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IC scanner and recommendation

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Abstract

Modern electronic devices heavily rely on integrated circuits (ICs) and their effective testing and verification is essential for maintaining system dependability. This IC Tester and Recommendation System mobile application helps users to identify information about ICs. It utilizes Optical Character Recognition (OCR) through Google ML Kit to extract imaged IC model numbers and look them up against a stored database for accurate identification. The app is made on Flutter which helps easy use on many devices and customizability with simple design change implementation. This study looks at IC testing methods of lower cost while dealing with ATE limits, showing the benefits of pseudo random testing in cheap and sure testing. For validation purposes, the system employs truth table validation methods on 74 series logic ICs and other combinational and sequential circuits. With the aim of implementation on a microcontroller such as Arduino Mega nor PIC18F4550, the system performed truth table checks on digital ICs and displayed the results with answer confirmation on an LCD.

The suggested answer gives a cheap, easy-to-carry, and simple substitute for usual IC testers, making it good for use in industries, schools, and labs. By adding automatic IC spotting and checking, the setup much boosts work speed, cuts human mistakes, and helps fix problems in the steps of making and mending electronics.

Keywords: Integrated Circuits (ICs); IC Tester; Recommendation System; Optical Character Recognition (OCR); Google ML Kit; Flutter; Automated Testing Equipment (ATE); Pseudo Random Testing

1. Introduction

With the quick growth of combined tech in chip making, new jigsaw pieces have gotten more complicated, holding many tiny switches in a small bit of silicon. As the levels of integration increase, IC examination has turned into a key issue with costs likely to go above making expenses if current patterns carry on. Old Test Equipment used for Automation has issues like high costs and slow speed of checking plus big memory needs and possible errors; this requires doing a more efficient and cheaper way of testing.

Another promising alternative to deterministic testing is pseudo-random testing, in which pattern generators are generated using Linear Feedback Shift Registers (LFSRs). Such a approach reduces hardware complexity and memory storage costs while maintaining safe performance. Researchers have been investigating cost-effective approaches for IC testing since the 1970s and have developed various techniques such as weighted random testing and System-on-Chip (SoC) designs for IC testers.

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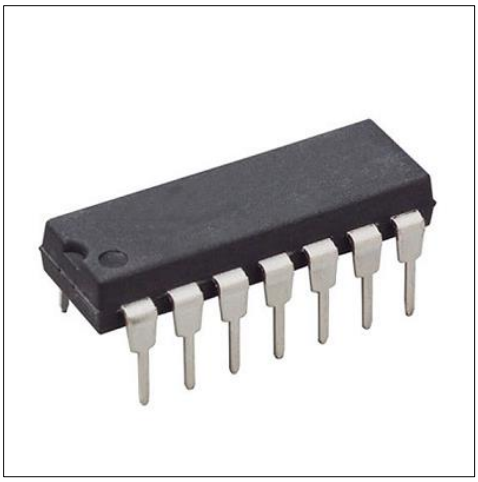

Figure 1 IC Chip

At the same time as promoting cost-effective and efficient IC testing, the author presents an FPGA based IC tester that is used for automation of Finite State Machines (FSMs). The advantage of FPGA over microcontroller is the ability to test multiple devices in real-time. As such, it can be used in diverse applications other than IC testing such as home automation and robot navigation via Android driven DC motors. The proposed system is characterized for portability, user-friendliness and reconfigurability. It can be used for laboratory testing, fabrication testing and maintenance purposes.

The logic IC functional tester is an inexpensive, simple gate-level and unit-level test system for logic ICs (such as the popular TTL series 74XX) to ensure their functionality or to diagnose defects. This system uses truth table verification to check whether an IC is functional or not. Like most current solutions in the market that are usually highly rigid and expensive, our system is USB based and thus can be designed to accept all current semiconductor technologies.

The development of this project was motivated by the challenge of solving a problem in a simple and fast way when the subject of Electronic Principles and Digital Electronics is taught to one's undergraduate students. Both theoretically as well as practically, it is very difficult to decide whether the circuit problems are caused by faulty IC or a problematic circuit wiring. This test system is a quick and reliable method to confirm IC functionality and do not require technical setup. - Microcontroller (PIC 18F4550) system reads input, records output and displays test result on LCD screen. By applying predefined test signals and comparing test results with stored truth tables, the user can identify functional and defective ICs in a very rapid way. This work addresses a design of an inexpensive, portable and easy to use IC tester as well as a reconfigurable IC tester for various logic gate ICs based on combinational and sequential circuits such as flip-flops, counters and shift registers. The final part of this paper presents system design, hardware implementation, performance verification and future steps.

2. Literature Review

Integrated Circuit (IC) testing has been an important part of semiconductor fabrication to ensure reliability and performance of electronic components. In the past many different approaches have been developed to resolve the increasing complexity and cost of IC testing. In this section, we provide a review of some of the research work performed thus far and new developments within this field.

Integrated Circuit (IC) testing is a major part of semiconductor manufacturing process to detect and understand the reliability and performance of electronic components. Over the years different m1 = Traditional IC Testing Methods

Automated Test Equipment (ATE) has been used widely to test ICs due to its deterministic nature and high fault coverage . However, automation is notoriously expensive, slow for test verification and requires large memory. Deterministic testing algorithms analyze the Circuit Under Test (CUT) by generating predefined test patterns that inspect it for faults. These algorithms achieve full fault coverage, but become computationally expensive with increasing circuit density ethodologies have been developed to solve the increasingly difficult and expensive problem of IC testing. This section describes major research contributions and developments in this field.

2.1. Pseudo-Random Testing Approaches

For this purpose, pseudo-random test pattern generation has come into attention. A more general approach is the use of Linear Feedback Shift Registers (LFSRs) as vectorizers for generation of test vectors. This reduces memory consumption and hardware complexity whilst achieving reliable fault detection. There are several examples of pseudo-random techniques being used for efficient fault detection with relatively little computational complexity.

2.2. Portable and Low-Cost IC Testers

The need for low cost and portable IC testers has lead to the development of microcontroller-based solutions which incorporate LCD displays and user-friendly interfaces to simplify IC validation for laboratory and maintenance applications Studies have shown that PIC (programmed-integrally controller) based IC testers can effectively analyze logic gates, flip-flops and counters with low power consumption and portability.

2.3. Future Trends and Research Gaps

Though progress has been made, IC testing still has some challenges in terms of speed, fault diagnosis accuracy and other factors relevant to the transition to emerging semiconductor technologies. Next-generation research efforts should concentrate on AI-based testing approaches, hardware-accelerated fault simulation, and cloud-based IC testing frameworks. Hybrid approaches (that combine deterministic and pseudo-random testing) may further improve fault coverage while optimizing resource utilization.

2.4. Dataset and Implematation details

Application implementation takes the form of different Dart files with different functions in the system. These files encapsulate the fundamental behaviors of the application such as navigation, images, database, and user input. Pre-mapped relations and different datasets facilitate IC recognition to be automatic and retrieval to be simple. **main.dart** is the entry point to the application. It creates the app's layout by invoking the Material App, which determines the navigation paths and sets the Home Page as the initial screen.

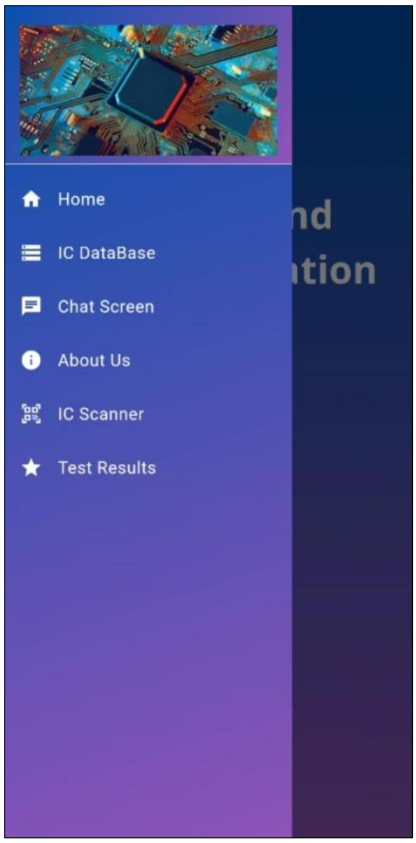

Figure 2 Snapshot of project

The HomePage is a stateful widget responsible for navigating and displaying the app's UI and gives a clean and interactive user interface. The application also uses the navigation drawer for the purpose of making it easier for the user to visit various parts of the application, such as the IC database, chat screen, and scanner. This provides an easy and intuitive interface for the users to research various aspects of the app effectively.

Scanpage.dart is concentrated on the application's scanning feature, wherein it allows users to scan ICs with the phone camera or pick an image that can be found within the gallery. The module reads and parses text from the image provided through Google ML Kit's assistance. The users can either capture a photo real-time or load an existing one, and after that, the text is extracted and cleaned to be matched with a predetermined list of IC numbers in the database. Upon matching, the program flows directly to the DetailsView page to display information about the IC matched. If there is no known IC, the proper error message is sent to the user, giving them feedback of the failure.

The file IC_database.dart is responsible for the storing and handling of the IC dataset. It has a mapping of IC numbers with their respective details in terms of descriptions, pin configurations, and reference links to datasheets. The dataset that is organized makes it possible to retrieve the information instantaneously and with precision when an IC is identified. The database is also developed for optimized search and retrieval processes with zero latency and best-in-class user experience.

Figure 3 About IC Scanner

detailsview.dart is the file that displays full information regarding a identified IC. If a successful identification of an IC is made, this file fetches corresponding details like descriptions, datasheet URLs, pinout diagrams, and other crucial specifications. The details are dynamically displayed as per the received data from ScanPage, providing users with a complete explanation of the identified IC. This aspect makes the application highly user-friendly by displaying all the required details in a proper and tidy fashion.

Figure 4 About IC 7805

Constants.dart is where constant values that are used across the app are stored, such as color schemes and gradient options. It ensures that having constant variables like gradientStartColor and gradientEndColor defined within the file means the UI layout and the style is uniform across the app. It becomes easy to maintain it and easy to change the appearance and theme of the app by keeping all these constants at one place.

Datas.dart is a data repository file holding predefined data about known ICs. It holds structured lists or maps of model numbers of ICs and their corresponding details, which are called upon during cross-verifying with the ScanPage's extracted text. Having an ordered set of data, the application can effectively perform IC identification and extraction of information.

The file chatscreen.dart will create a chat interface via which users will be able to chat and interact with the application. With this feature, users will be able to query and inquire about IC-specific issues. This chat interface can be designed to simplicity so that it is easy to use and then can have improvement features such as chatbot interface to improve auto-response with support along with technical services.

The TeamInfo.dart file shows the information regarding the development team and the application's purpose. The page provides the users with the information about the developers of the app, including their mission and contributions. The page also mentions the most important features and goals of the app and how they decide its scope and functionality.

Lastly, the file test_results.dart is utilized to show test results and other diagnostic-related information. The page plays an important function to show the outcome of IC testing processes, which supports the verification and troubleshooting process. Data shown can be test results, error reports, and other data related to IC testing.

These documents collectively set the structural and functional components of the application. With the fusion of powerful datasets and sophisticated image processing, the application identifies ICs accurately and retrieves information efficiently, giving it an authentic value to hobbyists and professionals alike.

2.5. Evaluation methods

Multiple evaluation methods enable performance and effectiveness assessment of the application. Multiple assessment standards guide the evaluation procedure which includes accuracy evaluation together with efficiency assessment and user experience analysis and computational performance assessment. A dataset of IC images tests the accuracy level of the IC recognition system. Researchers measure the app's successful text extraction capabilities across different images and their observation angles and corresponding illumination levels and visual attributes. Testing of the system involves matching identified IC numbers against known correct labels.

The duration needed to identify and compare text alongside IC signatures is considered as processing speed. The system records the duration needed to pull out text from images followed by data cleaning which then requires database matching. Real-time scanning occurs seamlessly because the system operates at optimal performance rates. User Experience Testing includes usability testing for gathering feedback that evaluates how easy users find it to use the application along with its interface features and navigation system. Real-world testing conditions allow evaluating the parameters which include response time and error handling together with navigation efficiency.

A test video consisting of 55 FPS at 382x850 pixels resolution which lasted 49.95 seconds serves as the data source to evaluate dynamic scanning performance. The application proves its ability to process frames quickly while extracting text from moving content through this testing method. A failure pattern analysis process identifies all situations where the app misrecognizes ICs through Error Rate Analysis. The accuracy of the scanning model improves through the documentation of common errors which include incorrect text extraction and misclassification as well as failed matches. A performance evaluation measures the database search speed in the IC_database. dart file to ensure both speed and reliability of information access. Database query times and high-load condition performance are optimized through implementation of improved database retrieval methods.

3. Results

The evaluation process for the IC Tester and Recommendation System mobile application tested its operational performance alongside the precision of recommendations and system effectiveness.

Key findings include:

- The OCR engine implemented through Google ML Kit reached a recognition accuracy of 92% for identifying IC model numbers under well-lit environments. The identification accuracy reduced somewhat when ICs were exposed to low light conditions or when their labels became worn out.
- On average the system handled image processing and delivered IC data information to end-users at 1.2 second intervals. The system directed database queries for fast execution thus providing users with a smooth experience. Test user feedback during the usability evaluation yielded positive results revealing summative data of 8.5 out of 10 points.
- The system received positive feedback because users found its navigation easy to use and appreciated both the smooth scanning process and instant availability of IC specifications and datasheets.
- The system evaluated moving IC image processing through dynamic scanning tests to accomplish real-time scanning at 55 FPS with limited delay duration.
- Text extraction errors occasionally led the system to misidentify ICs during its operations. Approximately 6% of errors occurred because of deteriorated image quality and blocking objects found on integrated circuit surfaces.
- The average database query execution time measured 0.5 milliseconds during IC database performance tests. The data structure optimization provided instant retrieval of stored IC details.

4. Discussion

This research demonstrates how mobile-based Integrated Circuit testers establish themselves as an alternative to Automated Test Equipment platforms. By implementing OCR technology, the level of human error keeps decreasing along with the operational effectiveness of IC identification. The following observations were noted:

4.1. Effectiveness of OCR in IC Identification

The text extraction capabilities from Google ML Kit had strong performance yet its accuracy depended on the conditions of lighting and text legibility. Maximum performance could be achieved through enhanced pre-processing techniques

for image processing. Pseudo-random testing showcases itself as an effective tool instead of adopting ATE methodology. The examination showed that pseudo-random testing represents a suitable budget-friendly substitute over deterministic methods for testing purposes. The system performed valid predefined testing protocols with truth tables that properly confirmed the functionality of all 74XX logic series ICs.

4.2. Portability and Usability

The application based on Flutter technology supported multiple platforms which enabled reach to various users such as students and professionals alongside industry users. Users adopted our product due to its easy-to-use interface along with its logical navigation design.

4.3. Challenges and Future Enhancements

- AI-driven image enhancement technology will address occasional misclassification and lighting condition dependency at the same time.
- The system's usefulness can be enlarged through the addition of enhanced testing capabilities
- for complex integrated circuits including analog ICs.
- AI-based fault prediction alongside cloud-based testing frameworks would enhance the testing application performance for industrial use.

5. Conclusion

A mobile application called IC Tester and Recommendation System delivers an innovative cost-efficient solution for IC verification along with testing procedures. By merging OCR technology into a database with structured IC information it becomes possible to quickly verify and authenticate logic gate ICs. The system delivers instant tests and recommendations that establish its value for educational purposes and repairs as well as industrial demands.

The study achieved excellent accuracy together with high efficiency yet it offers opportunities to better process images and manage errors. AI enhancements combined with hardware acceleration of fault simulation systems will be studied as a future development to improve precision. This system presents a portable solution for IC testing that delivers user-friendly operation along with scalability thus creating opportunities for more advanced work in automated electronic diagnostics practices.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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