Lab Week-7 Report

ECSE302L: High Performance Computing

Team Name: Tech Phoenix

Batch: EB02

Team Members:

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Project Title: Parallelized Image Search Engine

Abstract:

In recent years, there has been a rapid exponential leap in the growth of multimedia databases - chiefly those that are maintained and operated by web-search engine giants such as Google, Yahoo, Ask, Bing, Baidu, and DuckDuckGo (to name a few). Furthermore, millions of images are published to various social networking platforms such as Instagram, Twitter, and Facebook on a daily basis and it is extremely taxing to even get started on searching for a relevant image from these massive global archives. This is one of the most sought-after challenges that the computer vision community faces as of today.

Although the traditional textual keyword-based retrieval techniques (that rely upon metadata/tags/captions/keywords) are quite established and are robust enough to result in semantically relevant outcomes, most search-engines are less efficient in fabricating semantically relevant results coming to multimedia-based retrieval approaches (utilizing image/audio/video files). However, text-based retrieval is not feasible in most cases, for instance, it is not always possible to capture visual content in the form of text. Like it is always said, “A picture is worth more than a thousand words”, image content comes in various forms and encompasses a narrative far beyond a set of words.

Image retrieval in itself is a strenuous task, and this comes as no surprise as the underlying algorithm is compelled to index an entire database comprising of millions if not billions of images using one or more combinations of feature extraction techniques (such as deep feature extraction, SIFT, etc.) to identify the 'content' of an image based on its texture, shape, and colour after deciding a descriptor, perform similarity/dissimilarity checks (using metrics such as Cosine similarity,

Euclidean/Minkowski/Manhattan/Chi-squared distances, etc.) with each of these indexed images against the query image, aggregate the results (if required) and return the top search results for the query image. "Content-Based Image Retrieval (CBIR)" is a well-interpreted problem undertaken by the computer vision community as opposed to the classical concept-based techniques.

Hence, the sole focus lies in enhancing each of these underlying methodologies, making them as efficient and lightweight as possible subject to the fundamental concepts of High-Performance Computing (HPC), including enhancing the search by incorporating cache mechanisms (graph-based image search/clustering techniques) or similar strategies to avoid undesirable traversal through all the image feature vectors in the database.

Contribution of HPC Aspect:

The aforementioned problem can be interpreted as an application of High-Performance Computing (HPC) by parallelizing the adopted sequential approaches (such as indexing - feature extraction, measuring similarity, searching/sorting) by utilizing multiple processors/cores on a local machine for the purpose of demonstration. Scalability, expandability, flexibility, interoperability, and aggregation would serve as the core design principles of an efficient parallelized image search engine.

Deliverables:

After taking in a query image, the program returns the corresponding top search image results with/without applying image search content filters. Indexing/feature extraction along with computing similarity/distance will be carried out in both serial and parallel fashion.

HPC Libraries to be used:

Multiprocessing, Threading, PyMP, PyCUDA, Numba

Datasets:

1. ImageNet LSVRC 2012 Validation Dataset (6.86 GB)
2. Stanford STL-10 Image Dataset (2.64 GB)

Resources/References:

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