

Implementation of Voter by using Artificial Bee Colony Algorithm for Fault Tolerant System

Ponnaganti Rama Devi¹, Anusha Jetti²

^{1,2}Computer Science Engineering, GITAM School of Technology, GITAM (Deemed to be) University, Visakhapatnam, India

E-mail: ¹rponnaga@gitam.edu, ²ajetti@gitam.edu

Abstract

In a fault tolerant system, voting algorithm plays a major role in decision making. Inexact majority voting, majority voting, and weighted voters are most popular voting algorithms. In each of these techniques, redundant modules produce unpredictable outputs, and finding an agreement among these outputs is the functionality of voter. In this proposed system, voter is implemented using soft computing technique called ABC algorithm. The basic ABC algorithm is a very modest, adaptable and clear model. There are two categories of searchers in the hive of ABC; namely, unemployed searchers and employed searchers. Based on the intelligent performance of honey bee swarm, ABC is one of the optimization algorithms. The behaviours of bees are used to optimize weights of Triple Modular Redundant system, where each module plays an imperative role in the selection of voter. For evaluating the performance of voting algorithms, some performance measures have been defined; they are, safety and availability measures. ABC algorithm has been proposed to improve the safety and availability of the existing system.

Keywords: Artificial Bee Colony (ABC) algorithm, Fault Tolerant System, Triple Modular Redundant (TMR) system and voting algorithms

1. Introduction

The modern world people are bounded by computers and machines. Each and every person come to be contingent on more and more on computer systems, where they are involved and combined into almost every aspect of our lives. In the presence of the faults some applications display the risky behaviour. The most modern cars have central computers for directing various aspects of their operation. Other major examples are the safety-critical

control systems such as air-traffic control, communication networks and devices, systems involved in healthcare, satellites, and systems managing ATM withdrawals. Scientists, engineers design and build these complex computer systems, using a variety of tools and techniques, with the hope of wounding down on the number of faults built into them. In the above applications the main goal is to progress system's availability and safety. Fault-tolerance is the term used to designate the any existing faults or errors within a system. The fault-tolerance process is the set of activities; the main objective is to eliminate errors and before a failure occurs from computational state. Software fault-tolerance is a make available service fulfilling using the relevant requirement in malice of faults.

Subsequent a few basic definitions are:

- **Fault:** It's also called as "bug". It recognized reason of an error.
- **Error:** It's part of the system state-run and is responsible to lead in the direction of a failure. Failure can be detected or unrecognized as an error. When errors are detected known faults are there. An error may be transmitting to other errors.
- **Failure:** If the service delivered by the system opportunities from the specified service then failure occurs, otherwise considered as an incorrect result.

1.1 Fault Tolerance Processes

When the system processes some of its components failures then the fault-tolerant is belonging that enables a system to continue operating appropriately. Fault-tolerance is occasionally referred to as redundancy management. Redundancy is facility of functional experiences that would be presented unnecessary trendy an unflawed or otherwise known as fault-free atmosphere. Redundancy is not appropriate but essential in place of fault-tolerance. A computer system may possibly deliver redundant outputs in the being current of a fault at least one output is correct. Fault-tolerance involves subsequent actions: - Fault-Masking, Fault-Diagnosis, Fault-Repair, Fault-Detection, Fault-Containment and Fault-Compensation. Appearances of fault tolerant system are Availability, reliability, safety and maintainability. In a fault tolerant system voting algorithm shows a major role for decision making. Majority voting, Median voting and weighted voting are most widespread voting algorithms. In majority voter, based on the majority values this voter products the correct or incorrect or benign output. The median voter based on the middle value this voter product the correct or incorrect output. In weighted voter, based on the weights this voter product the correct or incorrect or benign output these weights are prearranged or dynamically adjusted. In each of

these techniques redundant modules products inconsistent outputs, finding a settlement among these outputs is the functionality of voter.

In this system voter is applied using soft computing technique like ABC algorithm. It's very humble, clear and adaptable model. It's specifically founded going on the searching behaviour in colonies of honey bees, by using behaviours of bee it is used to optimize weights of Triple Modular Redundancy (TMR) system. TMR performs a procedure and that outcome is processed by a majority-voting system to produce a single output. If any one of the three systems fails, the other two systems can correct and mask the fault. Presentation of a system is evaluated using two non-functional attributes safety and availability.

2. Related Work

SourehLatif and Shabgahi [6], discussed the range of safety-critical systems one of the main principal approaches is fault-masking. In fault-masking [3], software versions or hardware modules were simulated, and the results of the voting were used to masking the influence of one or more run-time errors. The fault-masking methods distinguished in N-Modular Redundancy and N-Version Programming. Zahra Latifi and Abbas Karimi [8], suggested that Triple Modular Redundancy is one of the humblest forms for the N-Modular Redundancy. TarangAgarwal and AkhileshPathak [7], proposed that TMR is a three modules work in equivalent and based on the voting scheme voter produces the three outputs.

According to Soureh Latif-Shabgahi [6], traditional and usually used voting algorithms are the majority and the weighted average voters. The inputs of the majority voter calculated by the majority then voter products a correct output. In case of not at all majority, the voter can't products the output. The other hand weighted average voter, based on the redundant input values to determine the weighted mean. The weighted can be prearranged or can be adjusted dynamically.

G.Latif-Shabgahi and S.Bennett [5], illustrated that the particular performance measures safety and availability are considered based on the correct output (n_c), incorrect output (n_{ic}), benign output (n_b) and whole number of outputs (n). Normalized correct results demarcated as the ratio of n_c and n ; $\frac{n_c}{n}$. G. Latif-Shabgahi and Julian M. Bass [4], proposed that both hardware and software fault masking methodologies use voting mechanism for refereeing between the outcomes of redundant modules.

3. Proposed Work

To incredulous drawbacks and improve safety and availability of the existing system ABC algorithm is proposed, and it's an optimization algorithm built on the intelligence behaviour of honeybun bee scavenging. Dervis Karaboga introduced this model in 2005[1], based on the concept that some bees are finding juice and food sources information and sharing to another bees in the stockpile.

3.1 Artificial-Bee-Colony (ABC) algorithm

The ABC algorithm is motivated by the intelligent scavenging behavior of honey bees in proposed system. By using behavior of bees it is used to optimize weights of Triple Modular Redundant (TMR) system, where each module productions an important role in the selection of voter. In the ABC algorithm [1], the colony contains three groups of bees. These are Scouts bees, Employed bees and Onlooker bees. The Scouts bees are carrying out arbitrary investigation is called scout bees. The Employed bees are self-searching to the food source is called employed bee. The Onlooker bees are making decision to choose the food source in waiting on the dance zone is called onlooker bees.

3.1.1 Phases of ABC algorithm

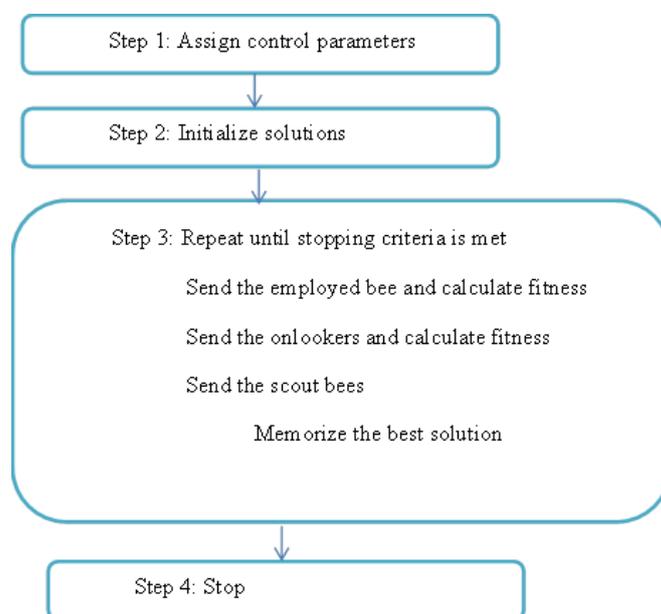


Figure 1. Flow chat of the ABC algorithm

In the formation of collective knowledge, the most important incidence is the interchange of information among bees. With respect to exchanging information is the dancing zone [2]

(This dance called waggle dance). It's the communication among bees associated to the quality of food sources that take place.

3.1.2 Block diagram of the proposed system

As in figure 2, Modules receives the input and perform the same function in three modules and products the three results. Amongst these three results which one is more safety, and reliable result is to be determined by voter by smearing the ABC algorithm on results. The voter products a single result sends to comparator. The difference between the initial input and voter output is within the boundary output is correct otherwise incorrect. Using based on these correct or incorrect outputs to evaluate safety and availability of the system.

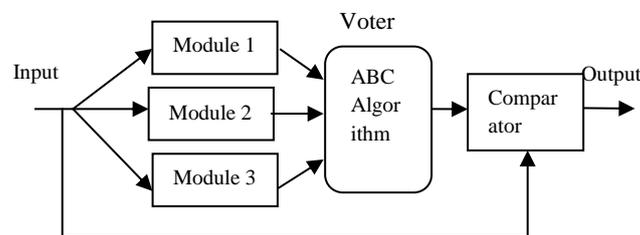


Figure 2. Block diagram of the proposed system

3.2 Working methodology

The working methodology of proposed system is input data $f(t)$ values are direct to the three modules. These modules collect $f(t)$ values and perform the same function in three modules and products the three results that is correct or incorrect values based on the injection of error. These values are sending to ABC voting algorithm. The algorithm decides among these three results which one best and products single output. The output is moreover correct or incorrect output. Based on these outputs evaluate safety and availability of system.

The subsequent data are used to proposed voter:

- Three modules the Input data is $f(t)=10+10*\sin(t)$ experimented at 0.1 seconds only.
- Threshold value is 0.5.
- Error range is $[-e_{\max}, +e_{\max}]$.
- Normalized correct results i.e., percentage of correct outputs (n_c) to the total number of outputs (n). Formula: Correct outputs for N runs: $\frac{n_c}{n}$
- Normalized incorrect results i.e. percentage of incorrect outputs (n_{ic}) to the total number of outputs (n). Formula: Incorrect outputs for N runs: $\frac{n_{ic}}{n}$

- Normalized disagreed results i.e. ratio of disagreed outputs (benign out limits (n_b)) to the whole number of outputs (n). Formula: Benign outputs for N runs : $\frac{n_b}{n}$
- The system Safety (S) is demarcated as $S = 1 - \frac{n_{ic}}{n}$
- The system Availability (A) is demarcated as $A = \frac{n_c}{n}$.

4. Results and Discussion

Evaluation the existing system results and proposed system results. The non-functional attributes (safety and availability) are used to compare the existing system and proposed system. The TMR perform following these cases:

Case1: Modules receive a set of inputs and three parallel modules accomplish an identical function and passing the result to the voter. The voter calculated the result by using ABC algorithm and products a single output. The output is either correct (n_c) or incorrect (n_{ic}) or benign (n_b) output.

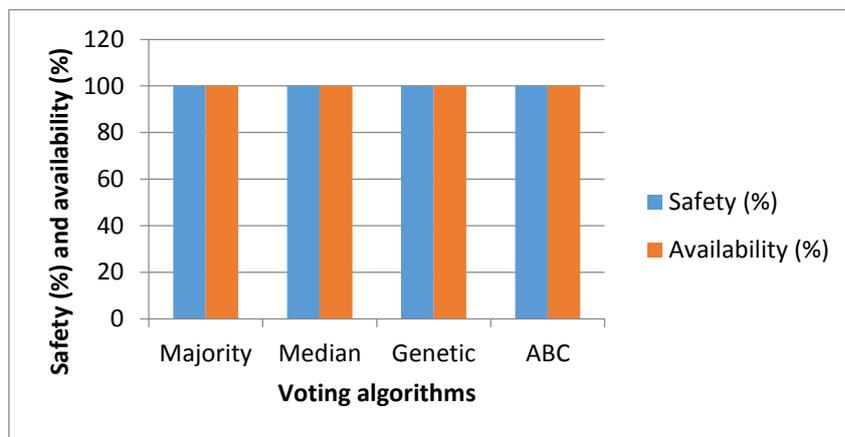


Figure 3. Column chart representation of existing and proposed systems (Case 1)

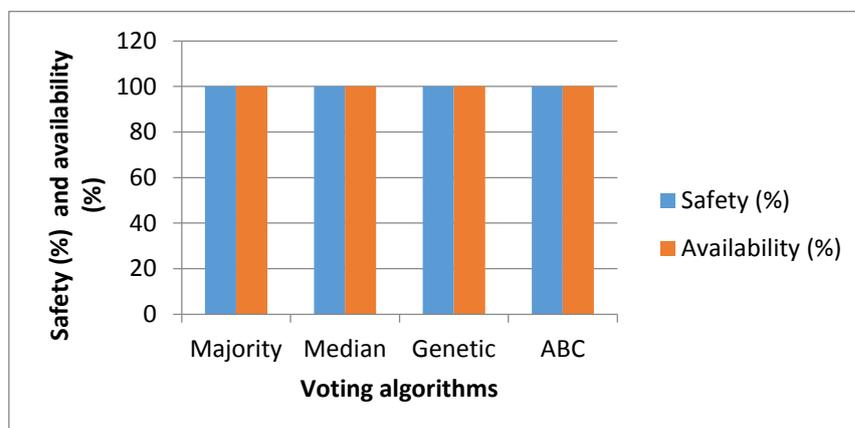


Figure 4. Column chart representation of existing and proposed systems (Case 2)

Case 2: Input is send to three modules. Error should be injected to only module 2 and module 1, 3 are error free. These modules accomplish an identical function and passing the result to the voter. The voter calculated the result by using ABC algorithm and produces a single output. The output is either correct output (n_c) or incorrect output (n_{ic}) or benign output (n_b).

Case 3: Input is send to three modules. Module 1 is error free and error should be injected to both Module 2, 3. These modules accomplish an identical function and passing the result to the voter. The voter calculated the result by using ABC algorithm and products a single output. The output is either correct output (n_c) or incorrect output (n_{ic}) or benign output (n_b).

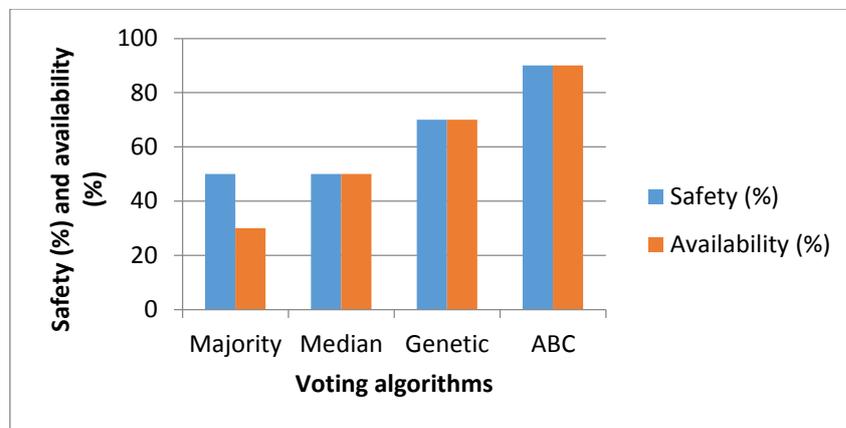


Figure 5. Column chart representation of existing and proposed systems (Case 3)

In this ABC voter, the voter produces the single output using the bee behaviours. To achieve the safety and availability are 20% more than genetic voting algorithm, 40% more than median voting algorithm and 40% safety, 60% availability is more than majority voting algorithm. Based on above chart percentages ABC is best voting algorithm for fault tolerant system when compared to all existing voting algorithms.

5. Conclusion

To achieve fault-tolerance, one of the systems employed is Triple Modular Redundant (TMR) system. In TMR, voter plays a major role in decision making. Majority, Median, Genetic voting algorithms are used in the existing system to achieve the safety and availability. Based on the majority among the inputs, it is observed that majority-voting algorithm provides enhanced safety performance. Its availability is very less due to non-majority among inputs. The performance when compared to majority- voting algorithm is

that the median voting algorithm gives 20% enhanced safety and availability. Genetic voting algorithm also gives 40% and 20% more performance when compared to majority and median voting algorithms respectively. In the existing system, performance measures of safety and availability are very less. In the proposed system, voter is implemented using Artificial Bee Colony (ABC) algorithm which is computer-generated using JAVA, and the existing voting techniques are compared to the proposed voting technique which has been found to have better performance with respect to safety and availability. This voter can be implemented in the systems necessitating high availability and safety. The error is injected to the input ABC algorithm which produces 20% better performance measures compared to the genetic algorithm in the existing system. The total number of correct (n_c) outputs and incorrect (n_{ic}) outputs are experimental based on threshold value. These n_c and n_{ic} values are used to evaluate the safety and availability of the system. Therefore, the proposed voting algorithm (ABC) is an optimized algorithm when compared to the existing voting algorithms.

References

- [1] Ashita S.Bhagade,Parag. V.puranik, “Artificial bee Colony (ABC) Algorithm for Vehicle Routing Optimization Problem”, International Journal of Soft Computing and Engineering (IJSCE), volume-2, Issue-2, May 2012.
- [2] DervisKaraboga, BeyzaGorkemli, CelalOzturkNurhanKaraboga, “A comprehensive survey: Artificial Bee Colony (ABC) algorithm and applications”, Springer Science, March 2012.
- [3] F. Zarafshan, G. R. Latif-Shabgahi, and A. Karimi, “A Novel Weighted Voting Algorithm based on neural networks for Fault-tolerant systems”, in Proceedings of the 3rd IEEE International Conference on Computer Science and Information Technology (ICCSIT), vol. 9, pp. 135–139, July 2010.
- [4] G. Latif-Shabgahi, Julian M. Bass, “A Taxonomy for Software Voting Algorithms Used in Safety-Critical Systems”, IEEE transactions on reliability, vol.53, no.3, September 2004.
- [5] G.Latif-Shabgahi, S.Bennett, J.M. Bass, “Smoothing voter: a novel voting algorithm for handling multiple errors in fault-tolerant control systems”, Microprocessors and Microsystems 27, pp. 303-313, February 2003.
- [6] SourehLatif-Shabgahi, “An Integrated Voting Algorithm for Fault Tolerant Systems”, International Conference on Software and Computer Applications, IPCSIT vol.9, 2011.

- [7] Tarang Agarwal, Akhilesh Pathak, Anand Mohan, "A Novel Hybrid Voter Using Genetic Algorithm and Performance History", International Journal of Artificial Intelligence and Expert Systems (IJAE), pp.117-25, 2011.
- [8] Zahra latifi, Abbas Karimi, "A TMR Genetic Voting Algorithm for Fault-tolerant Medical Robot", Procedia Computer Science 42, pp.301-307, 2014.

Author's biography

Ponnaganti Rama Devi, M.Tech, B.Tech, received her B.Tech from V.S.Lakshmi Engineering College for women affiliated to Jawaharlal Nehru Technological University, Kakinada and Received the M.Tech Information Technology with Specialization in Software Engineering from GVP affiliated to Jawaharlal Nehru Technological University, Kakinada. Now she is working as Assistant professor in GITAM School of Technology, GITAM (Deemed to be) University, Visakhapatnam, Andhra Pradesh. Her Area of interest including are Computer Graphics, DBMS, JAVA, Computer Networks, Design and Analysis of Algorithms, Cryptography and Network Security and Unified Modelling Language.

Anusha Jetti, M.Tech. (CSE), RVR&JC Engineering College, Guntur (Dt) April 2017 and B.Tech. (CSE), Bapatla Engineering College, Guntur (Dt), 2015, Now she is working as Assistant professor in GITAM School of Technology, GITAM (Deemed to be) University, Visakhapatnam, Andhra Pradesh. Her Area of interest including are Computer Networks, Operating Systems, Software Engineering, OOAD using UML, C-Language and Real Time Systems.