

CONCEPTUAL DESIGN OF A UNIFIED CITIZEN IDENTIFICATION SYSTEM IN NIGERIA USING REACT JS AND FIREBASE

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ABSTRACT

Nigeria faces challenges associated with data redundancy as a result of fragmented and outdated identification systems; this emphasizes the necessity for a unified, efficient, and secure solution. This research introduces a unique Citizen Identification System with the aim of improving Nigeria's identity management infrastructure. The proposed system capitalizes on machine learning to deliver user-friendly registration, biometric data integration, secure data storage, and robust access controls. It holds significance for policymakers, technologists, and stakeholders invested in the advancement of identity management within developing nations, offering a dynamic solution for improving governance and public services. The comprehensive evaluation indicates that the Unified Citizen Identification System (UCIS) displays impressive results in scalability, security, and precision, positioning it as a promising solution for addressing Nigeria's citizen identification challenges, prompting the need for further validation through pilot implementations.

Keywords: Unique ID, Centralized Database, Real-time authentication, citizen data, component-based architecture, data security

1.0 INTRODUCTION

A citizen's identity encompasses distinguishing features, such as name, gender, age, and LGA, uniquely associating an individual with a community or nation. Verba (1968) posited that national identity correlates with citizens' belief in belonging to a specific culture, emphasizing the importance of citizens viewing themselves as natives of a given state. Therefore, national identity is deemed a social imperative and entitlement for every citizen.

Efficient identity management is vital for economic growth and societal functioning. Elwell (2009)

highlights its significance, stating that a national identity management system provides swift access to social services and enhances government functions, including budget planning and law enforcement. Notably, it facilitates data interoperability in both public and private institutions, improving overall system efficiency (Ayamba and Ekanem, 2016).

Despite numerous attempts since Nigeria's independence in 1960 to establish effective citizen identification systems, past efforts have proven insufficient. In 2007, the National Identity Management Commission (NIMC) was established, introducing the National Identity Number (NIN) to create a comprehensive identity database. However, challenges persist, with federal agencies maintaining separate databases, leading to data redundancy, inefficiency, and hindering national development.

The aim of this research is to design and develop a unified citizen identification system that can be used to accurately and reliably identify Nigerian citizens, while protecting their privacy and ensuring the security of their personal data.

Objectives of the study

The objectives of the study were to:

- i. identify the current challenges and limitations of existing citizen identification systems in Nigeria.
- ii. carry out in-depth review of relevant literature on citizen identification system and related technologies.
- iii. design and develop a machine learning algorithm capable of accurately identifying citizens based on their biometric and demographic data.
- iv. design a centralized database to store entities with primary key generated using Pseudorandom Number Generator (PRNG) algorithm.
- v. evaluate the performance of the system and also, comparing the results to that of similar citizen identification systems.

2.0 REVIEW OF RELATED LITERATURE

Lykidis *et al.* (2022) assessed the use of blockchain in e-government services. The authors stated that blockchain technology offers several benefits (e.g., improved security, transparency, and immutability) that make it well-suited for use in unified citizen identification systems. The authors also claimed that the decentralized nature of blockchain can help address privacy concerns associated

with centralized identification systems. Nevertheless, the authors also identified numerous challenges accompanying the use of blockchain like technical difficulties, high implementation costs, and the need for a high degree of user adoption.

Oyeniran *et al.* (2019) proposed a centralized database system for identity management that can enhance security control in Nigeria. The authors projected a centralized database system which contains a comprehensive database of citizen information, including biometric data such as fingerprints, photographs, and signatures. The database would be accessible to authorized government agencies and would be protected by a security control system that includes firewalls, intrusion detection systems, and other measures to protect against cyber threats. The authors concluded that the proposed system can improve the security of identity management in Nigeria and can be implemented using existing technologies and infrastructure. They also stressed the need for synergy between governmental bodies and citizens to ensure the acceptance and success of the system.

Muhammad *et al.* (2013) in their article proposed a framework for the application of an e-government interoperability system based on a national identity management system (NIMS). The authors reported that NIMS can play a serious role in refining interoperability across government agencies, reducing data duplication, improving security and efficiency. The proposed framework encompasses the development of a common data format, common data model, common data dictionary, and standard API for data access. The authors also proposed the use of metadata and ontology to facilitate the sharing and reuse of data across government agencies. The framework was tested on a prototype system, and the results showed that it could successfully integrate different e-government systems and provide a seamless user experience for citizens.

Tawiah & Boateng (2019) examined the implementation, adoption, and implications of the National Identity Management System (NIMS) in Ghana for the purpose of e-governance. The study used a mixed-method research design by means of qualitative and quantitative approaches. The data were obtained over a random survey of 242 respondents. The study discovered that the NIMS has the likelihood to improve e-government service delivery, citizen identification and authentication. Nevertheless, the study also revealed several challenges such as the lack of awareness and education on the NIMS, inadequate funding, and political interference.

Olabode *et al.* (2017) in their paper proposed the development and implementation of a national identity card

system in Nigeria. The design of the system involved the use of biometric technology and the creation of a central database for storing citizen data. The implementation of the system was carried out in phases beginning with a pilot project in select states before being rolled out nationwide. The results of the study showed that the implementation of the national identity card system in Nigeria had improved citizen identification and verification, reduced the incidence of identity fraud, and enhanced access to government services

3.0. METHODOLOGY

The research methodology used in this study included a combination of qualitative and quantitative research methods. Qualitative research methods were used to gather in-depth insights into the existing identification systems in Nigeria, identifying their respective strengths, weaknesses, and gaps. This was carried out through a comprehensive and extensive review of existing literatures. On the other hand, quantitative research methods were used to gather data on the population and to analyze the potential impact of a unified citizen identification system on the country's economy and security.

The Proposed Model

The proposed unified citizen identification system aims to establish a comprehensive and standardized citizen identification system that can be used by various government agencies and departments in Nigeria. The system will use modern technology to create a reliable and secure database of citizens' information. This information will include personal details, such as name, date of birth, gender, address. The system will be designed to ensure that citizens' data is accurate, up-to-date, and accessible only to authorized personnel. This will help to prevent identity theft, fraud, and other forms of cybercrime.

The model will likely consist of several components, including:

1. **Database:** The system will require a large and secure database to store citizens' personal information, biometric data, and other relevant details. The database will be accessible to authorized government agencies and will be designed with strong security measures to protect against unauthorized access or data breaches.
2. **Registration Process:** The system will require a robust and efficient registration process to ensure that all citizens are properly enrolled in the system. The registration process will involve collecting citizens' personal information, biometric data, and other relevant details, which will be used to create a unique

identification record for each citizen.

3. Authentication: The system will include a mechanism for authenticating citizens' identities, such as a unique identification number, smart card, or mobile app. This will enable authorized government agencies to quickly and accurately verify citizens' identities for various purposes, such as voting, accessing government services, or applying for loans.
4. Integration: The proposed model will offer an avenue to integrate with existing government databases, such as the National Identity Management Commission (NIMC) and the Independent National Electoral Commission (INEC), to ensure that citizens' information is accurate and up-to-date.

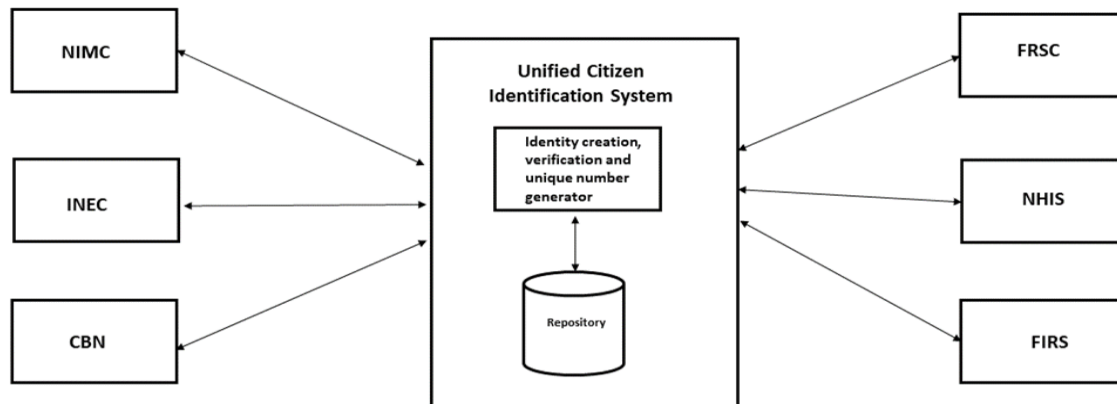


Fig. 1.0 Annotated Diagram for the Proposed Model

The above annotated diagram illustrates the architecture of the proposed system. The UCIS is designed with the aim of facilitating data sharing within 6 government agencies (NIMC, INEC, CBN, FIRS, FRSC and NHIS).

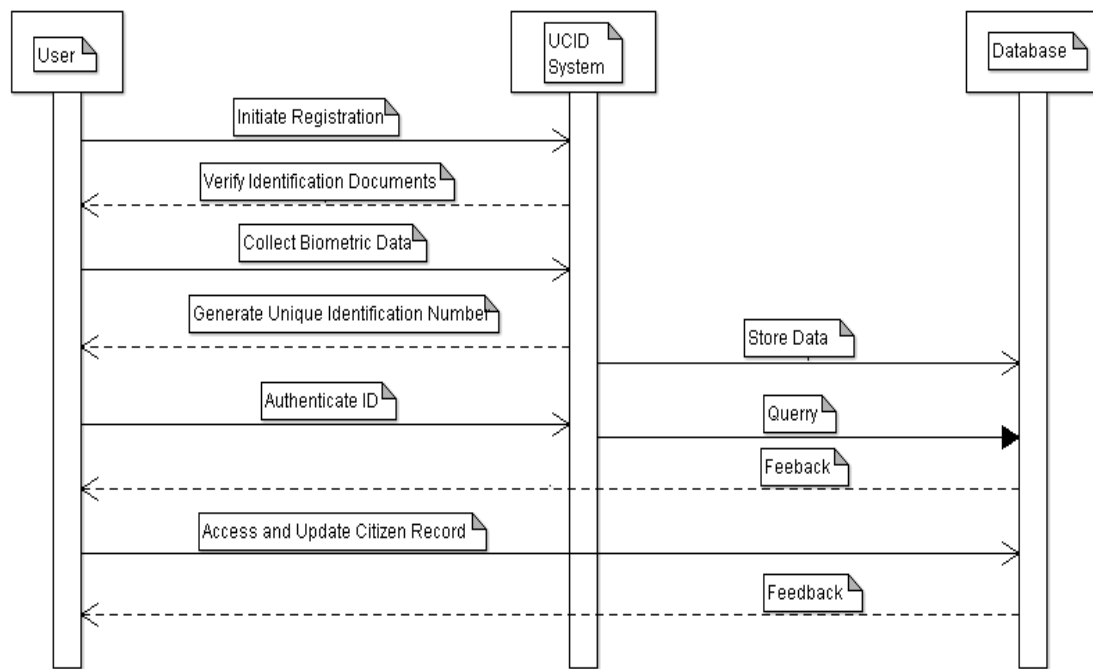


Fig. 2.0 Sequence Diagram of the Proposed Model

The sequence diagram provided above serves as an illustrative representation which depicts the dynamic behavior inherent in the conceptualized system, placing a particular emphasis on the intricacies of run-time interactions between the user and the system components.

4.0. IMPLEMENTATION

The proposed system was implemented using React JS and Firebase Realtime Database. React and Firebase were chosen for designing the system due to React's efficient component-based architecture, enabling modular development and seamless user interface updates, while Firebase's real-time database and authentication features provided a scalable and secure backend solution for managing and verifying citizen data in real-time.

This integrated approach was utilized to facilitate the development of a modern, secure, and user-friendly

system for managing citizen identification. React JS was used to implement the user interface components, such as login forms and user profile pages while Firebase was used for the purpose of data storage and authentication.

The Unified Citizen Identification System was designed and hosted remotely. From the homepage, the user is given the opportunity to log into the API of any of the 6 aforementioned government agencies (NIMC, INEC, CBN, FIRS, FRSC and NHIS).

The NIMC portal is considered to be the primary portal as it's the only portal assigned the primary function of creating/registering a new user (citizen). Other portals can only create or update records that pertains to them. For example, In the CBN portal, only financial records of a citizen could be created or updated.

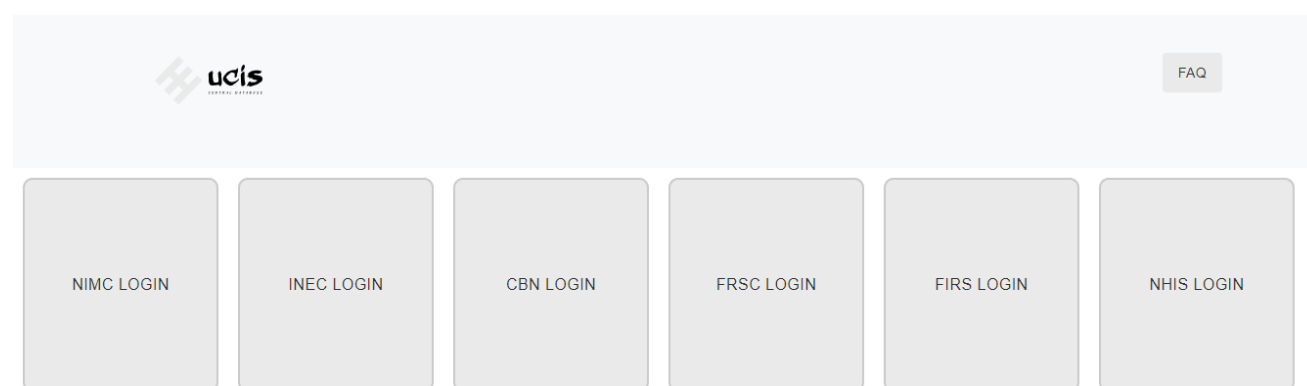


Fig. 3.0 UCIS Homepage

The Unified Citizen Identification System was hosted remotely and could be accessed with any internet enabled device (mobile phone or PC) using the address: <https://ucis-1f265.web.app>. From the homepage, the user is given the opportunity to log into the API of any of the 6 aforementioned government agencies (NIMC, INEC, CBN, FIRS, FRSC and NHIS).

Source of Test Data

The experimental test data was methodically sourced from a prominent online platform known as “Kaggle” which serves as an invaluable resource, housing an expansive and multifaceted repository of diverse test data

types. These include, structured datasets presented in tabular form, a rich collection of photographic content encompassing both authentic imagery and AI-generated visuals, and datasets containing names and personal identifiers. Kaggle's comprehensive and varied collection plays an essential role in enriching the experimentation process by offering a wide spectrum of data for evaluation and analysis.

Experimental Setup

The proposed model was tested with over 500 artificial users generated using the dataset obtained from Kaggle. Employing artificial citizen IDs enabled controlled testing environment which allowed us to systematically assess the system's performance under various scenarios and conditions. This approach facilitates the emulation of diverse user profiles and usage patterns, ensuring comprehensive coverage of potential real-world scenarios. Additionally, the use of artificial IDs mitigated privacy concerns associated with using actual citizen data during the testing phase, aligning with ethical considerations and legal requirements.

The UCIS portal was executed using Google Chrome which runs on a Microsoft Windows 10 64bits operating system. The hardware used for this experiment was a HP computer with Intel core(R) processor, 4 GB RAM, and a 1 TB hard disk. The combination of these elements ensures a robust, reliable, and efficient experimental environment, facilitating comprehensive testing and evaluation of the UCIS model.

A functional test was performed in a bid to evaluate the system's functionality by carrying out tests to ensure it meets its intended objectives. various use cases and functions including user registration, data retrieval, updates, and verification were tested.

Results

Firstly, the Unified Citizen Identification System (UCIS) successfully passed a functionality test by demonstrating its ability to seamlessly and accurately perform its core functions. During the test, the system exhibited the following key attributes:

1. **Data Integration:** The system was able to integrate data from the various government agencies and sources, making sure that citizen information is up-to-date and well collated.

2. **User Authentication:** The UCIS reliably authenticated the administrators of the different portals through the implementation of a unique log in details assigned to each admin. This helps to checkmate the possibility of unauthorized access.
3. **Data Retrieval:** The system efficiently retrieved citizen information, enabling authorized users to access the required data in real-time. This was achieved with the aid of the unique ID generated and assigned to every registered citizen.
4. **Data Accuracy:** The system consistently upheld an exceptionally high standard of data accuracy, diligently mitigating the occurrence of errors and discrepancies within citizen records, thereby ensuring the utmost precision and reliability in the maintenance of these crucial data repositories.
5. **Scalability:** The system convincingly showcased its capacity to seamlessly manage a substantial influx of requests and a concurrent registration of high volume of users (over 500) without any discernible degradation in its performance therefore, affirming its robust scalability and resilience under heavy workloads.

The system showed compelling results across various dimensions. The system's architecture exhibits a modular and scalable framework that seamlessly integrates with existing databases, ensuring adaptability to evolving technological landscapes. The incorporation of the machine learning algorithm demonstrates high precision and reliability in citizen identification. Impressive results from the scalability assessments confirm the UCIS's capability to handle the nation's growing population, while robust security measures like data encryption and access controls confirms the system's resilience against potential cyber threats. Positive feedback from usability testing underscores the user-friendly design, enhancing public acceptance. Overall, the results affirm the UCIS as a promising solution, warranting further validation through pilot implementations for real-world efficacy in addressing Nigeria's citizen identification challenges.

5.0. CONTRIBUTION

The integration of React JS and Firebase in the development of a unified citizen identification system represents a substantial contribution to knowledge in the field of public administration. This innovative approach deals with the critical challenges associated with citizen identification and data management. The noteworthy

contributions of this research include:

1. **Real-Time Data Management:** This system's ability to provide real-time updates for citizen data is a significant contribution. It ensures that citizen information is always current and accurate, thereby enhancing the efficiency and reliability of government services. This real-time feature can be adapted for various public administration applications beyond citizen identification, such as emergency response systems and government dashboards.
2. **Scalable Government Solutions:** The scalability of Firebase in combination with React JS is an important contribution to the development of government systems. It provides a model for building scalable, citizen-centric solutions that can grow with the population's needs. This is essential in an era of expanding urbanization and increasing government responsibilities.
3. **Security and Privacy Assurance:** The secure authentication mechanisms offered by Firebase ensure the protection of sensitive citizen data, contributing to maintaining the trust and confidence of citizens in government systems. This is particularly relevant in a world where data privacy and security concerns are paramount.
4. **Serverless Government:** The serverless architecture of Firebase reduces the complexity and costs of maintaining server infrastructure. This contribution can lead to more efficient government operations, freeing resources for other essential public services and reducing the administrative burden associated with traditional server management.
5. **Cost-Effective Government IT:** The pay-as-you-go pricing model of Firebase introduces a cost-effective approach to government IT projects. This can serve as a model for fiscally responsible government initiatives and projects, ensuring taxpayer funds are spent efficiently.
6. **Efficient Public Service Delivery:** By expediting development cycles, React JS and Firebase contribute to timelier implementation of government systems. This accelerates the delivery of public services, reducing bureaucratic delays and improving the overall efficiency of government operations.

In a nutshell, this approach addresses fundamental issues related to data management, scalability, security, and cost-effectiveness in government operations. It sets a precedent for more efficient, secure, and citizen-centric public service delivery, ultimately enhancing the knowledge and capabilities of the government sector in

serving its citizens.

Recommendation

Further studies should consider the integration of advanced biometric features, particularly fingerprint and iris recognition. This could further improve on seamless integration, robust matching algorithms, and user experience. Additionally, ethical and legal considerations surrounding biometric data use should be carefully explored to ensure compliance with privacy regulations and ethical guidelines.

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