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Application of Parallel Processing - A Case Study on Pattern Recognition

Muhammed Nazrin bin Nordin [#1], Mohamed Faidz Mohamed Said [#2]

[#] *Faculty of Computer & Mathematical Sciences, Universiti Teknologi MARA*
70300, Seremban, Negeri Sembilan, MALAYSIA

[1] nazrinnordin94@gmail.com

[2] faidzms@ieee.org

***Abstract*—This paper will explain a case study on pattern recognition in parallel processing. It is about the organisation of input data into familiar classes through the abstraction of significant structures or characteristics of the data from a background of unrelated detail. A simpler definition of pattern recognition of parallel processing is searching for structure in data that exist in the system or in database. For example, a pattern could be a fingerprint image, a handwritten word, a human face, movement pattern or a speech signal. The pattern recognition problems are important in a variety of engineering and scientific disciplines such as biology, psychology, medicine, marketing, artificial intelligence, computer vision and remote sensing. Forensics use pattern recognition to recognize a fingerprint pattern of a suspect. Besides that, in a medical situation, doctors use pattern in reading X-ray, ultrasound and other types of scan to detect patient diseases. This research will clarify the use of pattern recognition using parallel processing in statistical pattern, fingerprint detection, face recognition and natural disaster forecasting. There is a variety of ways to apply the knowledge of pattern recognition in our daily life.**

Keywords: **pattern, recognition, parallel, processing, detection**

I. INTRODUCTION

A standout amongst the most critical capacities of humanity is learning by understanding, by our endeavours and by our obligations. When humans achieve an age of five the greater part of them can perceive digits, characters, regardless of whether it is enormous or little, capitalized or lowercase, turned or tilted. Human visual recognition is an intricate procedure which includes the eyes and human mind. The eyes carry on as electronic gadgets that gather the information, while the mind performs continuous data processing [1]. Taking a gander at the historical overview of the human search for information, people are intrigued with perceiving designs in nature, comprehend it and endeavour to relate designs into an arrangement of tenets [2].

The question is how this experience can be used to make machines to learn. Pattern recognition can also be found in a sports activity such as a basketball free-throw shooting. The presence of coordinative structures and more complicated examination units will produce development design acknowledgment [3]. Movements between players in sports have different patterns [3]. Generally, pattern recognition procedure is to give a sensible response to every single conceivable information and to perform it in all likelihood coordinating of the data sources, considering their factual variety [4].

Pattern recognition process also occurs as a geometric process in a scalable parallel procedure. Geometric pattern recognition occurs in a vital region of study through uses in image computing, constructing and apply autonomy [5]. Pattern recognition can also solve problems in mathematics study [6].

A. Definition

- Parallel processing
  - A set of processing elements that collaborate and commune to quickly resolve huge problems
  - The concurrent use of several process to resolve a computational problem
- Pattern Recognition
  - Pattern recognition is a division of machine learning that focuses on the recognition of patterns and resemblance in data, though it is in some cases considered to be nearly identical with machine learning

II. BACKGROUND

Pattern recognition is a standout amongst the most essential functionalities for intelligent behaviours and it is shown by both natural and artificial systems. The first type of pattern recognition is fingerprint that was introduced by Vucetich and Henry in the 1890s through the advent of automated fingerprint identification. Pattern recognition involves finding patterns and similarities among smaller problems to help users solve more complex problems. It is usually used in forensics and medical. The stages of pattern recognition are distinguished attributes, extract features and compare patterns for a match or mismatch.

III. METHODOLOGY

A. Statistical Pattern Recognition (SPR)

In the last four decades, diagram based strategies in pattern recognition has been deciphered with the objective of perceiving the method of reasoning [7]. The utilization of graphs in Pattern Recognition (PR) has been utilized as an effective tool for indicating and categorising visual patterns, particularly in structured techniques, whose basis is a

visualisation of the matters as made of parts reasonably associated with each other [7].

It is acknowledged that SPR implies actual matters by means of a feature. After these features have been removed, an object turns into an n-dimensional point in the equivalent vector space [7]. The reasoning method of SPR is be placed in the way that the numerical objects of vector spaces remain utilized just before confronting the issue of reviewing and organization of patterns by keen and fine justifiable procedures. When the utilized components have been satisfactorily chosen, a vital property should hold two focuses which are near to each other in the vector space, compared to comparative questions in this present reality. In the meantime, the two comparative items are anticipated to close focuses in the considered vector space [7].

Fig. 1 below displays the issue of assessing how different two items are basically taken back to assess the separation between the relating highlight vectors.

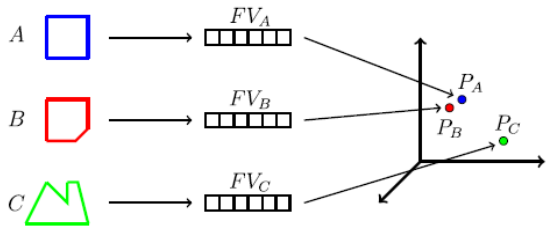

Fig. 1. SPR object representation [7]

The element vectors are separated and subsequently the matters move towards becoming purposes in vector space whose axes compared to the utilized components. Since the 1960s, this affecting property offered drive to the utilization of vector spaces in PR and a lot of measurable learning and order calculations. The edges and the nodes of the graphs are so related to fragments and its connections [7].

B. Parallel Computing Architectures

Utilizing parallel figuring models for manipulating algorithmic parallelism can be a complicated assignment [8]. This exposition shows different procedures for utilizing parallel processing structures to manipulate algorithmic parallelism. Particularly, the three pattern recognition methods are observed for acceleration through several parallel processing architectures. This includes Field Programmable Gate Arrays (FPGAs) and General Purpose Graphical Processing Units (GPGPUs) [8].

One of the parallel computing architectures on pattern recognition is fingerprint identification. It is driven by the use of optical filters and correlation to accomplish great processing speed and poor power conditions [8]. With the extensive use of fingerprinting, here are huge galleries of prints that must be explored. This problem could make a slow process needing high computational inputs [8]. Fig. 2 demonstrates a simple pattern recognition system of a fingerprint identification.

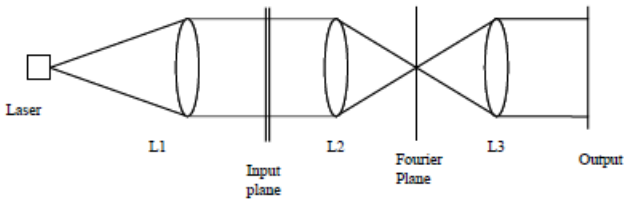

Fig. 2. Optical pattern recognition [8]

The input plane is illumined by constant coherent light formed by a laser source and lens L1. Inside the area of fingerprint recognition, it is necessary to locate the nearest fit between a probe fingerprint to be known [8]. In some circumstances, the fingerprint identification could lose some data. This can be shown in Fig. 3 below.

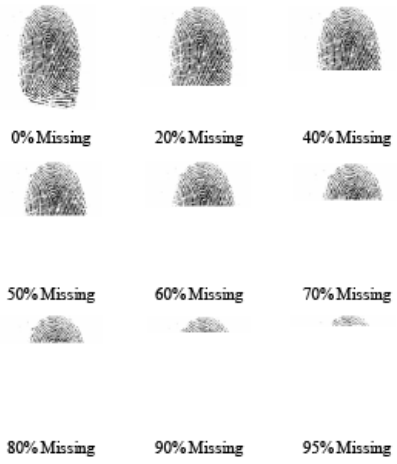

Fig. 3. Input image of lose data [8]

Fig. 4 displays the difference of correlation peak with percentage of losing data once each losing data image was correlated. It can be perceived that the correlation peak lessens nearly linearly with raises in the percentage of data losing. Each image with losing data was also correlated with all models in the gallery to observe whether they might be detected accurately.

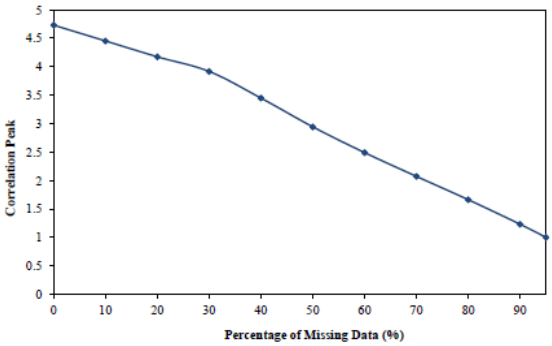

Fig. 4. Correlation peak of lose data [8]

It is important that even once 95% of the fingerprint data is losing, it is however probable to recognize the analysis. This

is because the fingerprint imageries logically have extraordinary spatial frequencies.

C. Extensible in DSP Programs using Cetus

Recent special purpose chip multiprocessor architectures invented for special purpose function fields for instance digital signal processing (DSP) are greatly optimized. Thus, various parallel systems should fulfil the extreme requests on power proficiency [9].

There are three types of recognition methods and tool designs in digital signal processing programs which are pattern detection, pattern definition and system architecture.

Pattern detection is about the pairing procedure at the origin node of the illustrated subtree. The origin node is intended for loop header with just one child, which previously has been identified as incidence of a SINIT pattern. This is shown in Fig. 5 below.

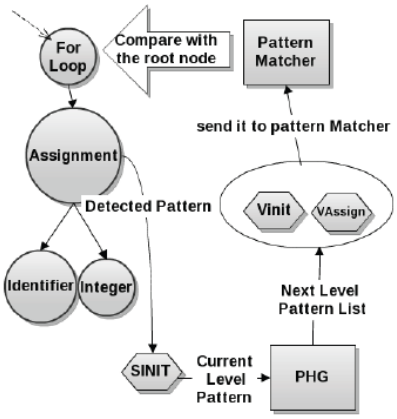

Fig. 5. Pattern detection process [9]

The patterns are delivered to the pattern matcher, which evaluates the internal structure of each pattern with the structure of the parent node and its children [9].

Pattern definition is the independent type of patterns mutually through categorized and extensible arrangement [10]. Each pattern is described as XML nodes in a pattern specification file. For every pattern, there is an XML element that explains the name and the structural part of recognition rules [9].

```
<basepattern    name="SINIT"   >
<roottype>AssignmentExpression</roottype>
<structure>
 <element orderid="1">
  <type>Identifier</type>
  <type>ArrayAccess</type>
 </element>
 <element orderid="2">
  <type>FloatLiteral</type>
  <type>IntegerLiteral</type>
 </element>
</structure>
...
</basepattern>
```

Fig. 6. XML specification of SINIT pattern [9]

Fig. 6 above shows that SINIT has double components, where the primary components are either Identifier or ArrayAccess, and the secondary one can be whichever FloatLiteral or IntegerLiteral. The general architecture of the system can be viewed in Fig. 7 below.

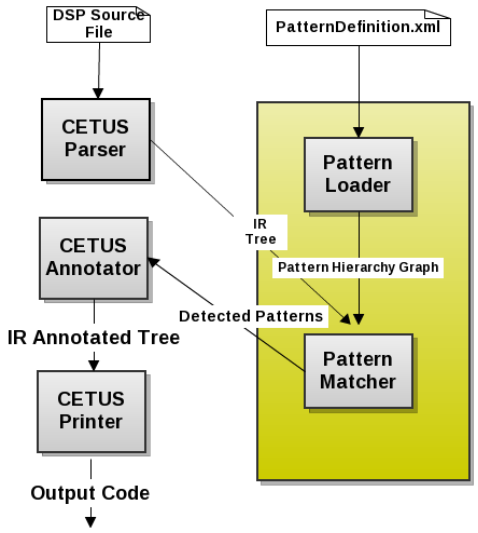

Fig. 7. Pattern Recognition Architectures [9]

The input program source file is analysed by Cetus and the IR tree is created. The tool constructs the PHG data structures from the XML specification file, which are next delivered to the pattern matcher to begin the matching process [9]. The finishing results are sent out to the Cetus annotator which interprets each node by its corresponding pattern [9].

D. Distinct Classes of Volcanic Tremor

Systematic studies of the equivalences and varieties among volcanic tremor at a scale of volcano kinds might keep critical data about the probability of inferred source mechanisms, which in turn might be vital for eruption forecasting [11]. To identify systematics, pattern recognition is used to determine characteristic spectral shapes for tremor from four volcanoes with well-studied and strongly contrasting eruptions [11].

To identify high amplitudes as depicted in Fig. 8, there are three approaches. The first approach is estimate median absolute background amplitude. The second approach is divide continuous seismic data into non-overlapping 5-minute windows, as shown in Fig. 9. The third approach is compare median absolute amplitude over each window to median absolute background amplitude.

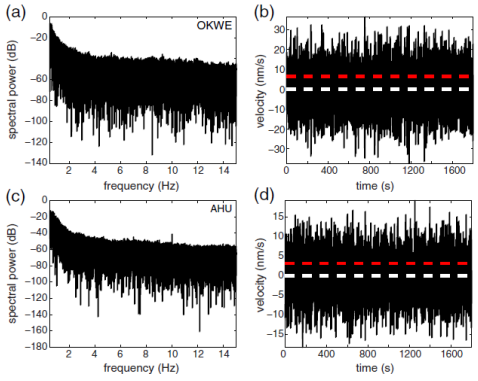

Fig. 8. Signal estimation background [11]

In figure above, (a) is the estimation for background spectrum, (b) is the associated time domain signal at station, while (c) and (d) are the same graph for a volcanic station. The white dash indicates zero velocity while the red dash indicates the median value of absolute amplitudes.

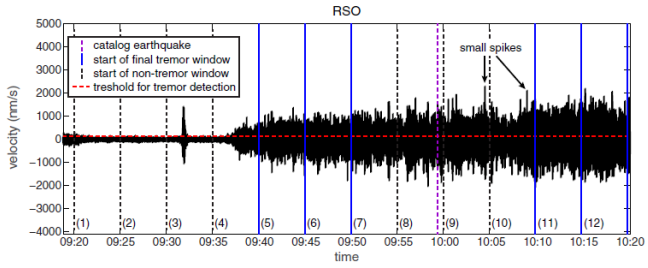

Fig. 9. Volcanic Seismogram [11]

Fig. 9 above shows several time windows that represent different cases of the tremor detection [11]. Windows (1) to (4) fall below the detection threshold, window (8) includes a catalogue earthquake, and windows (9) to (10) include spikes. Only windows (5) to (7) and (11) to (12) are kept as final detections.

E. Parallel Face Detection on GPU

Human face recognition or detection discovers many functions in general for example camera surveillance, law enforcement and interactive game [12]. The engine computation of human faces is usually a popular study topic in pattern recognition. In order to develop exactly how users and computers interact, multi-touch functions, movement recognition and voice processing are normally needed in the end-user hardware [13]. Face recognition and detection process are possible for parallel processing [12].

A standard face processing system consists of face recognition, face tracking and face detection [12]. Nowadays, researchers realize that Graphics Processing Units greatly provide parallel processing abilities. For instance, the GeForce GTX 770 created by NVIDIA graphics card is able to provide 3,213 GFLOPS [12]. The CUDA offered by NVIDIA is C-based programming model that provides developer to discover the use of parallel computation abilities of graphics processing unit in simple way without making algorithm to graphics programming structure [12].

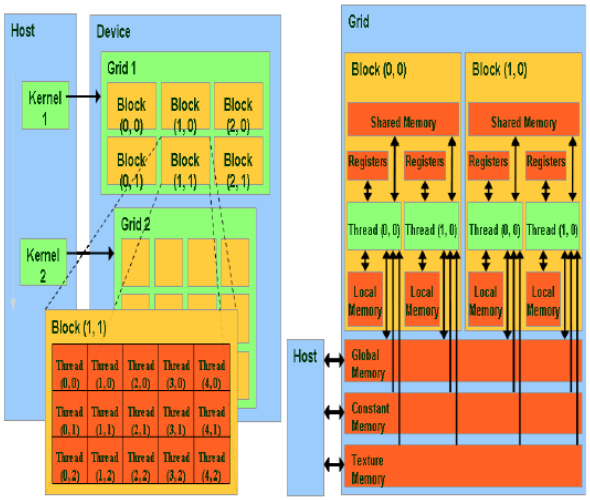

Fig. 10. CUDA Programming and Memory model [12]

Fig. 10 displayed above is a CUDA programming model memory that contains a grid. The grid is initiated from host code, and includes three dimensions initiated in x, y, z coordinates. It then forms several grids that can be presented in a single device as presented. The grid holds thread block and is also initiated in three dimensions typically indicated to get into thread Index and Block Index [12].

Fig. 11. CUDA Image pyramid [12]

Fig. 11 above demonstrates the image pyramid for respective blocks. Every block calculates its individual image down sampled while waiting for the image size becomes 24×24. Fig. 12 below shows the result of face detection in a static image.

Fig. 12. Face detection on static image [12]

The advanced system could process face recognition and detection in real time on GPU, quicker than CPU. The processes are executed in parallel, where one could identify a face and send it to face processing system [12]. For recognizing a face of an image, the first step is to detach it from the image, and next it would be recognized from a database that is known as one of the faces [14].

IV. CONCLUSION

There are many types of situation that use pattern recognition in our daily life. For example, fingerprint and face detection, weather forecasting and playing sports. Parallel processing of pattern recognition is very important to help us solve any practical problems. In this study, there are five types of situation in real life that use pattern recognition of parallel processing. First is a Statistical Pattern Recognition (SPR) that collects a visual pattern and transforms it in a vector space. Secondly, in parallel computing architectures, it processes an image parallelly to produce one image that can be recognized as a fingerprint. This can be used in forensics to recognize the fingerprint of a suspect. Besides that, extensible pattern recognition of parallel processing is also used in digital signal processing (DSP) programs using Cetus. It uses chip multiprocessor architectures for instant DSP to develop a power efficiently in parallel system. Furthermore, pattern recognition is also used in recognizing a volcanic tremor behaviour. It detects pattern of a volcanic to forecast the time of volcano eruptions.

Finally, pattern recognition uses parallel process in graphics processing unit (GPU) for detecting face. It processes an image that has human face for example in surveillance camera. It uses Nvidia graphic processors to process an image parallelly to detect human faces. The application of parallel processing is important for pattern recognition to process a pattern or an image quickly. This is because by using parallel processing the image can be processed simultaneously at one time without delaying the process. This will give same result with sequential processing and it is faster than normal processing.

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