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Design of DNA Based Biometric Security System for Examination Conduct

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Authors' contributions

This work was carried out in collaboration between both authors. Author AOA designed the study, wrote the protocol and supervised the work. Author OMA carried out all laboratories work and performed the statistical analysis. Both authors managed the analyses of the study and managed the literature searches and edited the manuscript. Both authors read and approved the final manuscript.

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Abstract

Biometrics is a technique of using characteristics and behavioral traits for identification of people this is more effective that common personal identification number(PIN) for an improved security technique. The basic procedure in a biometric system is the collection of biometric data through a sensor elements, the module extracted bares biometric data which is compared to its templates in a database to identify the data subject. In this work, the design of DNA (Deoxyribonucleic acid) based biometric was carried out for securing a system for Examination Conduct. DNA samples are to be collected from would be candidates through Electrophoresis platforms, it covers slab-gels to capillary electrophoresis (CE), and this is done by the use of a cross-linked polymer solution to separate the DNA molecules, After this procedure data collection by the Capillary Electrophoresis is done by where the alleles are analyzed using software that accompanies the Capillary Electrophoresis machine. With the time duration of about four hours the collection of data, with DNA extraction in the initial, then acquisition of data from 16 STRs with the sex determination locus. The DNA profiling shows the value of VNTR (variable number tandem repeat) which repeats at a number of distinctive loci the templates are encrypted using algorithmic transformation of biometric samples. Then the STR (Short Tandem Repeats) value is found by which is

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generated number with several tens of digits, and this results in a personal identification information that is unique which will be used for statistical and theoretical analysis for final recognition and authentication of the personality concerned.

Keywords: DNA- deoxyribonucleic acid; biometrics; identity; short tandem repeats; personnal identification information.

1 Introduction

Biometrics is the Science and Technology of measuring and statistically analysing biological data. The present development technology has made life easier by discovery of better techniques to curtail thefts of private personal data and information. DNA biometrics is one of the recent biometric technology that is used in security systems. The characteristics cannot be faked because each person's DNA is unique to the person. Each person's DNA contains personal trait from parents [1]. Which shows the amount of VNTR (variable number tandem repeat) which repeats at a number of distinctive loci in the body? These amounts of Variable number tandem repeat make up an individual's DNA profile. DNA biometrics technology is highly unique and the chance of two individuals having the exact same DNA profile is extremely impossible. This paper addresses two questions: First, tracing the personally identifying information obtained to a particular DNA sequences in the human genome? Secondly, how do we generate a person's identity from DNA-based information? The objective of the study is to provide an overview of recent technology developments in the field of biometric security, with particular emphasis on how the use of DNA based biometrics system impacts on the lives of individuals and cyber security. Also to develop a DNA based biometric system that will be used for identification of an individual. In order to reduce the rate of inaccuracy that renders existing technologies unsuitable for a universal ID system.

2 Methodology

To develop a reliable and effective DNA based biometric identification system, the following process must be ensured:

1. Blood samples from five individuals will be collected.
2. The blood collected will be air dried or be pressed against a treated collection card in order to transfer epithelial cells for storage purpose.
3. Short Tandem Repeat (STR) polymorphisms will be amplified by the Polymerase Chain Reaction (PCR) and the length of products will be measured precisely.
4. Short Tandem Repeat (STR) alleles will be measured at each locus.
5. A compile able and executable code written in Arduino.CC programming language will be written to make the system developed work and function appropriately.
6. The code written will be implemented into hardware component by the use of integrated circuit (IC).

2.1 DNA based biometric system

The biometric authentication technologies, such as fingerprint, face recognition and iris scanning, are becoming prominent in the study of biometric techniques. However, these methods are based on the measurement of similarity of feature-points and this has been a demerit of a kind. This brings an element of inaccuracy which affects the existing technologies making it unsuitable for a global identity system. With this background, deoxyribonucleic acid (DNA) personal identification system provides one of the most reliable personal identification paradigm. It is basically digital, and suffers no alteration during a lifetime of any human before or after death. Therefore DNA based biometric system can be referred to as a biometric system that can be used to recognise and identify an individual based on the already collected DNA sample of the individual.

The prominent biometrics that have been studied and implemented are fingerprint, face, iris, retina, and the patterns of vein, voice, signature and hand geometry 1999 [2,3]. Furthermore, these technologies are based on the measurement of intrinsic features of similarity. This phenomenon allows some element of inaccuracy that makes the existing technologies unreliable for a global identification system. DNA polymorphism information, provides better reliable personal identification results. Therefore, DNA identification data is being used in the forensic sciences. On the other side, one of the challenges in using DNA is the time taken for the extraction of nucleic acid and the evaluation of STR or SNP data. Also, there are several other issues such as the high cost of analysis,like monozygotic twins, and ethical concerns.

The digital nature of DNA information provides the exactness in identification by using multiple STRs (short tandem repeats). This scheme enables the development of novel application of DNA-based person identifiers (DNA personal IDs). Short tandem repeats (STRs) in the DNA base sequence are a promising informational source for personal identification.

2.2 Analysis and design

Human body make up is about 60 trillion cells. DNA, is considered as primary identity for the framework of the human body, is contained in the nucleus of each cell. DNA is a polymer, comprises of nucleotide units that has three divisions: a sugar, a base, and a phosphate. The bases are adenine, guanine, cytosine and thymine, shortened as A, G, C and T, respectively. These four letters stands for content of information in each nucleotide unit; variations in the nucleotide sequence is the factor that responsible for biological diversity, not only among human beings but among all living creatures. Also, phosphate and sugar parts form the backbone structure of the DNA molecule. In a cell, DNA exists in form of double-stranded form, where two antiparallel strands spiral is around each other in a double helix.

2.3 Design architecture

Design Architecture frame work shows the sequential flow of series of procedure to take in detecting and authenticating the identity of a particular DNA.

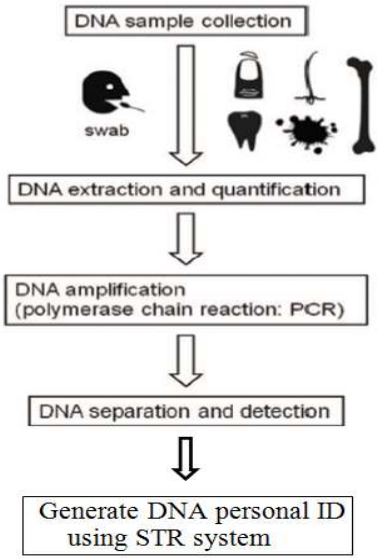

Fig. 1. Design architecture framework

2.3.1 DNA sample collection

To obtain DNA a variety of biological sources can be the source of the sample like body fluid, nail, hair and used razors [4]. For biometric applications, a buccal swab is the most simple, convenient and painless sample collection method [5].

2.3.2 DNA extraction and quantification

There are many methods available for extracting DNA [6] Several factors determine the choice of collection, among these are the number of cost, samples, and speed. When large quantities of fresh cells are used then it is possible to extract DNA in a short time. In forensic cases, DNA quantization is an important step [7] However, this step can be avoided in biometrics as a result of a relatively large quantity of DNA can be recovered from fresh buccal samples taken.

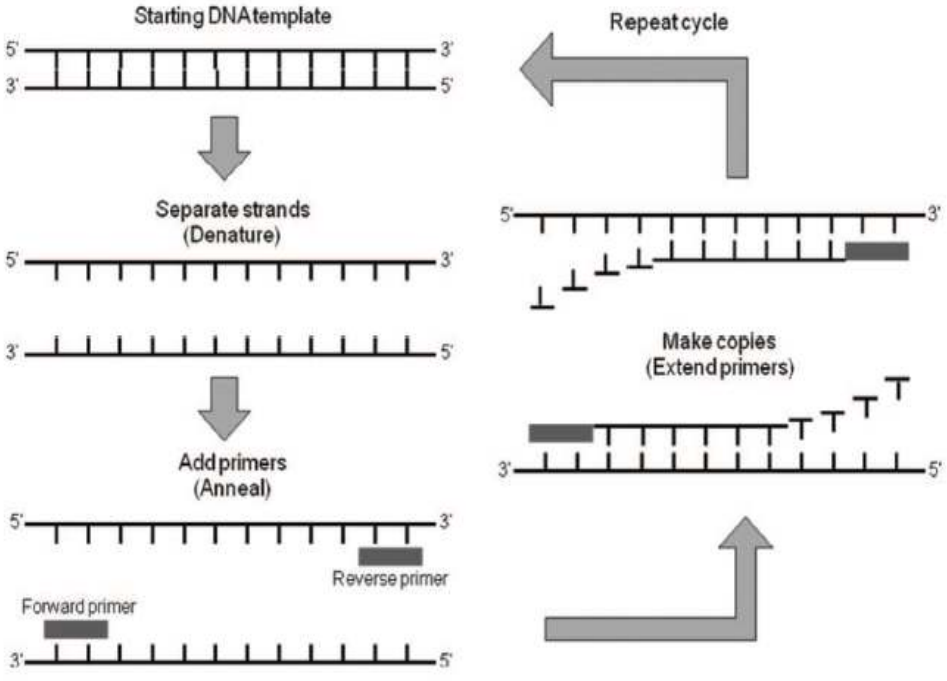

Fig. 2. DNA amplification with polymerase chain reaction (PCR)

2.4 Circuit design

Components Used and their functions

1. **Voltage regulator:** For regulating 12v battery to 5v for ATMEGA328P microcontroller.
2. **ATMEGA328P microcontroller:** the code written in Arduino.CC language is stored in the ATMEGA328P microcontroller. It has 28 pins consisting of 14 digital pins and 6 analog pins; pins 7 and 8 are connected to the supply power source. Pins 8 and 22 are connected to the ground. Pins 9 and 10 are connected to crystal oscillator to oscillate the transfer speed.
3. **Liquid Crystal Display (LCD):** For displaying the name of the designed the system and denying and acceptance to the system is displays on the LCD.

4. **Radio-frequency identification** (**RFID**) **module:** It is used for accessing the DNA-ID by the Radio-frequency identification (RFID) card.
5. **Buzzer:** For alarming
6. **Light Emitting Diode (LED):** It is used as indicator.
7. **Jumper wire:** For connection.
8. **Power source (two 9volts battery):** For supplying power into the circuit.
9. **Switch:** for chosen between on and off.

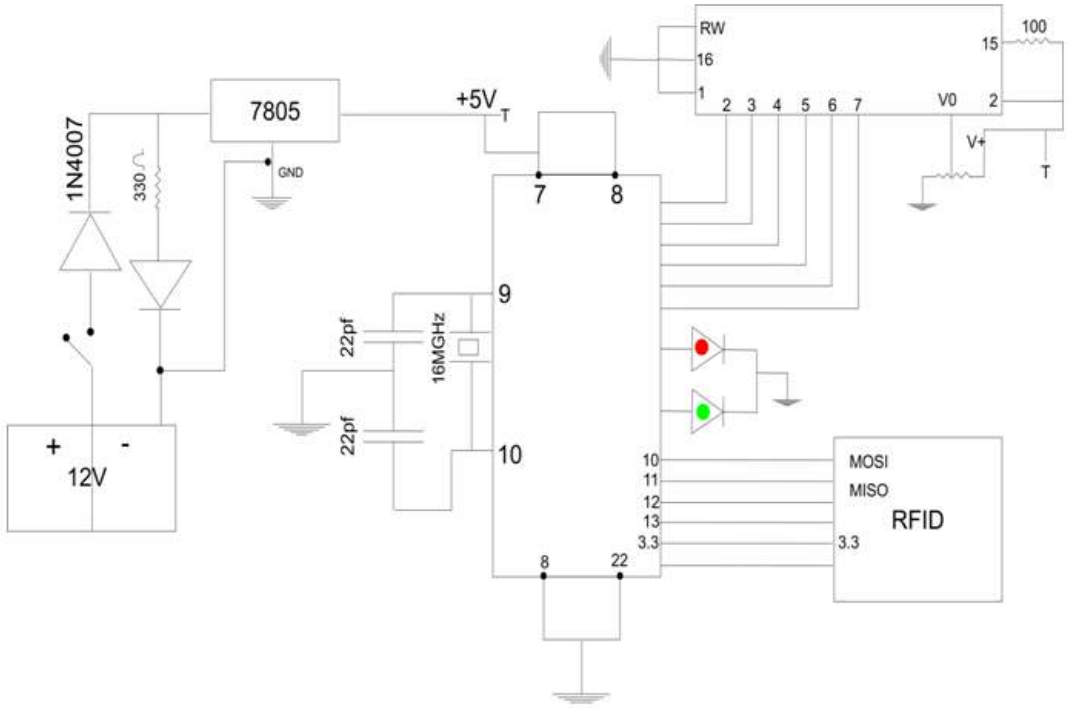

Fig. 3. Circuit of the developed system

2.5 Radio-frequency identification (RFID)

The personal DNA-ID() of the individuals generated are encrypted in different RFID cards. (RFID) Radio-frequency identification is the wireless technology for electromagnetic fields to transfer data, it is used for identifying and tracking tags attached to objects. These are used by electromagnetic induction from magnetic fields produced near the reader [8].

3 How the Sytem Works

The framework of the system is shown on Fig. 4 it depicts the full components involve in the activities of the whole system. The complete process for STR typing includes sample collection, DNA extraction, DNA quantitation, PCR amplification of multiple STR loci, STR allele separation and sizing, STR typing and profile interpretation, and a report of the statistical significance of a match (if observed). In many casework situations, such as sexual assault evidence, DNA mixtures may result from a combination of the victim and perpetrator's bodily fluids and create a complex and challenging result to interpret [9,10].

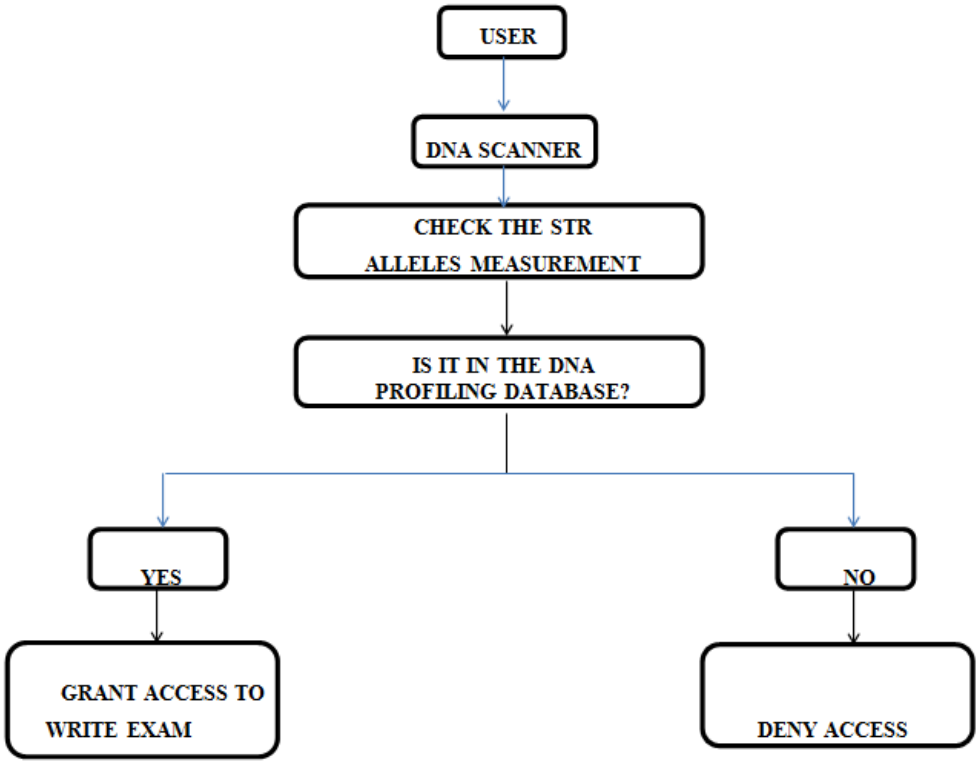

Fig. 4. Framework of the system

4 Conclusion

The phenomenon of biometric authentication technologies has witnessed a steady progress globally of recent particularly as result of security challenges that has become a wave of experience in nations of the earth [11]. Several methods of verification are based on matching patterns or feature-point comparisons within the context of various types of biometric information source, the DNA-Identity is considered most reliable method for personal identification. DNA information is intrinsically and basically digital, it bears no alteration in life and after life [12]. The distinguishing effect of the data can be improved upon by increasing STR loci numbers. The DNA-ID could be encrypted via the one-way function (SHA-1) to protect privacy and to reduce data length. Hence this technique being new has a lot of advantages to offer particularly in forensic security analysis and investigations.

Competing Interests

Authors have declared that no competing interests exist.

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