and hardware overhead. Moreover, harsh environmental conditions (e.g., prolonged sunlight, rain, temperature changes) impact the stability of microcontrollers and integrated circuits in

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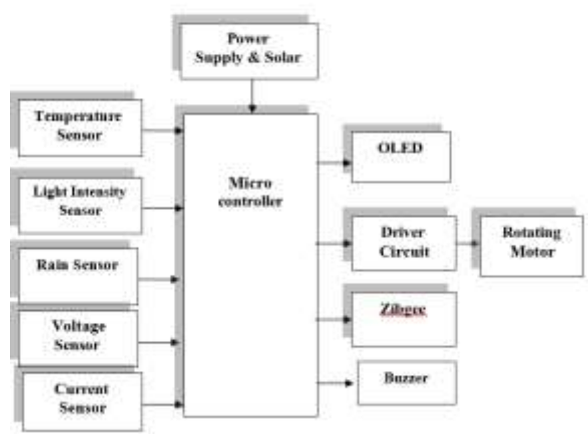
solar trackers, leading to faults that compromise system performance.
Past research highlights the need for routine diagnostics in PV components like DC-DC converters, charge controllers, and power electronics. Techniques using ANNs, fast detection modules with STATCOM, SoC-based architectures, and Mathematical Morphology-based filters have been employed for fault detection. However, mobile PV systems present greater challenges in Design for Testing (DFT) due to their complex electrical architecture.

Efforts to reduce carbon footprint have driven the use of low-power embedded systems (e.g., Arduino, STM32), with researchers building solar trackers that use sensors, motors, and control boards. The hardware setup used in this work improves upon existing designs by replacing traditional sensors with optocouplers (LTV-847 IC), paired with Arduino UNO, L298N motor drivers, and stepper motors, guided by the cast-shadow principle.

2. LITERATURE SURVEY

Review paper 1:
Title: Increasing the Solar Reliability Factor of a Dual-Axis Solar Tracker Using an Improved Online Built-In Self-Test Architecture
Year: 2023
Author(s): Sorin Liviu Jurj, Raul Rotar
Methodologies Adopted:
Designed an improved Online Built-In Self-Test (OBIST) architecture. Integrated extended Hamming codes to detect and correct single bit-flip faults.
Review paper 2:
Title: Improving the Solar Reliability Factor of a Dual-Axis Solar Tracking System Using Energy-Efficient Testing Solutions
Year: 2022
Author(s): Flavius Opritoiu, Mircea Vladutiu
Methodologies Adopted:
Developed an energy-efficient testing framework for dual-axis trackers. Implemented continuous performance monitoring using embedded sensors. Review paper 3:
Title: Dual Axis Solar Tracking System
Year: 2021
Author(s): Mugachintala Dilip Kumar, Tenugu Manish Kumar, Kongari Akshay, Sowdapuram Yashwanth Kumar, Udutha Vikas
Methodologies Adopted:
Designed a dual-axis mechanical tracking system using cost-effective materials. Used photoelectric sensors and photoresistors to determine sunlight direction

3. BLOCK DIAGRAM



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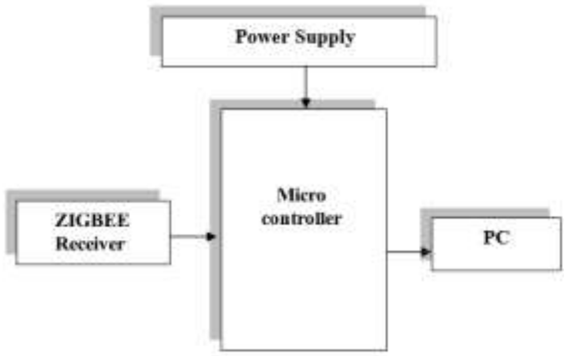

FIG: 1 Block diagram

3.1. HARDWARE COMPONENTS

- Regulated power supply.
- Micro controller.
- Zig bee

3.2. SOFTWARE REQUIREMENTS:

- Embedded C

4. IMPLEMENTATION

This simulation and design phase confirms that the improved OBIST architecture significantly enhances the fault detection and correction capabilities of dual-axis solar trackers. The system is now capable of real-time error correction, minimizing downtime, and improving the Solar Reliability Factor (SRF) by over 47.48%. The simulation results validate the robustness of the proposed model and its feasibility for real-world deployment.

5. RESULT

This project is well prepared and acting accordingly as per the initia specifications and requirements of our project. Because of the creative nature and design the id of applying this project is very new, the opportunities for this project are immense. The practical representation of an experimental board is shown below:

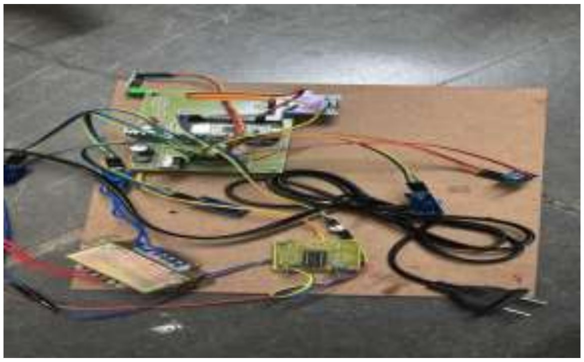

Fig:3. Project Model

6. CONCLUSION

This project presents an OBIST architecture using an LFSR as a test pattern generator and a MISR for result analysis, targeting dual-axis solar tracking systems. The setup includes components like an Optocoupler, Arduino UNO, and L298N Dual-H Bridge ICs, all found susceptible to hardware faults. Extended Hamming codes are used for single bit-flip error correction, enhancing system reliability. A revised metrics system brings single bit-flip fault coverage down to 0%, raising the Solar Reliability Factor (SRF) by 47.48%. The OBIST software efficiently injects test vectors and collects MISR signatures, achieving 72.15% global error coverage. A 100% correction rate is demonstrated for single bit-flip errors, significantly improving reliability. Future enhancements may include multi-bit fault correction and remote diagnostics via wireless integration. Adopting FPGAs and advanced microcontrollers could boost processing and fault resolution speed. AI-driven predictive maintenance

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may further reduce faults and optimize system management. Scalability and low-cost PCB integration would enhance commercial deployment in renewable energy sectors

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