

Design and Implementation of a Secured Census Information Management System

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Abstract

Census in most countries has been faced with various natural and human made barriers. Thus, the aim of this research is to develop a systematic, coordinated, and responsive database which will adequately interact with a web application by harnessing the strengths of computational science and biometrics. The programming language employed in the development of this web-based application was the C#.NET programming language. Microsoft Visual Studio was used as an integrated environment for the development of this tool. Microsoft SQL Server (2005) served as a relational database management application for handling the data used in this research. From the results obtained from this research work, it had shown that with design and implementation of a secured system information countries can make informed decisions for effective policy, planning and management of their ever-increasing populace and economy.

Keyword: *Census, Census information management, programming, biometrics*

1. Introduction

Census refers to the process of retrieving, compiling and publishing demographic, economic and social data pertaining to all persons in a country or territory at a specified time. Conducting a census, however, is not without its own problems. It has become a very sensitive and challenging issue, especially in Nigeria. The data accumulated from several censuses makes it easier to evaluate the past, accurately describe the present, and also assess the future. Thus, it is obvious that accumulation of accurate information which stems from census taken over a certain area is necessary for policy making, development planning, information resource and political purposes as well. According to the 1962 report on Census conducted in Nigeria, there was disputation in the authenticity of the census figures computed [1]. Another study critically examined the controversy surrounding the recently concluded population census in Nigeria which came up in 2006; the paper argued that the 2006 population census was no way different from the past falsified ones in Nigeria [2].

It is evident that the methods used for the conduct of such past census programs proved not only to be inefficient, but also inaccurate in terms of data collation, management and storage. Furthermore, such approach must have been characterized by mismanagement of census information, insecure census figures and redundancy in registered persons.

The aim of this research thus makes it imperative to develop a systematic, coordinated, and responsive database which will adequately interact with a web application by harnessing the strengths of computational science and bioinformatics. This aim will be achieved through the following objectives; to effectively collate, store and manage census data about a particular area; to have a functional database for population information that ensures information integrity, accuracy, and eliminates redundancy; to ensure a stress free counting with more accurate, organized, secure and digitally inclined census procedures; to have a functional web application that automates census procedures; and to store biometric information (specifically fingerprint information) of each person counted and registered, to eliminate and stifle violation of personal data integrity and fraudulent activities. This will complement the effort of the Nigerian government to make informed decisions for policy and planning, to assess the positive impact of these decisions on the populace and economy at large. It will also act as motivation to other African countries.

2. Review of relevant literatures

Several approaches have been applied toward solving census related challenges. A computational and statistical approach was recently applied to leverage any possible errors associated with census data, this method used a demographic approach to fine tune census figures, to obtain a more statistically sound and viable estimate [3]. A recent research demonstrated the feasibility of fingerprint-based individual identification for population-based research in developing countries, as applied to health and health related facility data [4]. Another work discussed the putting of census information on the web for access, by applying the internet as an information dissemination tool [5]. An online internet based application for census counting was presented in another work [6]. Biometrics has been applied and integrated into information systems in some studies [7]. Another study reinforced the need for an efficient land use planning, and represented the first approach integrating satellite imagery with population census data for studying the human environment in the Caribbean [8]. The processes put in place to provide an internet option to the Australian public at the 2006 Census, was briefly outlined in another work [9]. Another work described Canada's first attempt to making census questionnaires available online, this system employs the use of internet as an alternative to the paper mailing method of the census questionnaires [10]. However, most of these approaches did not incorporate biometrics into their various applications as a support for conducting proper census program.

3. Materials and Methods

3.1 Data collection.

Data was collated by conducting discrete census activity with some selected categories of people within some selected regions of the Sango Ota environment, Ogun State Nigeria. Sango Ota is located in Ado-Odo Local government of Ogun State. We tested our system with few data for a start. About 25-50 individuals were counted with our application and the results were promising. These different individuals were registered based on the bio-metric based application in order to guarantee security and a safer census activity.

3.2 System architecture

The tier structure for this system is the 2-tier structure. That means, the three code layers exist on two servers, the Presentation server and the Database server. Since this is a large scale distributed web application, the tiers are bounded by firewalls.

P: Presentation

D: Database

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- Tier 1 - Presentation tier (PT), it interacts closely with the user.
- Tier 2 - Application tier (AT), it holds the business logic and the data access logic.
- Tier 3 - Database tier (DT), houses database or data source. **Data layer:** This is the most critical aspect of the application; it is where the user data, operational data and meta data are stored for easy access and retrieval. All database logic and entity relationships will be defined here. It consists of Database servers. A database implies a persistent and integrated storage allowing concurrent access to it by many users. It is a collection of records related by referential integrity. Thus, a database is an organized collection of structured data, to serve many applications with minimum redundancy.

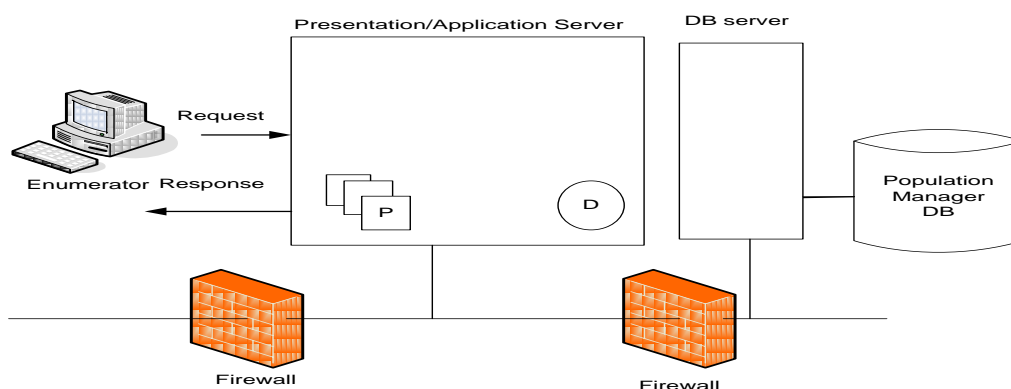


Figure1. Two-tier architecture of the census based information management system.

3.3 System Design and modeling

System design is the creative process of transforming a real-life problem into a solution. This is done through the description of the structure of the software to be implemented, data which is part of the system and the interfaces between system components. For this system, the structure will be represented through its logical design. The logical design specifies the methods of interaction in of system components like the input and outputs, menu structures,

procedures, controls and functions and command structures. For this census information management system, it comprises of four (3) essential modules, namely: the enumerator module, the system administration module and the census registration module.

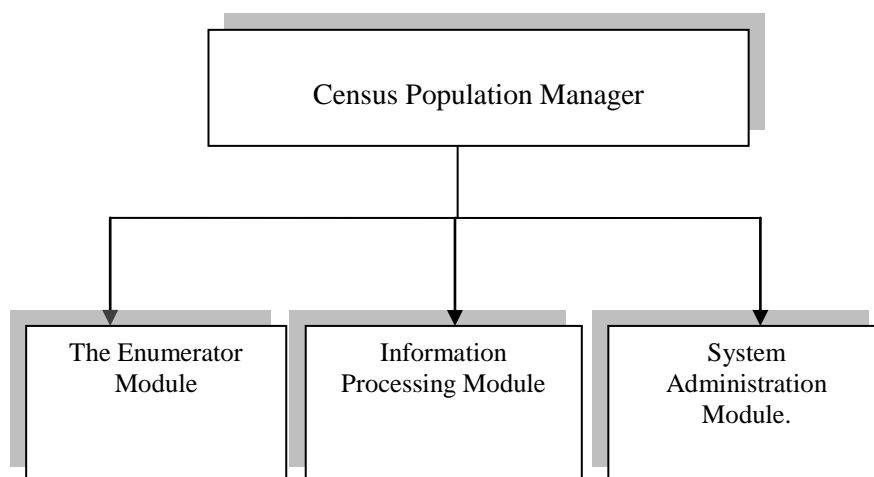


Figure 2. Logical design of the census information system.

System modeling involves the evaluation of system components in relationship with one another to determine their requirements and how to satisfy them. Some system modeling tools will be employed during the course of this project that will support development tasks, from analysis to design, then to implementation. This will be represented with the use of the sequence diagram for the census information system.

The sequence diagram is a type of UML diagram that models the logic flow within a system in a visual manner, which enables documentation and logic validation. It is mostly used for analysis and design. The next figure shows the sequence diagram of the three actors in the system, their interaction with the interface and their interaction with the database.

3.4 Implementation

The tools and programming language employed in the development of this web-based application was chosen based on their suitability towards solving the problem at hand. The programming language that seemed appropriate was the C# programming language on the .NET platform. The choice of C# was chosen based on its flexibility, effectiveness and the ease of easily integrating biometrics modules and functionality into the web-based application developed with it.

Microsoft Visual Studio was also used as the development tool because of its simplicity, ease of use, and its vast robust functions. It was easy to integrate it with Microsoft SQL Server. Microsoft SQL Server (2005) is a relational database management application that handles robust and complex data rather effectively. It also allows easy integration with visual studio's interfaces, making it even more appropriate for the application at hand.

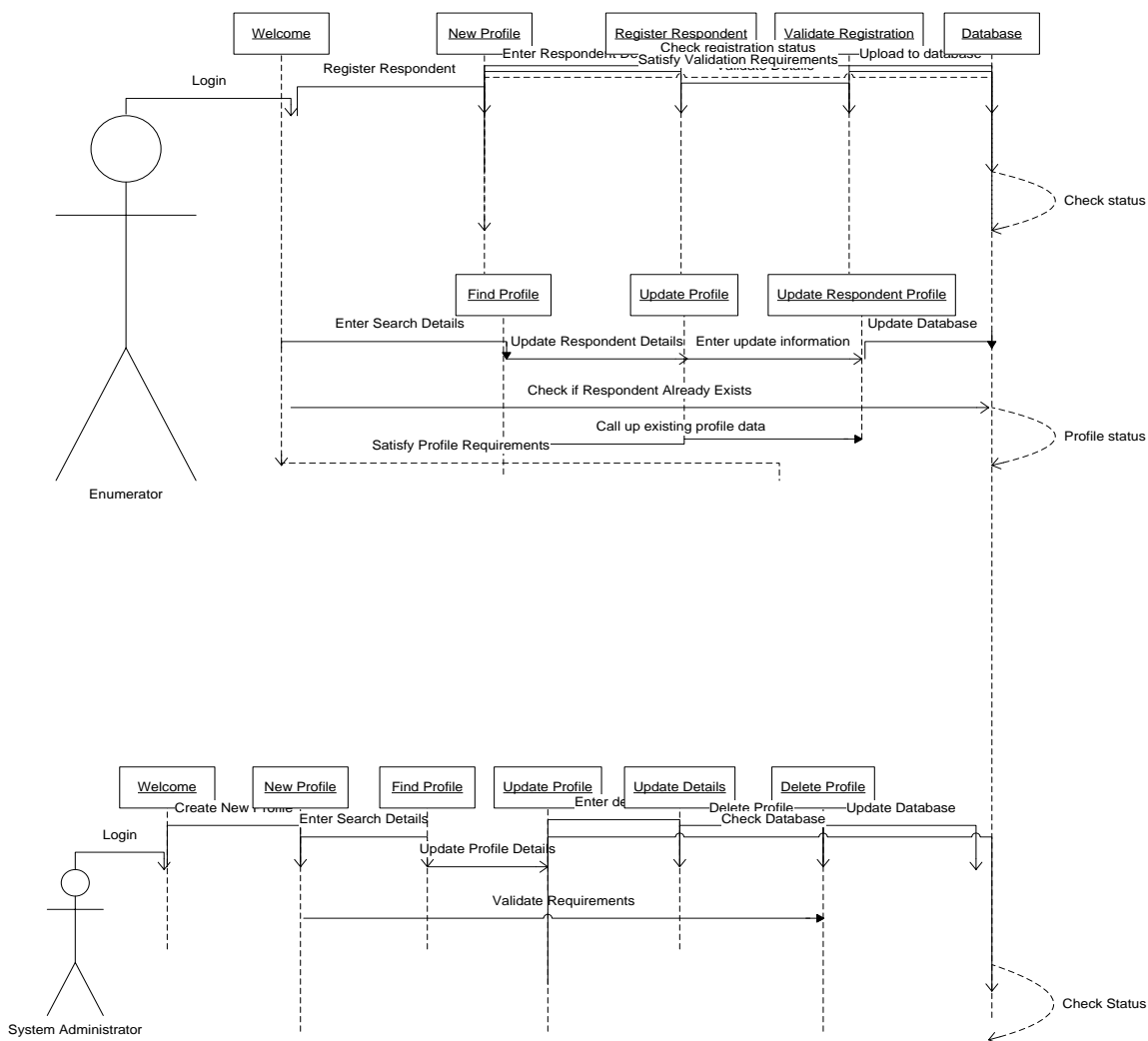


Figure3. Sequence diagram of the census information system

3.5 Explanation on the Sequence diagram of the census information system

The enumerator logs into the system and has the capability to register a respondent. The profile of the respondent can be checked whether it exists in the system. If the profile of the respondent exists, such profile can be updated by the enumerator within the system. In such cases, the database becomes updated. If the profile of the respondent does not exist within the database of the census information system, the enumerator registers the respondent, validates the profile and stores inside the database of the census information system.

The Administrator on the other hand, logs into the system and updates registered respondent profiles, validates and also performs consistency check on the database of the census information management system.

4. Results & Discussion

A web-based census management information system helps to ensure the conduct of a good and credible census program.

There are two (2) primary modules contained in this system. The integration and systematic combination is what makes the entirety of the system. The modules are as follows:

1. Administrator Module
2. Enumerator Module

4.1 Enumerator Module

This is the Login page through which the enumerator specifies a valid National Identification number and password for him/her to be granted access into the system. The enumerators' access is denied until he enters a valid ID number and password. Figure 4 shows this.

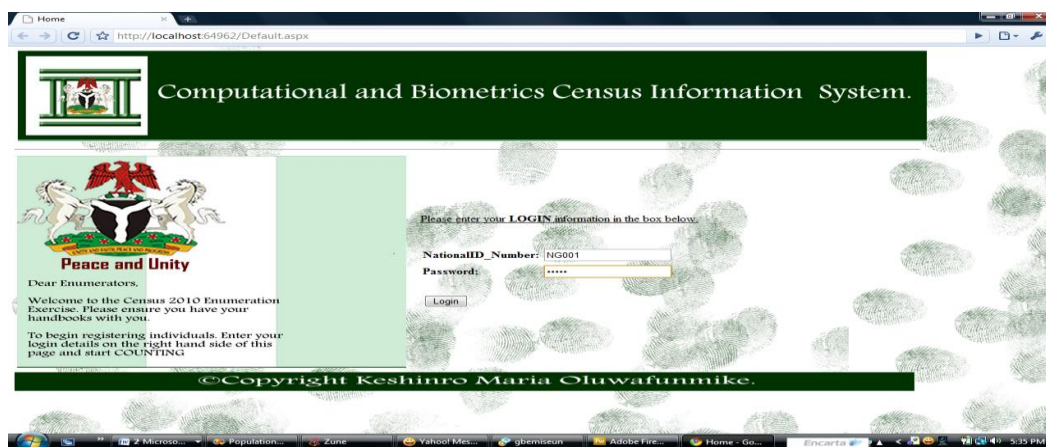


Figure 4.1 Enumerator Login page.

4.2 Enumerator Welcome Page

After the enumerator has entered a valid National ID Number and Password, and it has been authenticated. He/she is allowed access into the system. Where there is a choice of functionalities. He can either choose to register an individual, view and individual's records, delete an individual, or edit individual details. Depending on the selected, the corresponding page is executed. Figure4.2 depicts this.

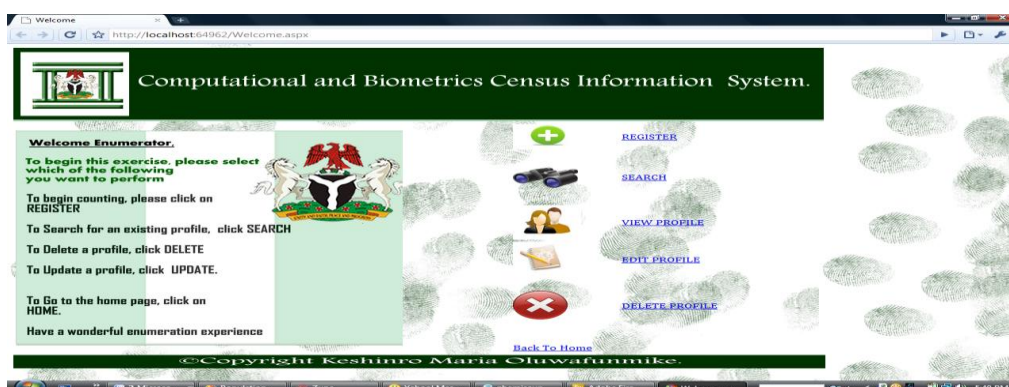


Fig 4.2 Welcome Page after Enumerator Login

4.3 Registering Individuals

After clicking on the register icon, the system navigates to a form where the enumerator is required to fill in certain information about the respondent as pre-requisite to registration. The individuals are grouped into categories which the enumerator is required to select one between Infant, Minor, Adult or Senior category.

But before proceeding to these categories, this system checks if the user about to be registered already exists in the database by starting up the fingerprint application for fingerprint verification (Figure 4.4). Below is an image of fingerprint verification before proceeding to the registration. If an individual has already been registered, the enumerator is not granted access to the categories page.

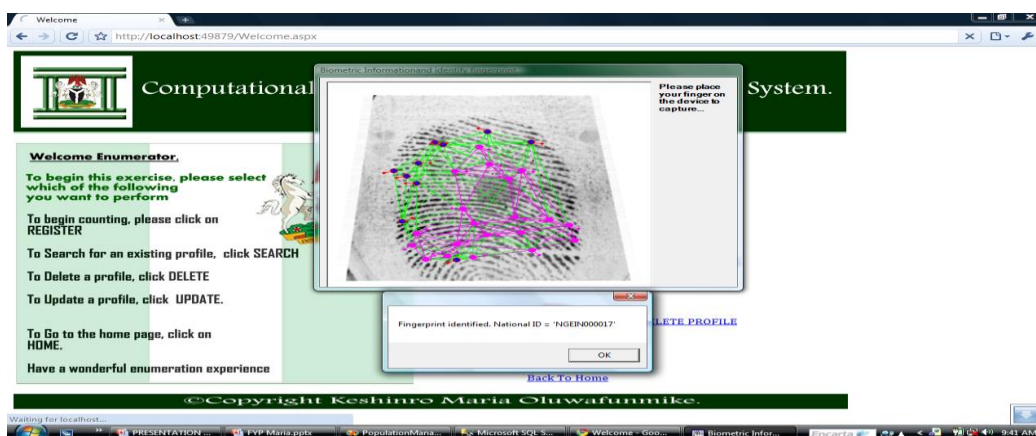


Fig 4.4 Fingerprint verification before proceeding to category select

The image shown in Figure 4.4 is a representation of an already existing fingerprint, as seen above, the identification number was identified, and under this circumstance, the system will not proceed to the categories page, else, it will proceed to category page as shown below in Figure 4.5.

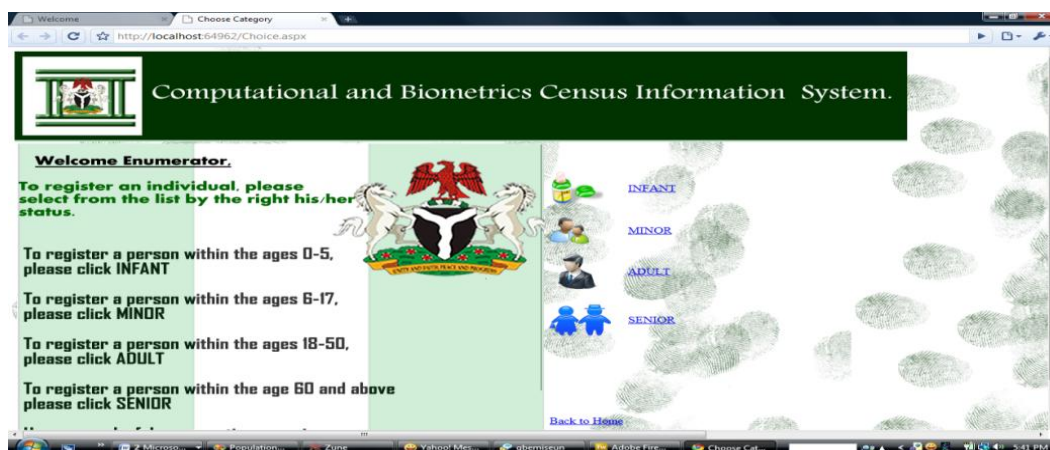


Fig 4.5 Screen shot of category selection during registration.

4.4 Post-Select Category

After a category has been selected, for instance the adult category, the new category becomes displayed as shown in Figure 4.6. In the adult category above, there is a constraint that accepts only ages between 18 to 59 years of age. Any violation will trigger a prompt requesting for the appropriate age range.

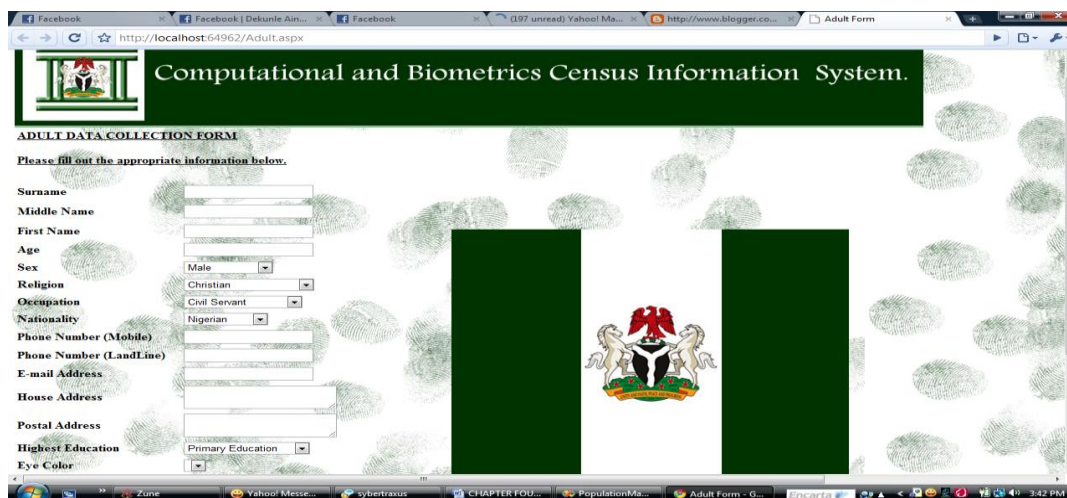


Fig 4.6 Screen shot of ADULT category selection during registration.

4.5 Biometric Information Page

After input and upload of post-category related information upon clicking of the save button, when the next button is clicked, the system navigates to the biometric information page. Here the enumerator is required to enter biometric information of the individual. That is, a passport picture, and the fingerprint scan of the individual.

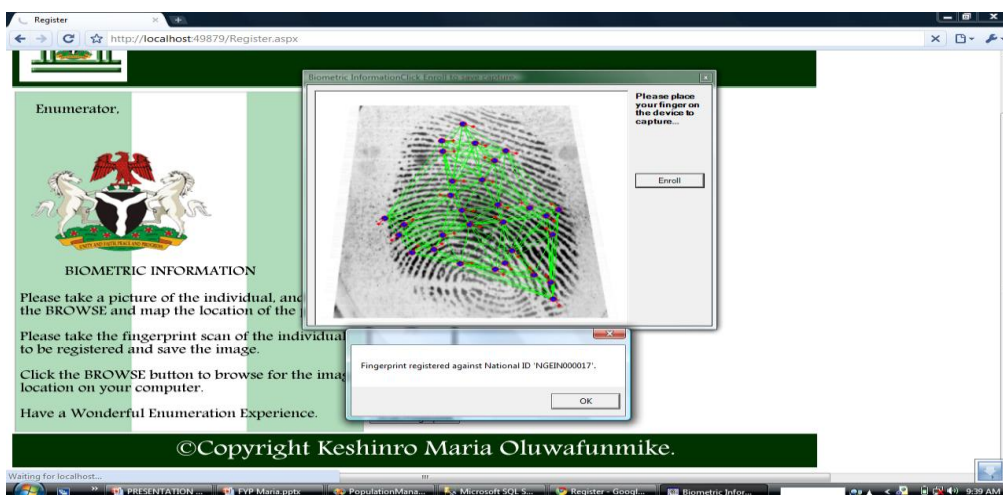


Fig 4.7 Screen shot of biometric information input during registration.

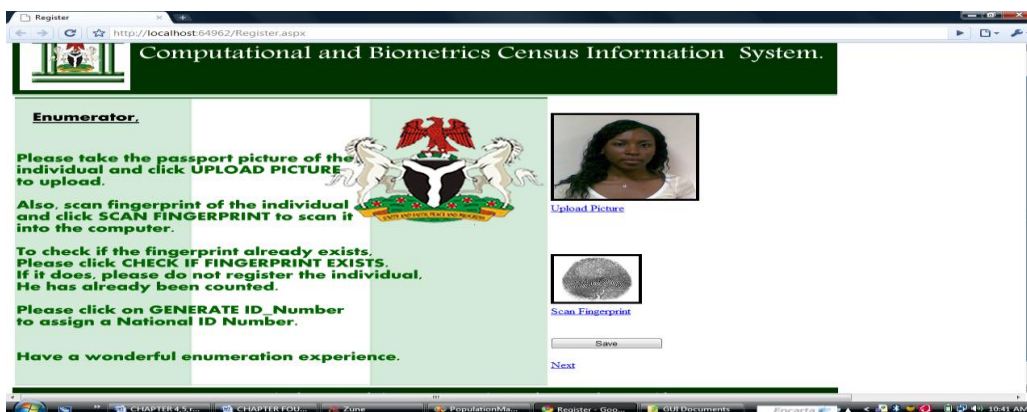


Figure 4.8 Screen shot of the passport identification information input during registration

This represents the registration of the fingerprint of individuals, otherwise known as the registration of biometric information of the individuals. Upon registration, verification is possible as we can now compare an inputted fingerprint data scan with an already existing fingerprint data scanned image. The Fingerprint machine used for this project/ Microsoft Fingerprint Scanner is shown in Figure 4.9a.

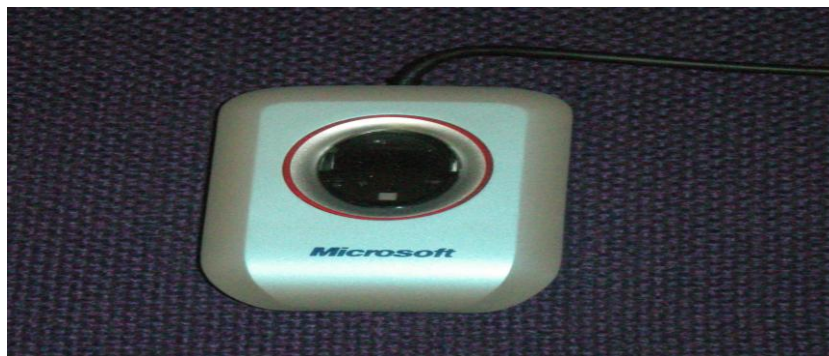


Fig 4.9a the Microsoft Scanning device used in this research work.

4.6 Admin Login Page

This is the Login page through which the enumerator specifies a valid National Identification number and password for him/her to be granted access into the system. The enumerators' access is denied until he enters a valid ID number and password.

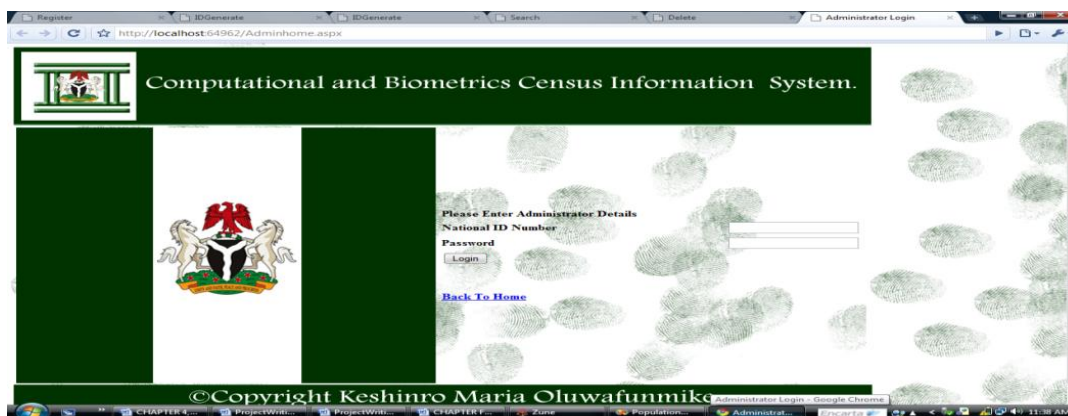


Figure 4.9.b

5. Conclusion

It is our believe that with the adoption of this system prototype and its implementation on a large scale, a guaranteed safe, secured and reliable data for successful implementation of national and economic polices will be realized.

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