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Agent approach to Feature Based Image Retrieval in a Network

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Abstract

The developments in the field of internet allow users in almost all the professional areas for exploiting the opportunities offered by the ability to access and manipulate remotely-stored images. The large multimedia database has to be processed within a small fraction of seconds for many of the real time applications. This demand of using the technique of content based image retrieval (CBIR) as a scheme for searching large database for image retrieval has addressed some of the issues that need to be solved for having an efficient system. The project focused on the issues of image retrieval and also suggests a method to get an accurate result by using a hybrid search methodology. It works with genetic algorithm to get a local optimal result and neural network to get a global optimal result. The overall system architecture is based on a multi-agent paradigm where agents autonomously search for images. Results show that this system is capable of significantly reducing the time and management effort associated with large amounts of image data.

Keywords: Feature based image retrieval, Jade, Agent.

1.INTRODUCTION

The recent advances in the digital technologies have created a great demand for organizing the available digital images for easy retrieval [1]. The retrieval of similar images based on a query from the large digital image database is a challenging task. A content based image retrieval system, commonly known as image search engine is used for image retrieval of relevant query similar images from the large digital image database. The term has been widely used to describe the process of retrieving desired images from a large collection on the basis of features that can be automatically extracted from the images themselves. The features used for retrieval can be either primitive or semantic, but the extraction process must be predominantly automatic [2]. The applications of image retrieval system include areas such as medical imaging, criminal investigation, computer aided design etc. The CBIR technique is an emerging technology that attracts more and more people from different fields such as computer vision, information retrieval, database systems, and machine learning [3]. But there are some problems which are becoming widely recognized such as the semantic gap between low-level visual content and higher level conceptsand the high computational time taken for image analysis, image indexing and image searching. This work proposes a solution for the second issue, which will make the system more efficient with less computational time for image analysis, searching and image retrieval. In this proposed work, the optimal image retrieval scheme is aimed by implementing genetic algorithm.

The content based image retrieval (CBIR) system works by extracting several textual features and these features are used for analyzing and retrieving the optimal image results for the query from the user. Genetic algorithm is used as the optimization technique for getting a local optimal result and this result is trained to an optimal result by using neural network. There are so many issues like selecting the good features, large computational time, large storage space etc. as addressed in the papers[3][4][5].

Agents that are independently compute the similarity between the query image and each database images, based on their specialized similarity criterion and matching algorithm. A multiagent system is inherently dynamic, flexible and adjustable to the needs of a particular retrieval. Each agent is responsible for assessing the similarity of the query image to each candidate image contained in a collection based on a specific primitive feature and a corresponding similarity criterion. The overall system architecture is based on a multi-agent paradigm where agents autonomously search for images.

Problem definition: The project is focused on the issues of image retrieval and also suggests a method to get an accurate result by using a hybrid methodology based on a multi-agent paradigm

The paper is organized as follows:Section two presents Literature Review which includes a review of the retrieval techniques so far developed, an overview of genetic algorithm and neural network. Section three describes the Feature based Image Retrieval which includes block diagram and Algorithm of proposed solution, and Section four discussed Agent based approach which include a block diagram. Section five to seven contains Implementation modules description, and Section eight gives the testing strategies and Section nine hold the summary of results

2.LITERATURE REVIEW

In this paper we proposed an algorithm called Feature based Image Retrieval (FBIR). Hence in this section I included the technologies which related to the work. A brief description of an overview of Content Based Image Retrieval (CBIR), Genetic Algorithm and Neural Network are the following:

2.1OVERVIEW OF CBIR

The word"Content Based" says that the retrieval of images are taking place rather than the metadata like keywords, tags, descriptions etc. Retrieval of images based on the content which refers to colours, shapes, textures or any other information that can be derived from the image itself. The demand for using large multimedia database for the various real time applications have addressed many issues in the field of content based image retrieval. They can be addressed mainly as

• Image storage problem
• Image retrieval problem

Humans manually enter keywords for image retrieval in a large database can be inefficient and are difficult to capture every keyword that describes the image, which was the process in the traditional search methodology. CBIR will help to filter images based on the content and return more accurate results.

The process of content based image retrieval is that, images visual contents are extracted and described by multidimensional feature vectors and which forms a feature database. When the user gave an image query or sketched figure the system changes the image into feature vector. The system will check the similarities with the featured image database then the retrieval is performed with an indexing method which provides an efficient way to search for the image database. After the retrieval of image, the users can feedback to modify the process of retrieval for more accurate results [4].

Classifications of query types are into three levels [7].

- **Level 1** comprises primitive features such as color, texture, shape or the spatial location of image elements etc. For example, query might include "find images containing yellow stars arranged in a ring", which is both objective and directly derivable from images themselves, without the need to refer to any external knowledge base. Its use is largely limited to specialist applications such as trademark registration, identification of drawings in a design archive or color matching of fashion accessories [7].
- **Level 2** comprises retrieval by derived (logical) features, involving some degree of logical inference about the identity of the project depicted in the image. It can usefully be divided further into i) Retrieval of objects of a given type, example: "find pictures of a double Decker bus"; ii) Retrieval of individual objects or persons, example: "find a picture of the Eiffel Tower";[7].
- **Level 3** comprises retrieval by abstract attributes, involving a significant amount of high level reasoning about the meaning and purpose of the objects or scene depicted. Again this level of retrieval can be subdivided into: i) Retrieval of named events or type of activity, example:"find pictures of Scottish folk dancing"; ii) Retrieval of pictures with emotional or religious significance, example:"find a picture depicting suffering"; [7].

The CBIR technology can be of mainly four types [1] [7]

1)RETRIEVAL BASED ON COLOUR FEATURE

Histograms are generally used for describing colour feature of the images [8], which shows the proportion of pixels of each colour within the image. Each images of colour histogram are added to the database. User can either specify the colour or can give the image from which colour histogram is calculated. The matching technique such as histogram intersection is used to retrieval the images based on the colour feature.

2) RETRIEVAL BASED ON TEXTURAL FEATURE

Another important property of image is Texture. For measuring texture similarity a variety of techniques has been used. Texture representation schemes can be broadly classified as Structural and Statistical. Texture queries can be formulated in a similar manner to colour queries, by selecting examples of desired textures from a palette, or by supplying an example query image. The system then retrieves images with texture measures most similar in value to the query.

3) RETRIEVAL BASED ON SHAPE FEATURE

Shape is another important feature that is basically used describes image content. Two main types of shape feature are commonly used - global features such as aspect ratio, circularity and moment invariants and local features such as sets of consecutive boundary segments.

4) RETRIEVAL BY OTHER TYPES OF PRIMITIVE FEATURE

One of the oldest-established means of accessing pictorial data is retrieval by its position within an image. Most of these rely on complex transformations of pixel intensities which have no obvious counterpart in any human description of an image. Most of the techniques aim to extract features which reflect some aspect of image similarity which a human subject can perceive, even if he or she finds it difficult to describe [1][8]. With the progress of research and development of accurate and fast image retrieval systems, the performance of such systems needs to be improved. The performance can be improved by removing the irrelevant and redundant features from taking into consideration [9]. Many optimization techniques can be used to improve the performance of such image retrieval systems.

FBIR works in two main phases. In the first phase it works with genetic algorithm (GA). It performs a local optimization to generate a small set of images, depending on a fitness function value. The fitness function depends on the feature values of an object in the image. In the second phase, to get an optimal result, neural network is used to train the newly generated set of image from the first phase with the user query.

2.2OVERVIEW OF GENETIC ALGORITHM

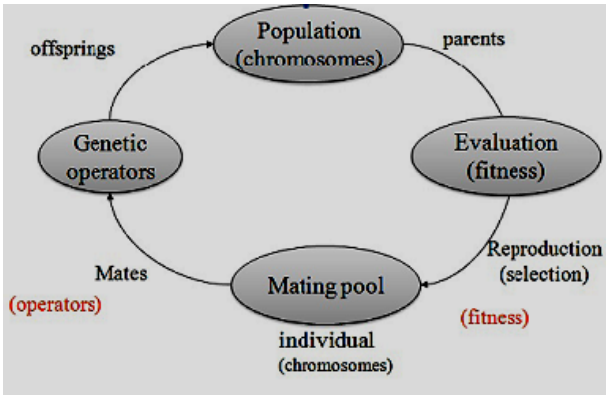
Genetic algorithms are used as nature inspired adaptive algorithms for solving real time practical problems. Genetic Algorithms search algorithms based on the mechanisms of natural selection and natural genetics, survival of fittest and randomized information exchange. GA was first introduced by John Holland for the formal investigation of the mechanisms of natural adaptation, but the algorithms have been modified to solve computational search problems.

"The genetic algorithm is a probabilistic search algorithm that iteratively transforms a set (called a population) of mathematical objects (typically fixed length binary character strings), each with an associated fitness value, into a new population of offspring objects using the Darwinian principle of natural selection and using operations that are patterned after naturally occurring genetic operations, such as crossover and mutation" [10].

Genetic algorithm works with the operators like:

- **Selection** - GA selection operators perform the equivalent role to natural selection. The overall effect is to bias the gene set in following generations to those genes which belong to the most fit individuals in the current generation [11].
- **Crossover** - Members of the newly reproduced strings in the mating pool are mated at random and each pair of strings undergo crossing over and crossover is the process by which good schema get combined.
- **Mutations** - Mutation enables the GA to maintain diversity whilst also introducing some random search behavior.
- **Inversion**- This operator aims to mimic the property from nature that, in general, the function of a gene is independent of its location on the chromosome.

The working of GA can be represented using the following diagram.



A Genetic Algorithm works with a population of individuals, also known as 'chromosomes', which represent the possible solutions to a given problem. In nature, the 'fitness' describes the ability of an organism to survive and reproduce. But in the case of genetic algorithm it is discussed as the result of the objective function. In the population, the organisms with a better fitness score (value of the fitness function) are more likely to be selected to the mating pool. This promotes the genes with more beneficial characteristics to propagate through generations [12].

For each problem to be solved, one has to supply a fitness function, and indeed its choice is crucial to the good performance of the GA. For a chromosome or an individual, a numerical value will be return as a fitness function, which represents the utility of an individual. This value will be used in both the parent's selection process and in the survival selection process for next generations, so the fittest individual is being chosen [13][5].

2.3OVERVIEW OF NEURAL NETWORK

Neural network is a bio- inspired methodology. Bio-inspired techniques often involve the method of specifying a set of simple rules, a set of simple organisms which adhere to those rules, and a method of iteratively applying those rules. After several generations of rule application it is usually the case that some forms of complex behavior arise [14]. There is a biologically inspired way of training recurrent neural networks that takes its methodology from another field of bio-inspired computing -genetic algorithms. The set of weights for a neural net can be seen as a genome. By introducing a fitness function that differentiates networks from each other according to how well they perform a task, the genomes of the more successful networks can be used as parents for future generations. The genomes are combined according to some algorithm, commonly taking half of one parent's and half of the other's genome. Mutations are introduced to make sure the genetic algorithms have more complete coverage of the solution space [15].

Neural Networks can be done in three modes, supervised learning, un-supervised learning and Reinforced Learning. In a supervised learning scheme, the inputs are trained to get the user-defined output. The cost function is the difference between the mapping and the data. This scheme has a prior knowledge about the problem domain. The average squared error between the network's output and the target value over the user defined data is minimized. The algorithms used commonly for training are back propagation algorithm [16] and least mean square error convergence (LMS) algorithm [17]. The most commonly seen application of supervised learning is pattern recognition and regression. This type of learning scheme is analogous to a 'teacher' in the form of a function that provides continuous feedback on the quality of solutions obtained so far.

In an unsupervised learning, a cost function dependent on the task is to be minimized. A set of data is given as the input and the set of assumptions and parameters are considered to solve the problems. The problems like clustering come under this scheme. It is as if there is no teacher is present the desired patterns and hence, the system learns of its own discovering and adapting to structural features in the input patterns [12].

In Reinforced Learning, a teacher through available, does not present the expected answer but only indicates if the computed output is correct or incorrect. The

information provided helps the network in its learning process. A reward is given for a correct answer computed and a penalty for a wrong answer [12].

3.FEATURE BASED IMAGE RETRIEVAL

3.1Block diagram

The FBIR works in two phases. The first phase is done using genetic algorithm as a local search optimization technique. Features are extracted from the query images and compared with the images in the image database. Based on a fitness function, the relevant features are given more priority and they are shown as the result of the first phase. The result of the first phase is given as the input to the second phase. In the second phase the result of the first phase is trained with the input image. In this phase neural network is used to train the first stage result, so that the difference between the input image and the local optimal result is minimized and thereby getting into a global optimal result.

In the first phase, an initial set of possible solutions are evaluated based on a fitness function. The population contains chromosomes and these chromosomes contain the genes. Each gene represents an image segment. For each segment the various features of the object are studied and coded to a gene. Various operators like selection, crossover and mutation operators are applied to obtain the 'fit' members of the next generation.

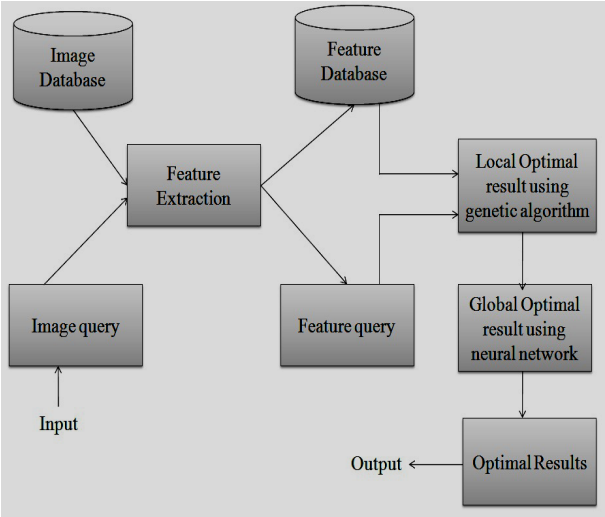


Figure 3.1: Block Diagram of FBIR System

Fitness function is used to evaluate the individual or chromosome quality in the population. So the fitness function (F) of image query (q) and chromosomes(c) are,

$$F(q, c) = w.h(x, color) + w.h(x, shape) + w.h(x, texture) \quad (1)$$

Where 'w' is the weight of feature, 'h' is the feature of images and x is the image region. The selection operator selects the members for the mating pool by a probabilistic approach. It calculates the probability [13] of an individual to get selected when it is in a population using equation (2).

$$p_j = \frac{f_j}{\sum_{j=1}^{N} f_j} \quad (2)$$

Where N is the number of individuals in the population and is the fitness value associated with each individual. A *roulette wheel* scheme is used commonly. In the mating pool, exchange of the chromosome material will happen during the crossover operation. Two individuals will mate each other to form two other individuals. The next operator is mutation. Mutation is basically any changes in the environment creating a significant change in the genetic make-up of an organism [18]. The probability of mutation is made very less. The genetic algor0ithm is an iterative process [19]. Search process using GA is controlled by certain control parameters like crossover probability, mutation probability, population size etc.

The output of the first phase is the local optimal results which serve as the input to the next stage. This output is trained using the least mean square convergence method of neural network. The LMS algorithm is an adaptive algorithm based on the gradient based approach [12]. LMS incorporates an iterative method of updating the weight vector based on the difference calculated from the feedback input image query with the set of local optimal result obtained from the first phase. The procedure leads to a minimum mean square error. The result thus obtained after the second phase is a global optimal result.

3.2ALGORITHM

Input: The Images in Database and query image

Output: Optimized search image

1. ***Start***
2. ***Initialization:***

   Collect many images and prepare a database for those images
3. ***Select a query image to the CBIR***
4. ***Extract features of the query image***
5. ***Calculate similarity measurement with the features of colour, shape, intensity, and edge***
6. ***Calculate fitness function and check it with the threshold and if the image score is greater than the threshold, display it as the local optimal result***
7. ***Based on the user's feedback, train the obtained outputset using neural network***
8. ***Get the optimal result***
9. ***Stop.***

3.3AGENT BASED APPROACH

Agents are defined as software or hardware entities that perform some set of task on behalf of users with some degree of autonomy. Increasing the number of agents might simplify the work each individual agent must accomplish; there is a corresponding increase in the complexity of the division of the labor and communication between agents. This in turn ensures that there is a smooth growth in agent oriented approach in the image retrieval system.

According to Maes [21], "agents are computational systems that inhabit some complex dynamic environment, sense and act autonomously in this environment, and by doing so, realize a set of goals or tasks for which they are designed". Multi-agent systems, furthermore, are a set of distributed agents that work in parallel with a certain degree of independence, however cooperatively. There are three main categories of agents: a) Biological agents, such as humans and animals, possess the maximum of the aforementioned properties. Their capabilities usually constitute the topmost target for any implementation, including the agents of the other two categories. b) Artificial agents are computational systems, such as robots, trying to mimic the behavior and the properties of the corresponding biological. c) Software agents are a subcategory of the previous one that lack the advantage of an embodied system but are capable of simulating and inhabiting any environment or situation.

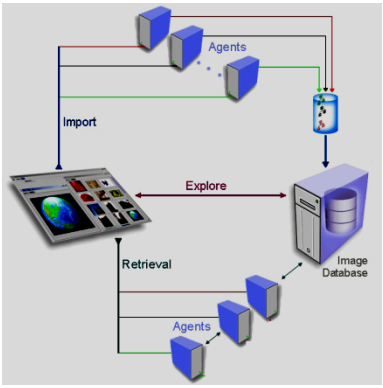


Figure. 4.1 Agent based approach

As shown in Figure Images can be imported into the database, viewed individually or in galleries, and can be retrieved based on their visual content. Images that are similar to a query image may be retrieved from a specific set of image or from all images contained in the database. The query image and the set of images are both selected by the user. During importing of images, each agent extracts the necessary features to be subsequently used for similarity matching and retrieval. This function induces a heavy computational cost. However, since it is not a real time function, it is executed prior to retrieval and does not affect the system's overall performance. Image retrieval is a real time function during which each agent uses its preprocessed information and, therefore, consumes limited computational resources. A retrieval process is based on a query image and a set of images contained in the database. Each agent works independently, and different agents work in parallel, to compute the similarity between the query image and image database based on its specialized similarity criterion and matching algorithm. Furthermore, the reasoningon which the final ranking of database image similarity is based is exported, thus allowing the user to interpret the response to a specific query and to fine tune relevant parameters in order to improve the response to subsequent queries. This reasoningconsists of the contribution of each agent to the final ranking of each database image. The FBIR system is fully scalable and can be easily extended with additional agents.

4. SYSTEM ANALYSIS

4.1 EXISTING SYSTEM

The retrieval of similar images based on a query from the large digital image database is a challenging task. There are many existing systems provide the image retrieval technique. The CBIR technique is an emerging technology that attracts more and more people from different fields. Traditional image retrieval mainly bases on the text, using keywords, or free text to descript each image and using text-matching to search. Therefore, content based image retrieval (CBIR) is proposed. This technology extracts visual image features automatically by machine such as color, texture, shape, object location and mutual relations match the images of the database and sample images in the feature space, then search out the similar image of the sample.

But there are some problems which are becoming widely recognized such as the semantic gap between low-level visual content and higher level concepts and the high computational time taken for image analysis, image indexing and image searching. For development of a real time CBIR system, feature processing time and query response time should be optimized. A better performance can be achieved if feature-dimensionality and space complexity of the algorithms are optimized. Specific issues, pertaining to application domains are to be addressed for meeting application-specific requirements. Choice of techniques, parameters and threshold-values are many a times application domain specific e.g. a set of techniques and parameters producing good results on an image database of natural images may not produce equally good results for medical or microbiological images.

4.2 PROPOSED SYSTEM

Our proposed system introduces a new technique for feature based image retrieval in distributed environment. Technique is the optimal image retrieval scheme is aimed by implementing genetic algorithm. Genetic algorithm is used as the optimization technique for getting a local optimal result and this result is trained to an optimal result by using neural network. The first phase is done using genetic algorithm as a local search optimization technique. Features are extracted from the query images and compared with the images in the image database. Based on a fitness function, the relevant features are given more priority and they are shown as the result of the first phase. The result of the first phase is given as the input to the second phase. In the second phase the result of the

first phase is trained with the input image. In this phase neural network is used to train the first stage result, so that the difference between the input image and the local optimal result is minimized and thereby getting into a global result.

We use Java Agent Development Environment method for this technique. Jade creates multiple containers for agents, each of which can be on the same computing system or different systems. Together, a set of containers forms a platform. Each platform must have a Main Container which holds two specialized agents called the AMS agent and the DF agent. The AMS (Agent Management System) agent is the authority in the platform. It is the only agent that can create and kill other agents, kill containers, and shut down the platform. The DF agent implements a yellow pages service which advertises the services of agents in the platform so other agents requiring those services can find them. based on the coexistence of several Java Virtual Machines and communication relies on Java Remote Method Invocation between different VMs and event signaling within a single VM. Each VM is a basic container of agents that provides a complete run time environment for agent execution and allows several agents to concurrently execute on the same host. In principle, the architecture allows also several VMs to be executed on the same host; however, this is discouraged because of the increase in overhead and the lack of whatever benefit. Each agent container is a multithreaded execution environment composed of one thread for every agent plus system threads spawned by RMI runtime system for message dispatching. A special container plays the front-end role, running management agents and representing the whole platform to the outside world.

4.3 ADVANTAGE OF PROPOSED SYSTEM

- GA works with population of individual strings and NN can learn various tasks from examples, classify phenomena and model nonlinear relationships.
- JADE tries to provide its users with standard agent technologies while keeping runtime overheads low.
- The overall reliability and usability of JADE was improved.
- Many JADE objects can be recycled instead of destroyed and recreated back, reducing dynamic memory allocation.
- The performance of the system is efficient in distributed environment.

5.MODULES

5.1.FEATURE EXTRACTION FROM IMAGES

A data set is a collection of data, usually presented in tabular form. Each column represents a particular variable. Each row corresponds to a given member of the data set in question. It lists values for each of the variables. Here they use four different data sets for distortion technique. These collections of all datasets are located in different distributed environment. A database is an organized collection of data for one or more purposes, usually in digital form. The data are typically organized to model relevant aspects of reality, in a way that supports processes requiring this information. The databases consist of list of images. First select the image and then extract the features from image. The retrieval is performed with an indexing method which provides an efficient way to search for the image database. After the retrieval of image, the users can feedback to modify the process of retrieval for more accurate results. The performance can be improved by removing the irrelevant and redundant features from taking into consideration.

5.2.GENERATION OF LOCAL OPTIMAL USING GA

Genetic algorithm is used as the optimization technique for getting a local optimal result and this result is trained to an optimal result by using neural network. The first phase is done using genetic algorithm as a local search optimization technique. Features are extracted from the query images and compared with the images in the image database. Based on a fitness function, the relevant features are given more priority and they are shown as the result of this phase. The result of the first phase is given as the input to next phase. For each problem to be solved, one has to supply a fitness function, and indeed its choice is crucial to the good performance of the GA. For a chromosome or an individual, a numerical value will be return as a fitness function, which represents the utility of an individual. This value will be used in both the parent's selection process and in the survival selection process for next generations, so the fittest individual is being chosen.

5.3.GENERATION OF GLOBAL OPTIMAL USING NN

In this phase the result of the previous phase is trained with the input image. In this phase neural network is used to train the first stage result, so that the difference between the input image and the local optimal result is minimized and thereby getting into a global result. Neural Networks can be done in three modes, supervised learning, un-supervised learning and Reinforced Learning. In a supervised learning scheme, the inputs are trained to get the user-defined output. The cost function is the difference between the mapping and the data. This scheme has a prior knowledge about the problem domain. The average squared error between the network's output and the target value over the user defined data is minimized. This output is trained using the least mean square convergence method of neural network. The LMS algorithm is an adaptive algorithm based on the gradient based approach. LMS incorporates an iterative method of updating the weight vector based on the difference calculated from the feedback input image query with the set of local optimal result obtained from the first phase. The procedure leads to a minimum mean square error

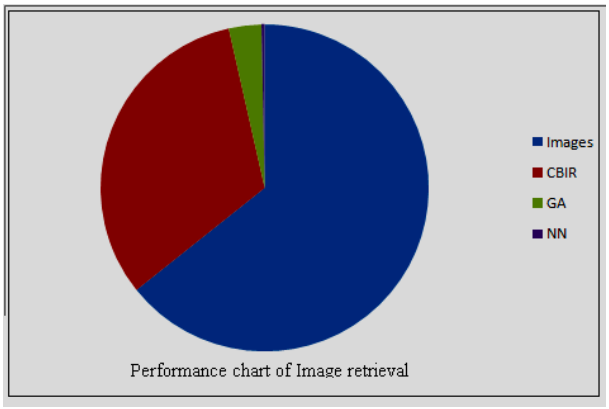
5.4.FEATURE EXTRACTION IN DISTRIBUTED ENVIRONMENT

In this module we implement the feature based image retrieval in distributed environment. We use Java Agent Development Environment method for this technique. Jade creates multiple containers for agents, each of which

can be on the same computing system or different systems. Together, a set of containers forms a platform. Each platform must have a Main Container which holds two specialized agents called the AMS agent and the DF agent. The AMS (Agent Management System) agent is the authority in the platform. It is the only agent that can create and kill other agents, kill containers, and shut down the platform. The DF agent implements a yellow pages service which advertises the services of agents in the platform so other agents requiring those services can find them. based on the coexistence of several Java Virtual Machines and communication relies on Java Remote Method Invocation between different VMs and event signaling within a single VM. Each VM is a basic container of agents that provides a complete run time environment for agent execution and allows several agents to concurrently execute on the same host.

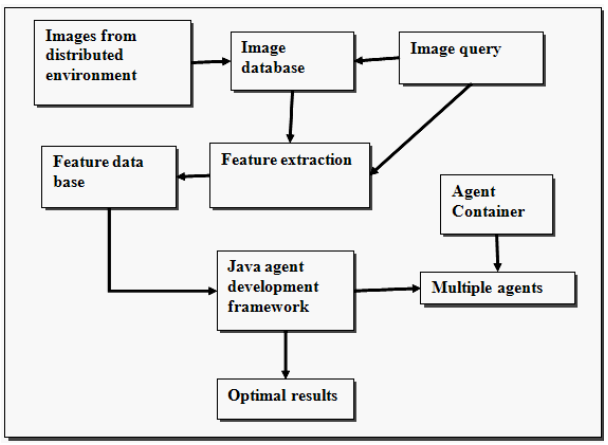
5.5.PERFORMANCE EVALUATION

Finally we have analyzed the performance of the proposed approach with the existing approach in terms of removing the irrelevant and redundant features. Our proposed system tries to provide its users with standard agent technologies while keeping runtime overheads low. Based on the comparison and results shows our proposed technique can be used to improve the performance of such image retrieval systems.



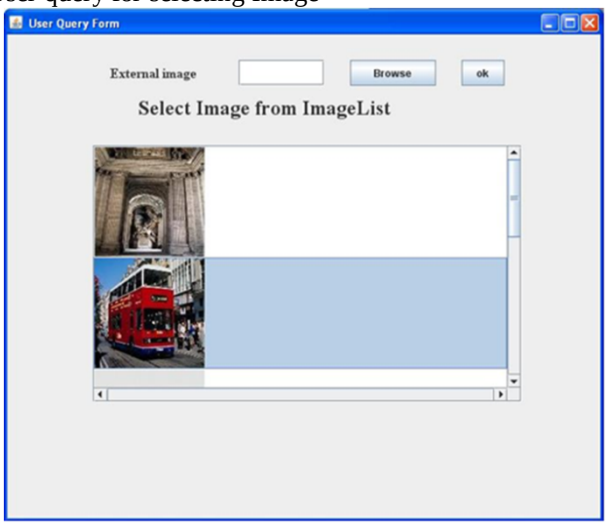
6.DESIGN IMPLEMENTATION

6.1ARCHITECTURE DIAGRAM

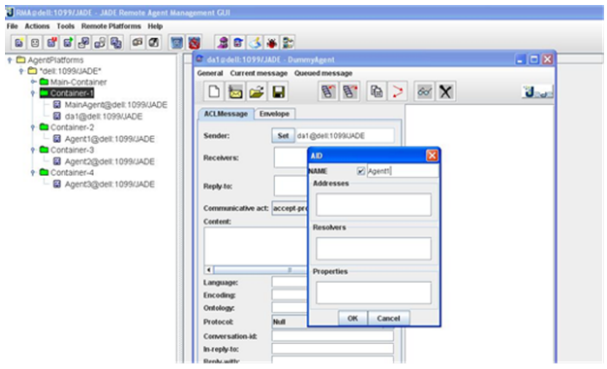


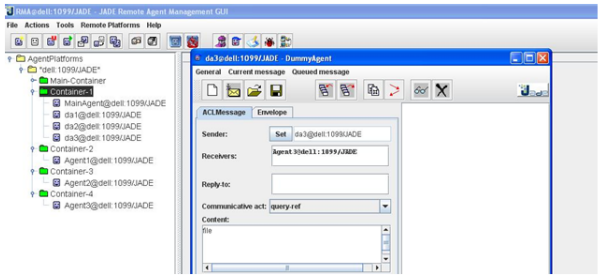
7.EXPERIMENTAL RESULTS

User query for selecting Image

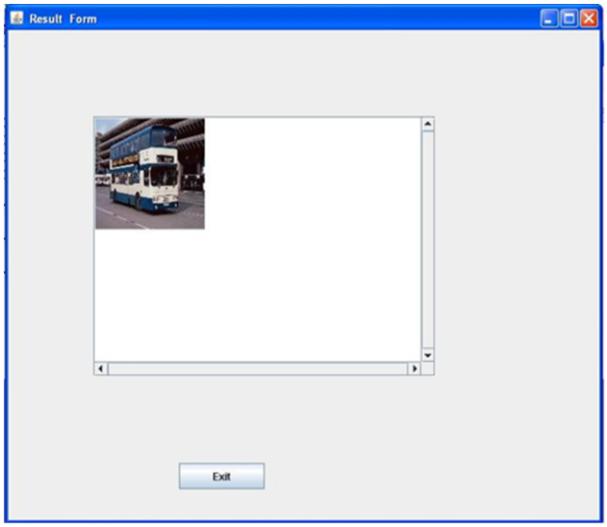


OPTIMIZATION BY THE AGENT USING GA & NN





FINAL OPTIMIZED RESULT



8.CONCLUSION AND FUTURE WORK

The proposed method examined the issue of content-based image retrieval and I presented the implementation of a corresponding platform based on the retrieval of an efficient image from a large database used by a hybrid search methodology. The algorithm includes Genetic Algorithm and Neural Network. The content based image retrieval system has worked by extracting several textual features and these features were used for analyzing and retrieving the optimal image results for the query from the user. The overall system architecture is based on a multi-agent paradigm where agents autonomously search for images and obtained the optimal result significantly reduce the time and management effort.

In Future work, the implementation of feature based image retrieval in Web using mobile agents will be done.

Biographies

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