ADOPTING GENETIC ALGORITHM AS A SMART OPTION IN DEVELOPING AN INTELLIGENT DATA LOGGER FOR SETTLING CASH DISPENSE ALTERCATION

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ABSTRACT

The customers of Nigerian banks are regularly faced with the issue of delay in reversing debited funds when dispense errors occur. These customers in some cases wait for days, weeks and months to get their reversal and sometimes they are never reversed. 24 hours auto reverse of debited funds only occurs in one out of hundreds of transactions made by customers which makes the existing system unreliable and inefficient. In order to improve the present system and get rid of the manual method of filling out the dispense dispute form at the banking hall, an intelligent data logger for resolving cash dispense disputes in banking industry using a Genetic Algorithm (GA) was developed. The data for the system was collected through the application of questionnaires and personal interviews of bank staff and customers. The GA optimization methodology was applied for automating the reversing of debited funds with an online user interface that speedily resolves the issue of debited funds in microseconds. The automated platform developed was tested on a real-life application of cash transaction and optimized result achieved. The achieved results were validated using Genetic Algorithm's fitness function on a MATLAB application while the dispense dispute e-form was developed and validated on the sublime text web application. The significant results obtained from the sampled banks indicated an optimized performance efficiency of 97% in resolving delay in reversing debited funds on dispense dispute.

Keywords: *Genetic Algorithm, MATLAB, Optimization, Cash Dispense, Fitness Function*

INTRODUCTION

Data loggers are intelligent systems which automatically monitor and record environmental parameters over time, allowing conditions to be measured, documented, analyzed, and validated. The retrieval of data from various devices is a function of a data logger machine. Data logger can automatically collect data on a 24-hour basis in relation to location either with built in sensor or via external sensors. Its application is not limited to data acquisition and storage but the ability to analyze and present the data to determine results and make necessary decisions Twum & Asante (2016).

According to Robert (2002). today's intelligent loggers also incorporate the ability to perform calculations on the measured values. This can be as simple as calculating and recording the difference between two measured values. For example, the successful and unsuccessful cash transactions of bank customers at Point of Sale (POS), and Automated Teller Machine (ATM) with debited funds can be measured through the intelligent data logger computations.

PROBLEM STATEMENT

The issue of delay in reversing debited funds of failed transactions at ATM terminals, POS terminals, Mobile applications terminals, and online platforms have posed serious challenge within the banking industry. According to banks, the debited funds are expected to be reversed within 24 hours of transaction once the customer is validated. Unfortunately, even after validation, one out of hundreds of transactions is reversed in 24 hours leaving behind a significant number of debited funds unresolved.

The problem therefore triggered the need to exploit a smart option in developing an intelligent data logger for resolving cash dispense disputes in banking industry using Genetic Algorithm.

The success of the research was dependent on the following research objectives:

1) Obtained data from the bank customers through interviews and questionnaire.
2) Analyzed data collected using probability distribution and pie chart on MATLAB application
3) Developed and modelled the system flowchart using Genetic Algorithm principle and mathematical functions.
4) Developed a prototype online dispense dispute form that was connected to the bank's mobile applications.
5) Integrated the modules, tested the accuracy, and carried out timely resolution of debited funds of dispense dispute using MATLAB application.

LITERATURE REVIEW

Methods of Electronic Funds Transfer

An Electronic Funds Transfer (EFT) is a system that involves the electronic movement of funds and funds information between financial institutions. EFT is a method of moving funds electronically from one bank to another without the use of paper money. It is a collection of technologies that allow financial transactions to be carried out electronically using a computer network rather than a paper instrument of exchange. According to Ogunsemor (1992), EFT transaction can be within or across multiple financial institutions. EFT systems provide the infrastructure for online financial transactions such as money transfer between bank accounts, electronic payments, balance enquiries, and bill payments using credit card, Automated Teller Machine (ATM), Wire Transfer, Point of Sale (POS), and online banking transactions. Each of these platforms has relieved customers from the stress of queuing up in the banking hall for financial activities.

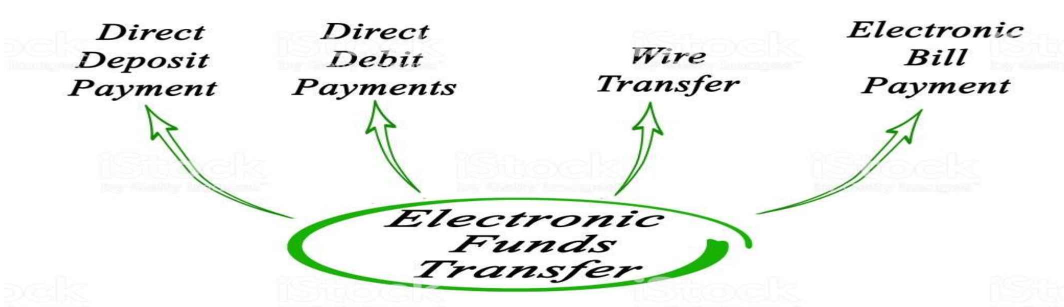

Fig 1: Electronic Fund Transfer Architecture (George, 2012) in (Sheema, 2022)

The funds transfer can be for direct deposit payment, direct debit payment, wire transfer or electronic bill payment as shown in Fig.1 (George, 2012) in (Sheema, 2022).

Its shortcoming is that the paper discussed the risks associated with the EFT technologies without considering the delay in reversing debited funds of failed transactions as a critical issue.

Asaadi *et al.* (2010) conducted research that applied model-based testing to an electronic funds transfer switch with the aim of testing EFT switch conformance to ISO 8583 standard. The test was based on a formalization of the ISO 8583 standard in terms of labelled Transitions Systems (LTSs). The research centered only on EFT switch conformance test without consideration of the issue of delay in reversing debited funds of dispense dispute.

Data Logging Systems

The ability to take sensor measurements and store the data for future use is, by definition, a characteristic of a data logger. However, a data-logging application rarely requires only data acquisition and storage. Inevitably, the ability to analyze and present the data to determine results and make decisions based on the logged data is needed. A complete data-logging application typically requires most of the steps described below (Perez. (1997) cited in Chinenye (2017)). Figure 2.5 is the data logger block diagram (Craig, (2012) cited in Chinenye (2017)).

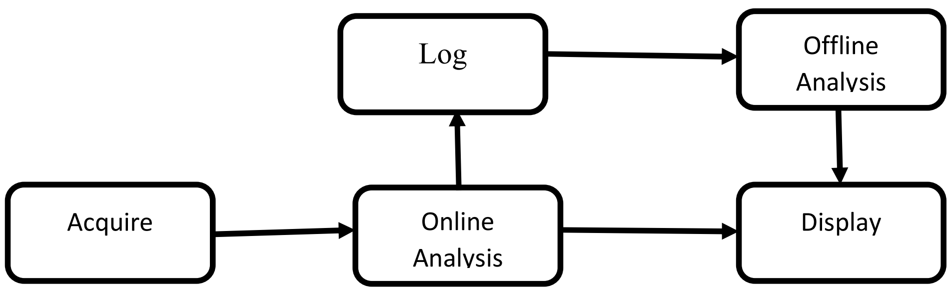

Fig 2: Block diagram of data logger (Craig, (2012) cited in Chinenye (2017))

Genetic Algorithm Modeling Method

The formulated Genetic Algorithm to solve the issue of mistakenly debited funds at customers transactions from any transaction channel strictly adhere to the following research steps.

Step 1: Cash transactions variable declaration and initialization of Genetic Algorithm

Step 2: Definition of bounds of parameters of the proposed data logging system with GA

Step 3: $n_t = 0 \begin{bmatrix} n_t \text{ represents the number of transactions} \\ \text{of current generation} \end{bmatrix}$

Step 4: $\text{f(t) initialization} \begin{bmatrix} \text{f(t)represents the} \\ \text{population time of the generation} \end{bmatrix}$

$Step\ 4: Evaluate\ f(t)$

$Step\ 5: Calculate\ the\ time\ of\ cash\ transaction\ f(t)$ and reversal of debited funds

$Step\ 6: t = cash\ transaction\ (ct) * Machine(M)$

$Step\ 7: Determine\ the\ transaction\ location\ f(L)$

$Step\ 8: if\ transaction\ time\ f(t)\ ! = the\ claimed\ location\ f(L)\ go\ to\ step\ 6$

$Step\ 9: if\ (f(n) > maximum\ generation\ number)\ go\ to\ step\ 12$

$Step\ 10: Select\ f(C, L, t) from\ F(C-1, L-1, t-1, A) by\ ranking\ selection\ process$

$Step\ 11: Alter\ f(t), f(C_t) and\ f(L)\ by\ crossover\ and\ mutation\ process$

$Setep\ 12: Evaluete\ f(t), f(C_t) and\ f(L)$

$Step\ 13: Calculate\ the\ best\ f(t)\ andAmount\ f(A)\ transacted$

$Step\ 14: Compare\ \ f(C, L, t)\ and\ f(C-1, L-1, -1, A) and\ accept\ better\ one$

$Step\ 15: reverse\ the\ debited\ Amount\ f(A)$

$Step\ 16$: $Go\ to\ step\ 6$. [either continue to print result or commence transaction again after reversal is achieved]

$Step\ 17: Print\ the\ \ result.$

$Step\ 18: Stop$

The various stages and steps of the genetic algorithm design in string cash dispense dispute are implemented with the designed interval objectives of the numerical integration model that defines these GA components:

I. Initialization

II. Fitness Check

III. Offspring

The Maximum transaction Limit (ML) of daily cash transactions, together with transaction Location (L) of transaction, time of transaction (t) are the important parameters by which the genetic algorithms population size, selection, generation, crossover, mutation and fitness function are formulated. The new system is designed by formulating the genetic algorithms chromosome with the datasets collated from the bank customers 'daily, weekly, and monthly transactions that has debited funds attributes. The value of the formulated chromosome is assumed to be nonlinear containing both discrete and continuous variables structured into a matrix of a real number which represented the cash transaction taken to be the data logging system's chromosome. A row matrix $C_a = [\,C_{ai-j}, C_{aj-n}, C_{n+i-j}]$ is used as a chromosome where the vector components $C_{ai-j}, C_{aj-n},\ and\ C_{n+i-j}$ represent the decision variable and condition for un-dispensed debited funds.

$$Cash\ Reversal = \frac{reversing\ Debited\ Cash\ (R_{DC})}{Not\ reversing\ debited\ cash\ (R_{nDC})} * 100\% \qquad (1)$$

Immediately each chromosome is formulated, it is selected and initialized.

Therefore, the genotype of the transactions will be stored in arrays. Each index of the array stores one piece of information about a transaction. Each index of an array is comparable to a structure in the basic structure of a mammalian gene in Figure 3.2. When the formation of an array is complete, a new transaction gene has been formed. One array will store all of the categorized information about a transaction. Figure 3.2 depicts a typical transaction gene for genetic algorithm.

The genes produce offspring through crossover. Each two parent transaction genes will produce two offspring. The offspring produced by the crossover breeding of the previous generation will make up the new generation's population.

Account	Credit Card	Amount	Transaction Channel	Demography	Client	Time

Table 1. The transaction platform (TPtf) or channel consists of the ATM-Machine, POS/WEB, and USSD. In this study our design specification is anchored on the transaction card attributes because none of the transaction channels works without an ATM-Card. Therefore, this section of the study, defined some set models that simulate the ATM-Card behavior of every transaction to validate or invalidate card user on the account of debited funds in a failed transaction.

Table 1: Data Set Cash Transaction Attributes

Item	Attribute
Transaction Card (TC)	ATM Card (MasterCard, Visa, Verve), Card Expiration, Bank, Security Code, Account Type.
Transaction Day (TD)	Monday, Tuesday… Sunday
Transaction Person (TP)	Name, Sex, Age, Work, Signature, State of Origin
Transaction Time (TT)	Morning, Noon, Evening, Night
Transaction Platform (TPtf)	ATM -Machine, POS/WEB, USSD

The list of items attributes in Table 1 are used in the proposed system design for effective reversal of debited fund from cash transactions. The rules or strategy for reversing every debited fund of failed transactions are mathematically expressed thus:

$$IF\ C_a(L_t, n, t) = Dispensed * C_n \quad (2)$$

$else$

$$C_a(L_t, n, t) = Un - dispensed * \frac{Error}{C_n}(R_c) \quad (3)$$

Where R_c denotes cash reversal of debited fund. The condition for cash reversal when the ATMCard transaction is either successful or unsuccessful at a verifiable transaction location and time is stated thus:

$$ATM\ (C_a, t, n) = C_n \frac{(Dispensed*A)}{\sum_{i=1}^{n}(R^{t-1})} \quad (4)$$

$$T_{pu} = ATMCard\ \frac{T_D}{PN} * \sum_{i=1}^{n}(R^{t-1}) - A_i \quad (5)$$

Where T_{pu} is the set of transaction person and ATMCard is the set of possible ATM Types (Visa, Master, and Verve), T_D is the set of transaction day (Monday, Tuesday…Sunday), while PN is the transaction person's name, and A_i is the set possible set outcome of the transaction amount.

$$Reverse\ (R) = C_{a1} * Ca_2 * \ldots * C_{an} * L \quad (6)$$

Where L is the set of possible transaction location and a rule set K is specified by $K \rightarrow R$. We aim to find the subset of K that applied to a single ATMCard or to group of them, hence minimizes the daily average exceeding transaction (ET) within the allowable time interval depicting several transactions that are unsuccessful to generate a defined data set.

$$A(C_a, t, n, L) = \sum_{j=1}^{n} \frac{R^{n-1}}{T_{pu}} * \alpha \rightarrow Data\ Set \quad (7)$$

The application of the genetic algorithm is to optimize the current system by getting rid of delay in reversing debited funds at failed cash transactions. In the new system, we ensured that set of inputs and outputs are considered for proper card analysis on every transaction. Figure 3.1 depicts input output process of the system.

Mathematical to solve the problem of delay in refunding debited funds of failed transactions, we employed the equation below to handle stalagmite function of genetic algorithm.

$$f(x, y) = f(C_x, C_y) = f1,\ xf2,\ xf1,\ yf2,\ y \quad (8)$$

$$f1.x = [\sin(\pi x + t)]^6 \cos[(d\pi x + A_t)]^6 \quad (9)$$

$$f1.y = [\sin(\pi y + t)]^6 \cos[(d\pi y + A_t)]^6 \quad (10)$$

$$f2.x = \exp\left[-4|n(d)\frac{(x-A_t)^2}{C_y}\right] \quad (11)$$

$$f2.y = \exp\left[-4|n(d)\frac{(x-A_t)^2}{C_y}\right] \quad (12)$$

Where $C_x$the undispersed is debited funds, $C_y$is the dispensed debited funds, t is the time of transaction, d is the amount transacted.

The new system delay resolution that reverses debited funds in seconds are stated in equation (12) through (13).

$$while\ A_t = d(t, C_x, C_y) - qu(t - \tau, x) \quad (13)$$

$$with\ f(x) \leq a < 1\ and\ \tau > 0,$$

Here, the lower bound index in $d_t$means the solution segment defined by

$$d_t(L, C_x, C_y) = dfast(t + L, C_x) \quad (14)$$

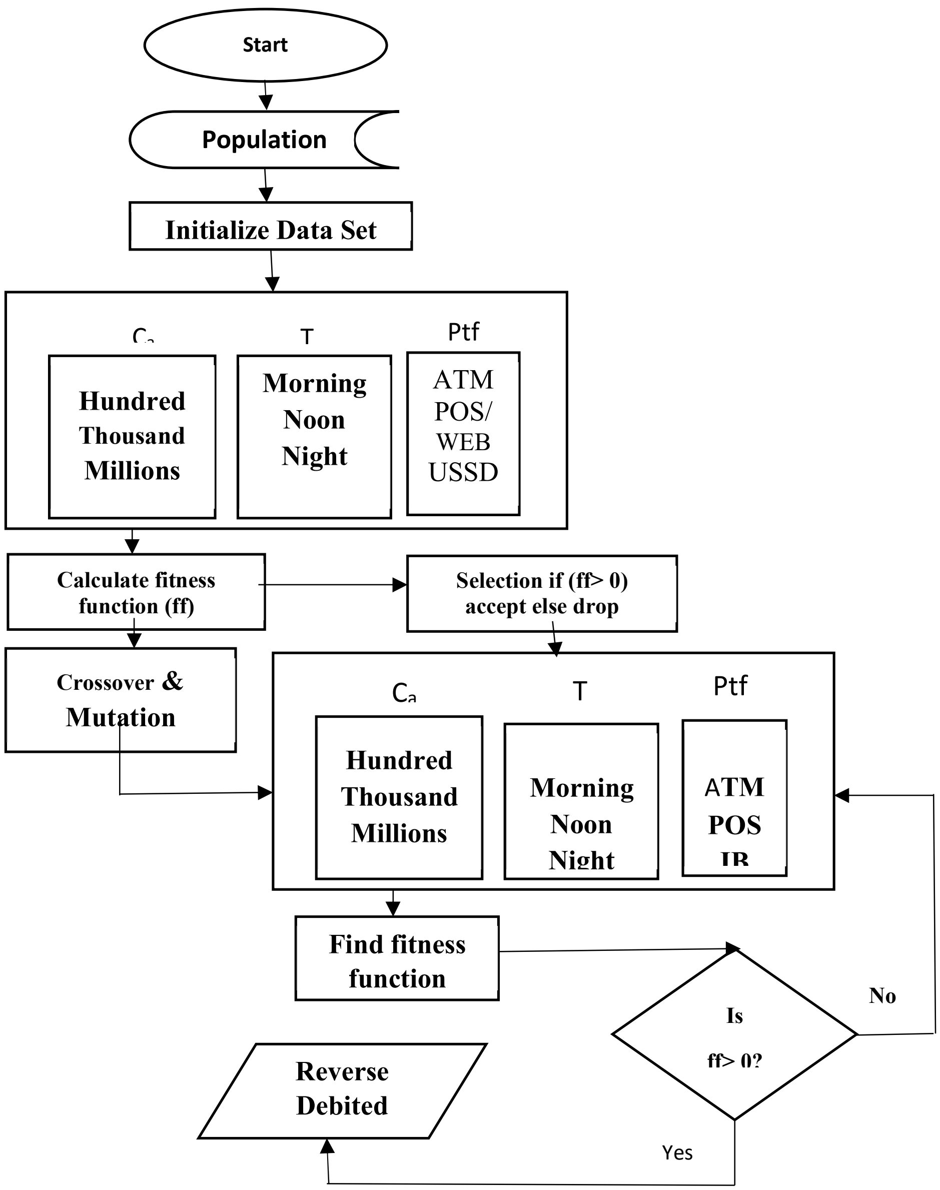

Fig. 3: Genetic Algorithm System Flowchart

Figure 3 shown above, consists of pictorial detailed operation of intelligent data logger system with the highlight of some important features such as population, data set, fitness function, crossover, mutation and selection. The minimum and maximum amount of cash debited in a failed cash transaction are what made up the data set information together with the time and location of the transaction. The new system is aimed at getting rid of cash reversal delay constantly observed in reversing debited funds of bank customers of the unsuccessful cash transactions.

The process of conducting this work involves the following activities:

1. Cash Dispense Error Data Collection: face to face survey through interviews with the bank customers who have had dispense error experience.
2. Cash Dispense Error Data Analysis: the survey data is analyzed.
3. Series of steps are proposed for developing an intelligent data logger mobile system that will be independent of inter-switch as currently practiced with respect to solving the issue of delay in reversing debited funds of dispense errors.

DATA LOGGER SYSTEM MODELING

In this section a model is designed to determine the bank customers whose transactions failed and were debited in error. Its function is to validate or invalidate the customer on the transactions activities that were unsuccessful with fund debited. Here, we describe a steady-state search algorithms that starts with a population η of size r. In most dispense dispute applications, this population would be chosen randomly from the search space, but there is no requirement for a random initial population. At each step of the algorithms, an element j is removed from the population, and an element i of Ω is added to the population, The selection of the element i is described by a heuristic function G. (For a genetic algorithm, G will describe crossover, mutation, and usually selection.) The selection of element j is described by another heuristic function D_r. (We include the population size r in this research as a subscript since there may be a dependence on population size.). In the steady state search algorithm, the heuristic functions G and D_r both depend on x, the current population. Thus, i is selected from the probability distribution $G(x)$, and j is selected from the probability distribution $D_r(x)$.

$Step$ 1: $Choose\ an\ initial\ population\ \mu\ of\ size\ r$

$Step$ 2: $X \leftarrow \mu$

$Step$ 3: $Select\ i\ from\ \sigma\ using\ the\ probability\ distribution\ G(X)$

$Step$ 4: $Select\ j\ using\ the\ probability\ distribution\ D_r(X)$

$Step$ 5: $Replace\ X\ by\ X - \frac{e_i}{r} + \frac{e_.}{r}$

$Step$ 6 : $Go\ to\ step$ 3.

Some heuristics that have been suggested for the D_r function include worst-element deletion, where a population element with the least fitness is chosen for deletion, reverse proportional selection, reverse ranking deletion, and random deletion, where the element to be deleted is chosen randomly from the population. In this thesis work the use of the term “steady-state genetic algorithm” for an algorithm that used random deletion. The random deletion is equivalent to reversing debited fund for unsuccessful cash transactions. Therefore, random deletion can be modeled by choosing $D_r(x) = x$.

The Condition for refunding failed Cash Transactions is mathematically formulated in the expression denoted by C_{Ft}

$$C_{Ft} \sum_{Min=0}^{Max=n} \frac{(D_c - A_e)}{(D_{uc} - A_e)} * \frac{100}{1}$$

$Where, D_c = Dispensed\ Cash;$

$A_e = Expected\ Amount\ to\ be\ withdrawn;$

$D_{uc} = un - dispensed\ cash\ Transaction$

$if\ (C_{Ft} > 0)$

This implies that the failed transaction is serious and critical. Here customers' identity must be validated before debited fund is reversed.

$else\ (C_{Ft} < 0)$

Here the case is minor and fund reversal is immediate and within few seconds without any delay.

RESULTS AND DISCUSSION

This section provides a description of implementation results and performance evaluation of the new system.

Fig. 3 illustrated debited funds at the ATM transactions channel. Fig. 4 illustrates debited funds at the POS/WEB transaction channel. Fig. 4 illustrates debited funds at the USSD transaction channel..

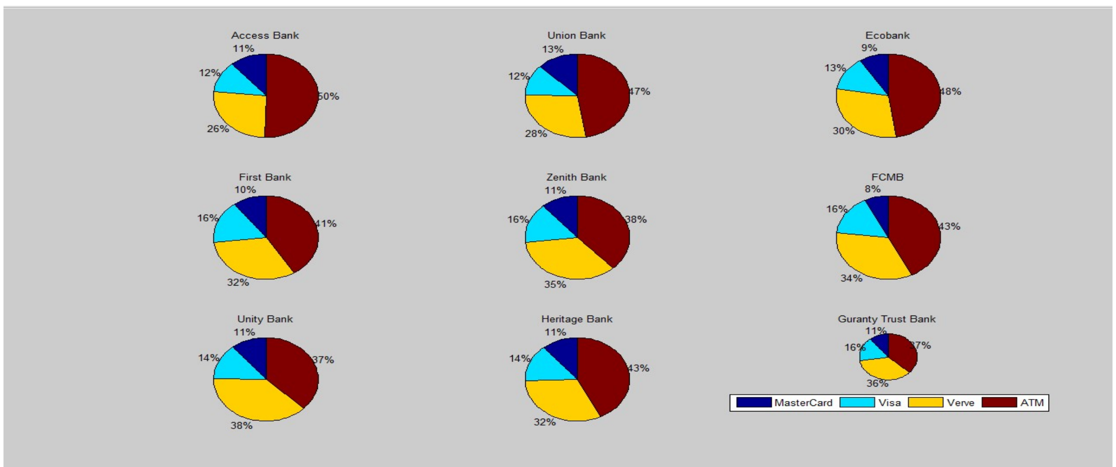

Fig. 4: Pie charts illustration of debited funds with ATM channel

While their MATLAB codes are shown in Appendices B, C and D respectively.

Genetic Algorithm Fitness Function (FF)

The data set of the system inputs and outputs defined in the system design are now tested with MATLAB IDE to calculate the genetic algorithm fitness function values. Other results and findings were represented in 2D and 3D graphs illustrating how the issue of delay in refunding debited funds was handled by the new system. Fig. 4 has the fitness function denoted by a letter x, while the GA fitness function code is represented in Appendix F. Also, at this point the unsuccessful transactions debited funds are reversed within seconds unlike the current system.

Transactions Iteration (Daily Allowable Transaction Limit)

The new system allows the user to make transactions with either debit or credit cards up to 50 times a day. Beyond the allowable iteration any debited fund will not be reversed. Fig. 6 depicts the daily allowable transaction limit for every bank customer. The new system is designed in such way that beyond this daily limit resulted issues of debited fund will not be resolved so it the duty of the user does not exceed this limit.

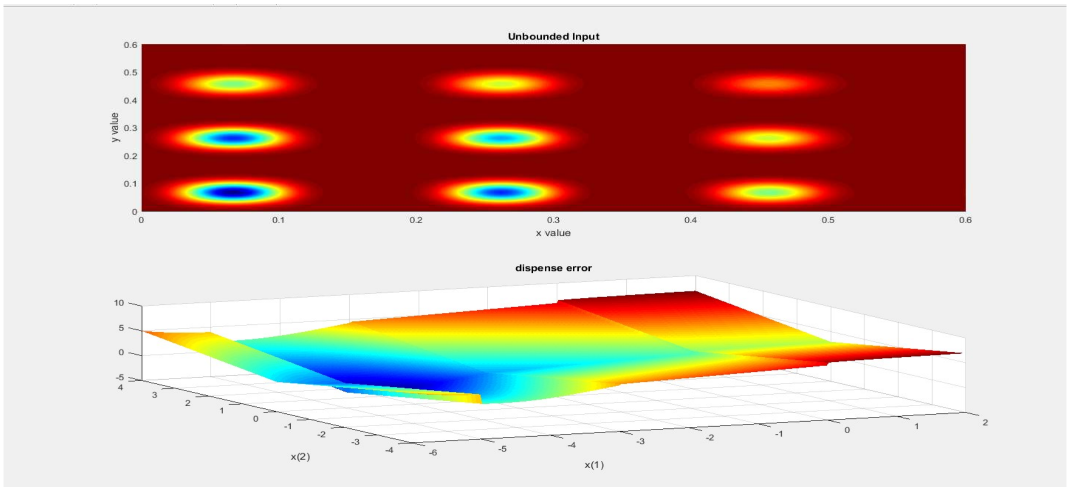

Fig. 5: Successful and Unsuccessful Debited Transactions

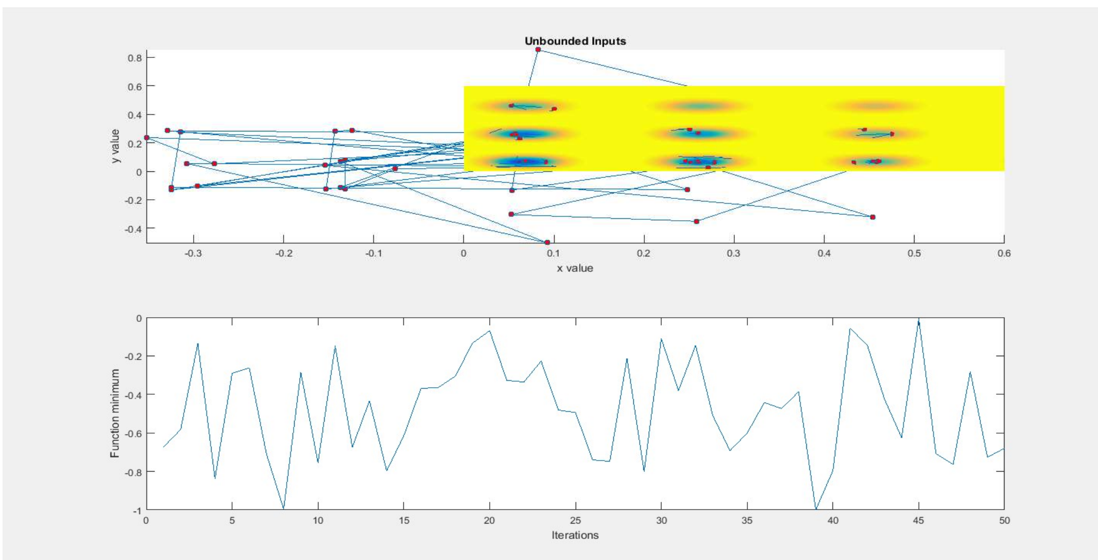

Fig. 6: Daily Limit of Card Usage

It was found from Fig. 6 that the minimum function values for all the iterations allowable for daily card usage are still less than zero (0). This simply means that the genetic algorithm fitness function (ff) which analyzes daily card usage is effectively optimized in the new system. It implies that every card transaction attempt that yielded unsuccessful transactions with debited funds would be reversed within seconds without any stress on the card user provided the daily card usage condition is adhered to or not exceeded.

CONCLUSION

The debited fund of dispense dispute is an ugly experience that threatens the bank customers in Nigeria. The delayed in reversing debited funds is also great concern. People wait arbitrarily in some cases before debited funds is reversed due to total dependence on the inter-switch management platform by banks in Nigeria. This research work developed a system that solves the issue of delay in reversing debited funds of bank customers using the Genetic Algorithm and online dispense dispute form. The Genetic Algorithm's fitness function obtained and the trial experiments of the dispense dispute e-form confirmed the efficacy of the new system in reversing debited funds in a timely manner.

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