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# Improved Approach for Energy-Efficient Fault-Tolerant Data Storage & Processing in Mobile Cloud Using Fuzzy Rules

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*Abstract— Energy efficiency and fault tolerance is nicely studied but hassle in Wi-Fi sensor networks due to the fact from its ultimate decade in recent year. However, in cell gadgets communication with information garage and cellular cloud processing systems, this hassle yet remains to be dealt completely. The useful resource intensive programs which include video, audio or picture processing and storage nevertheless remains headed away even though advanced hardware based mobile handheld devices delivered because of the requirement of large storage as well as computation fees for such programs. To cope with these problems, latest strategies proposed with the aid of the usage of far flung servers like clouds, peer cellular gadgets and many others but the cellular gadgets those are used for communication for flexible networks like cell cloud are suffered from the problems of energy consumption and reliability. On this venture, by extending this present work by adding method to enhance the electricity intake primarily based on kind conversation as well as enhance the conversation time, throughput. The method introduced right here is based on fuzzy rule algorithm. The aim of this set of rules is to check the opportunity of excessive strength loss of cell nodes and node failure situations which will enhance the reliability and power performance of cellular cloud information storage processing. The realistic evaluation proposed is carried out through simulations.*

## I. INTRODUCTION

Personal cellular devices have gained substantial popularity in latest years. Due to their restricted resources (e.g., computation, reminiscence, power), however, executing refined applications (e.g., video and photograph storage and process, or map-reduce kind) on mobile gadgets stays robust. As a result, many packages rely on offloading all or a part of their works to “far off servers” as well as clouds and peer cellular gadgets. Parenthetically, applications consisting of Google gawp and Seri manner have studied about the information on clouds and projected to dump procedures on mobile gadgets by means that of migrating a virtual machine (VM) overlay to near infrastructures. This approach essentially permits offloading any manner or utility, however it

needs a sophisticated VM mechanism and a solid network affiliation a few systems (e.g., good fortune even leverage peer cell gadgets as distant servers to finish computation intensive job. In dynamic networks, e.g., mobile cloud for disaster response or military operations, whereas choosing far flung servers, electricity intake for accessing them have to be compelled to be reduced as considering the dynamically ever-changing topology for good fortune.

Cloud computing is a growing business infrastructure and net focused charge-effective computing paradigm wherein know-how can be accessed from an online browser through purchasers for their requirement. it's far a modality of computing characterized by using on-demand availability of resources in a dynamic and scalable trend, where in the aid is used to symbolize infrastructure, systems, application, services, or storage. Cloud computing is a digital pool of computing resources. It gives computing sources the pool for customers via net built-in cloud computing is an entire dynamic computing gadget. It affords vital application software surroundings. It will probable set up, allocate or reallocate computing aid dynamically and display the usage of belongings at all time, probably speak cloud computing has an allocated system, to gain the cause of efficient use of the method. Therefore, the cloud computing pattern makes it feasible for the person to take part in a few utility particular operations on their own digital asset. Programs evolved using this mannequin will run throughout a couple of structures extracting information from each and every aspect of them combining and handing over it in them possess form to any tool at any location inside the planet. The electricity of offerings provided by manner of the cloud surroundings is limitless and those net services are randomly scattered over special servers and having access to and scheduling them which within reason a challenging assignment. Cloud computing are often classified in to sorts akin to forms of offerings provided and vicinity of cloud. The offerings are greatly categorized as Platform as a service (PaaS),Infrastructure as a carrier (IaaS) and software as a service (SaaS), and so forth... based totally on the location cloud computing can be labeled into 4 varieties like private cloud, public cloud, hybrid cloud and community cloud.

## II. LITERATURE SURVEY

IR.Saranya, P.Muthukumar [14] personal cellular phone gadgets have gained brilliant popularity in trendy years. As a result of their limited belongings (e.g., computation, memory, strength), however, executing trendy purposes (e.g., video and photograph garage and processing, or map-reduce style) on cellular gadgets remains tough because it should preserve energy consumption. Due to lacking of vigor in cloud computing of cellular gadgets, if any node turns into failure then, entire neighborhood of mobile conversation can also additionally have disordered. In this reply, cell objects correctly retrieve or manner facts, inside essentially the most pressure-inexperienced method, as long as k-out-of-n some distance flung servers are on hand through a real tool implementation, the technique proves the feasibility of the proposed method. Sizeable simulations are examined with fault tolerance and energy efficiency of the framework in greater scale networks. The combine okay-out-of-n reliability mechanism into disbursed computing in mobile cloud fashioned via the usage of only cell phone items. k-out-of-n, a correctly-studied discipline subject matter in reliability control, ensures that an approach of 'n' accessories operates adequately so long as good enough or more add-ons paintings. more specially, we study the right way to shop files as good as technique the saved files in cell cloud with okay-out of-n reliability such that: 1) the electrical strength consumption for retrieving disbursed data is minimized; 2) The power consumption for processing the distributed know-how is minimized and three) information and processing are allotted because of the fact dynamic topology changes.

Srinivas Sethi1, Anupama Sahu, Suwendu Kumar[5]In an international that sees new technological traits bloom and fade on near everyday foundation, one new development guarantees larger sturdiness. This style is called mobile cloud computing, and it will alternate the fashion we use computer and the net. on this paper we introduce idea of improving accessibility of Cloud using if then idea of Fuzzy, we've got now attempted to praise a model for comparing patron's delight in cloud computing. As a result, a conceptual version has been constructed for the reason that attributes to assess cloud computing client's delight in an net issuer provider (ISP) groups in Iran. To restrict any ambiguities which may be on account of linguistic methods, in this assessment model now we've used Fuzzy Inference method (FIS).

## III. PROPOSED APPROACH FRAMEWORK AND DESIGN

### A. Proposed System

In latest years cellular objects have attracted the full-size popularity. However, as cell devices are having restricted property along with force, computation and reminiscence, processing the purposes like video processing, photo processing on such objects is stays hard take a look at quandary to conquer the ones boundaries, many packages are accessed using cell cloud and peer mobiles techniques. In such solutions, cellular objects used may additionally be stricken via the issues of fault or vigor intake; eventually there's no force effectively and reliability supported. Many gift techniques don't have any answers to address hassle of power performance and cell phone tool failure efficaciously. In recent times the number one research in the direction of this is added wherein reliability and electricity efficiency for records garage and processing in cell cloud is proposed. The simulation outcomes are showing that force intake consequences are computed below one of a kind organization instances, topologies, and node

failures. Nevertheless, there's also however scope for enhancing the vigor intake overall performance while improving the entire verbal exchange throughput with minimal put off which isn't always continuously addressed.

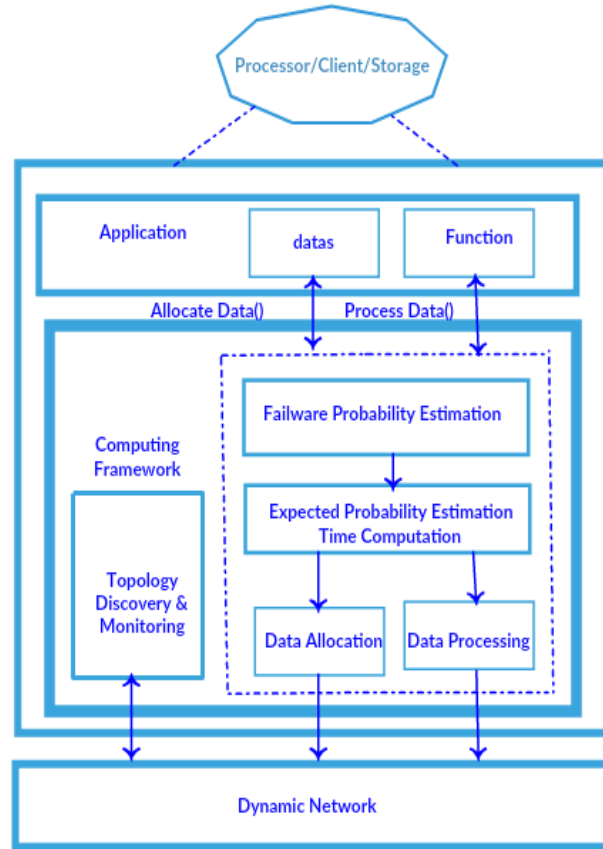


Figure 1: System architecture

**B.Mathematical Model**

Domain connation characterizes what proportion a term is related to a selected corpus (i.e., a domain) supported 2 sorts of statistics, namely, dispersion and deviation each dispersion and deviation are calculated using the well-known term frequency-inverse document frequency (TF-IDF) term weights. Every term  $T_i$  encompasses a term frequency  $[TF_{ij}]$  in a document  $D_j$ , and a world document frequency  $DF_i$ . the burden  $w_{ij}$  of term  $T_i$  in document  $D_j$  is then calculated as follows:

$$w_{ij} = \begin{cases} (1 + \log TF_{ij}) \times \log \frac{N}{DF_i} & \text{if } TF_{ij} > 0, \\ 0 & \text{Otherwise,} \end{cases}$$

Where  $i \in \{1; \dots; M\}$  for a complete range of  $M$  terms, and  $j \in \{1; \dots; N\}$  for a complete range of  $N$  documents within the corpus. The standard variances for term  $T_i$  is calculated as follows:

Follows:

$$s_i = \sqrt{\frac{\sum_{j=1}^N (w_{ij} - \bar{w}_i)^2}{N}}$$

Where the common weight  $\bar{w}_i$  of term  $T_i$  across all Documents is calculated by

$$\bar{w}_i = \frac{1}{N} \sum_{j=1}^N w_{ij}$$

The dispersion [disp<sub>i</sub>]of every term T<sub>i</sub> within the corpus is defined as follows:

$$disp_i = \frac{\bar{w}_i}{s_i}$$

Dispersion so measures the normalized average weight of term T<sub>i</sub>. It's high for terms that seems often across a large range of documents within the entire corpus.

The deviation [dev<sub>ij</sub>] of term T<sub>i</sub> in document D<sub>j</sub> given by

$$dev_{ij} = w_{ij} - \bar{w}_j$$

Where the typical weight  $\bar{w}_j$  within the document D<sub>j</sub> is Calculated over all M terms as follows:

$$\bar{w}_j = \frac{1}{M} \sum_{i=1}^M w_{ij}$$

Deviation [disp<sub>i</sub>] indicates the degree within which the load w<sub>ij</sub>of the term T<sub>i</sub> deviates from the typical  $\bar{w}_j$  in the document D<sub>j</sub> The deviation therefore characterizes however considerably a term is mentioned in every particular document within the corpus. The domain relevancy [dr<sub>i</sub>]for term T<sub>i</sub>in the corpus is finally outlined as follows:

$$dr_i = disp_i \times \sum_{j=0}^N dev_{ij}$$

#### A. Topology Discovery

Topology Discovery is dead throughout the network initialization section or whenever a big amendment of the configuration is detected (as detected by the Topology watching component). Throughout Topology Discovery, one delegated node floods asking packet throughout the network. Upon receiving the request packet, nodes reply with their neighbor tables and failure chances. Consequently, the delegated node obtains world property info and failure chances of all nodes. This topology info will later be queried by any node.

#### B. Failure Probability Estimation

We assume a fault model within which faults caused solely by node failures and a node is inaccessible and can't offer any service once it fails. The failure likelihood of a node calculable at time t is that the likelihood that the node fails by time t + T, wherever T may be a amount throughout that the calculable failure likelihood is effective. A node estimates its failure probability supported the subsequent events/causes: energy depletion, temporary disconnection from a network (e.g., thanks to mobility), and application-specific factors. we tend to assume that these events happen severally. Let F<sub>i</sub> be the event that node i fails and let F<sub>i</sub><sup>B</sup>, F<sub>i</sub><sup>C</sup>, and so lfa syllable i be the events that node I fails thanks to energy depletion, temporary disconnection from a network, and application-specific factors severally. Clearly, the domain relevancy [dr<sub>i</sub>]in company each horizontal (dispersion [disp<sub>i</sub>] and vertical (deviation [dev<sub>ij</sub>])distributinal significance of term T<sub>i</sub> within the corpus. The domain relevancy score so reflects the ranking and distributinal characteristics of a term within the entire corpus. Note that the domain relevancy scores for a few terms can be negative, that indicates a comparatively weaker association. The failure probability of a node is as follows: P[F<sub>i</sub>]=1-(1-P[F<sub>i</sub><sup>B</sup>])(1-P[F<sub>i</sub><sup>C</sup>])(1-[F<sub>i</sub><sup>A</sup>]),We now present how to estimate P[F<sub>i</sub><sup>B</sup>], P[F<sub>i</sub><sup>C</sup>],and P[F<sub>i</sub><sup>A</sup>].

#### C. Failure by Energy Depletion

Estimating the remaining energy of a powered device may be a well-researched downside [12]. We have a tendency to adopt the remaining energy estimation algorithmic program in [12] thanks to its simplicity and low overhead. The algorithmic program uses the history of periodic battery voltage readings to predict the battery remaining time. Considering that the error for estimating the battery remaining time follows a normal distribution [13], we discover the likelihood that the battery remaining time is a smaller amount than T by shrewd

the additive distributed operate (CDF) at T . Consequently, the predicted battery remaining time x may be a random variable following a traditional distribution with mean  $\mu$  and variance, as given by:

$$P[F_i^B]=P[\text{Rem. time} < T | \text{Current Energy}].$$

$$\int_{-\infty}^T f(x; \mu; \sigma^2) dx, f(x; \mu; \sigma^2) = \frac{1}{\sigma \sqrt{\pi}} e^{-\frac{1}{2} \frac{(x - \mu)^2}{\sigma^2}}$$

#### D. Failure by Temporary Disconnection

Nodes may be quickly disconnected from a network, e.g., thanks to the quality of nodes, or just once users put off the devices. The likelihood of temporary disconnection differs from application to application, but this data may be inferred from the history: a node step by step learns its behavior of disconnection and cumulatively creates a likelihood distribution of its disconnection. Then, given the present time  $t$ , we can estimate the likelihood that a node is disconnected from the network by the time  $t+T$  as follows:

$$P[F_i^c] = P[\text{Node } i \text{ disconnected between } t \text{ and } t + T].$$

#### E. Fuzzy Model

The characteristic perform of a crisp set assigns a charge of both 1 and zero to each character inside the standard set, thereby discriminating participants and nonmembers of the crisp set into consideration. This carry out will also be generalized such that the fee assigned to the factors of the established set fall within a chosen variety and suggest the membership grade of those elements inside the set in query for better values denote larger degrees of set membership. The sort of perform is known as club perform and the set outlined through it a fuzzy set. The range of values of membership functions is the unit interval  $[0, 1]$ . right here each membership perform maps elements of a given common set  $X$ , which is constantly a crisp set, into actual amount  $\sin [0, 1]$ . The membership function of a fuzzy set  $A$  is outlined through  $A, A: X \rightarrow [0, 1]$

##### E.1. Decision Making System

For decision-making, either style 1 fuzzy or type 2 fuzzy can be utilized as in line with the requirement. The 4 essential add-ons of range 1 fuzzy willpower-making applications are: 1) The Interface: This determines the center and output variables and maps them into linguistic variables which might be to be displayed for the Cloud individuals; 2). The talents Base: this is a part of informed techniques that entails the area skills club competencies, crew Key contract and control thoughts are decided by using manner of the government at this point, situated on their competencies of the technique; 3) the resolution making good judgment: This treats a fuzzy set as a fuzzy proposition. One fuzzy proposition can effortlessly an extra, and or greater fuzzy propositions can also be related by the usage of a Boolean connectivity relation to infer a closing fuzzy proposition; four). The defuzzification interface converts the fuzzy output right into a crisp rate [09].

##### E.2. Fuzzy Inference System

Fuzzy set theory is an appropriate system for modeling uncertainty arising from intellectual phenomena, which is probably neither random nor stochastic. In this paper, we use fuzzy inference technique (FIS) to evaluate the cloud computing person's pride, a fuzzy inference approach is a rule based method with principles and operations associated with fuzzy set notion and fuzzy right judgment. This approach is a rule hooked up technique which is mapping enters regions to output spaces. Accordingly, they allow growing buildings to be used to generate responses (outputs) by means of unique simulations (inputs) headquartered at the stored potential of the way the responses and simulations are related. The information is stored inside the shape of a rule base, it really is, an algorithm that specific the relation between inputs of a technique and expected outputs [11]. A "membership carry out" is a curve that defines how the worth of fuzzy variable is mapped in a diploma of membership between 0-1.in this paper to assess cloud computing man or woman's delight 3 steps were finished. In the first step, membership functions are used to calculate the degree of fuzzy character's pleasure in specific values expressed via manner of linguistic time period harking back to low, low to medium to immoderate and excessive .IF-THEN expression is the most not unusual method for representing human knowledge. This kind more often than not is called deductive type. It means that if we accept on a truth (premise, hypothesis, antecedent), then we are in a position to infer a further reality called end (consequent). The fuzzy inference technique is a standard approach for big range of technology and engineering. In step, for making thoughts the verbal options of authorities regarding the outcomes of distinct elements equivalent to safety, performance and overall performance, adaptability and charge are gathered and processed for generating a rule base and utilizing them as inputs of our fuzzy inference system [8].

## IV. WORK DONE

In this section, it introduces the input dataset, System requirement and practical environment and results.

#### A. Results of Practical Work

Practical work done is as shown in graphs given below. Following figure shows the graphical representation of time verses algorithms. Performance is computed according to the time required for set of transactions.

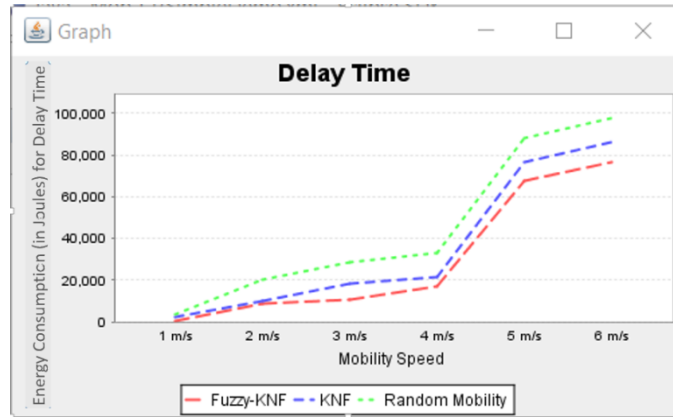


Fig 3. Energy Consumption during Delay Time when Mobility Speed is varied

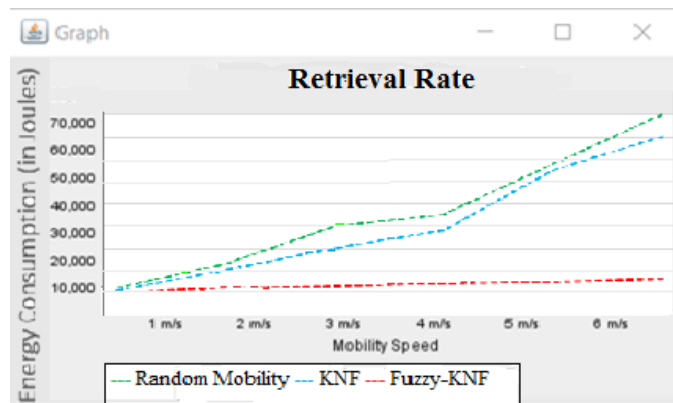


Fig. 3. Energy Consumption during Retrieval Rate when Mobility Speed is varied

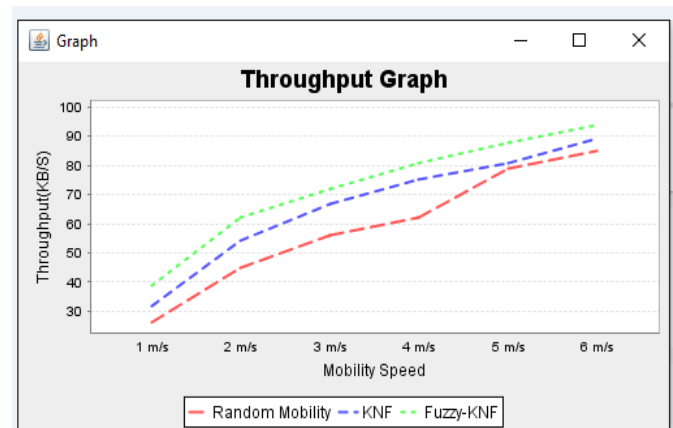


Fig 4. Throughput Graph

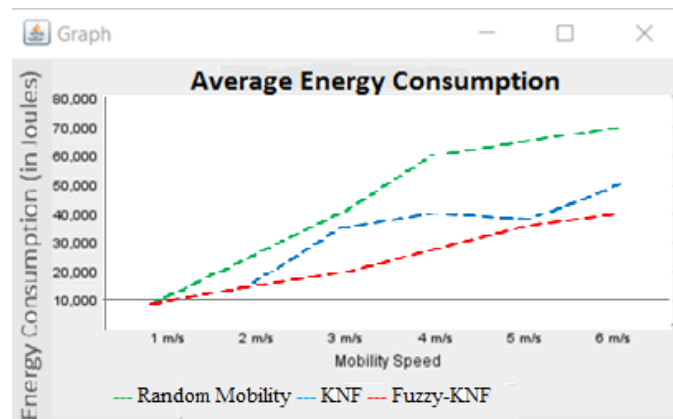


Fig. 5. Average Energy Consumption of the system during variations of Mobility Speed

## V. CONCLUSION AND FUTURE WORK

In this paper, fuzzy-based logic is introduced where the area unit by implementing new methodology mentioned. It provide the primary good Data Storage & Processing in Mobile Cloud Using Fuzzy Logic that together addresses the power-effectively and fault-tolerance challenges. Mobile computing clients are watching for additional study techniques to save and get information or data to their widespread amount of personal know-how. It assigns information fragments to nodes such that different nodes retrieve knowledge reliably with minimum electricity Consumption. Alternately Complexity of managing knowledge growing so better options has been given to put into effect. Proposed paintings is supplying extra flexibility to get admission to the information utilizing if then rule of fuzzy ideas. Also those facts should no longer be targeted. In future proposed approach ought to encompass fuzzy belief to reinforce accessibility of tremendous simulations in higher scale networks and prove the effectiveness of our answer. It also permits nodes to process disbursed data such that the energy consumption for processing the statistics is minimized.

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