A FUZZY AHP METHODOLOGYFOR SELECTING THE BEST MICROPROCESSOR WITH RESPECT TO BATTERY LIFE, NUMBER OF CORES, THREADING AND THROUGHPUT

Akshit Goyal[1], Prajjwal Mittal[2], Mohit Jadon[3], Anant Agarwal[1]

[1]Department of Computer Science Engineering, Graphic Era University, Dehradun, Uttarakhand, India

[3]Department of Petroleum Engineering, UPES, Dehradun, Uttarakhand, India

[2]Department of Production Engineering, NIT Kurukshetra, Dehradun, Uttarakhand, India

Abstract: This era is marked by our complete dependence on electronic gadgets that help make our life easier in many ways. One of the electronic gadget is laptop that most of the people use when they need to get their work done in less space and comfort or while travelling. The major industry that uses laptop on a daily basis is the education industry as almost every student requires to complete assignment, surf the internet and perform many other tasks. The most primarily field that students choose to pursue their graduation is computer science as in this field we get exposure to work and deal with the best. The renowned microprocessor manufacturing giant INTEL has managed to take over its rivals and be at the peek of the table. Intel has given the computer industry the best microprocessors till date. The processor that we will be discussing in this paper are:- Intel Broadwell i5-5200U and Intel Haswell i5-4310U.These two have been and will remain a popular processor in the industry because of their efficiency and performance. But in most of the cases, people who go to buy these machines often get confused as to which version of the processor they should go for that can fulfil their needs and demands. An individual can never identify the differences between these two versions of the microprocessor by just looking at them or by carrying out simple tasks. We can only spot the difference between them when both are rendered under high performance tasks that can get the most out of the processors. This research paper includes the mathematical derivation using Fuzzy AHP approach as to which one is the best for educational purpose. This paper will also help eliminate the confusion in choosing between the two processors. The factors the decision will be based on are:- battery life, number of cores, threading, throughput.

Keywords :Fuzzy AHP approach, Microprocessor, Broadwell, Haswell, Intel.

.

INTRODUCTION

Due to advancements in technology we experience many changes in electronic gadgets, which lead us to a confusion as to which product will suit us the best and whether we should buy it or not. The evolution in the field of technology over the past decade has been so rapid that we can call it as a revolution. The main reason or force behind this rapid change in the field of microprocessor is because of its capability to perform complex tasks in

minimal time and also at a minimum cost [1]. The primary interest of the students while choosing for an engineering field will be computer science as it gives a better exposure of electronics and technology [2]. Moreover, while there

are numerous processors available in the market with different architecture. Apart from this the choice always depends on the end user and neither on the supplier nor on the manufacturer. Every processor has it own characteristics with advantages and disadvantages [3]. This confusion mostly occurs while choosing a laptop, as to which processor configuration we should buy. The main reason for this confusion is due to the minimum difference the different variants of processor have between them. This makes the customer a bit conscious about choosing between wide range of processor available to them. This can be made easy by keeping the key factors in mind and applying some mathematical logics that can provide us with the optimum option that we should go for. Fuzzy Logic Approach is the mathematical method that help us decide between two things which have almost same specifications. This uses the factors and operates on those factors to give the correct and desired results.

Haswell is the result of deep thinking and integration of many ideas and concepts for creating an extra ordinary microprocessor by the Intel family. It is considered to be the 4th generation in the series by Intel. It introduces the concept of low power consumption. It has been designed to achieve a balance between power consumption and performance. It implemented vector processing, faster single threaded performance and multi threaded performance. Broadwell is the example of advancement in technology in the last decade. It is the result of integration of manyideas that can improve the efficiency and the performance of any microprocessor.

LITERATURE REVIEW

W.H Denis in his paper quoted as “electronics components and systems “has discussed about the advancement in technology in the field of microprocessor [1]. Further research by Tirado el at. in their paper quoted as “microprocessor instruction for undergraduate students” have discussed about the students pursuing their under graduation about choosing the microprocessor that best suites their needs as for an educational purpose [2]. In addition to all Steve Heath in his paper quoted as “microprocessor architecture and system” explained about the basic architecture of the microprocessor and the factors that decide as to which processor to opt for. This also discusses the advantages and disadvantages in architecture of many microprocessors [3]. Moreover Michael J.Debenham in his paper quoted as “microprocessor principle and applications” has discussed the main application that require and uses a microprocessor. It also defines the width of usage of microprocessors in any application [5].Andrew Colin in his paper quoted as “programming for microprocessor” has discussed about various ways of programming a microprocessor according to our usage and needs in order to make it do a specific task in order to reduce it’s cost and work load over the microprocessor chip [9].In the paper quotes as “The engineering of microprocessor system” , the authors have discussed about various factors and criteria upon which the selecting of any microprocessor is dependent upon. It basically categorises the types of microprocessor on the basis of some factors and let’s the end user decide as to which factor is most relevant to them and which microprocessor takes upon the charge of that factor [10].Mangla et al. in their paper quoted as “Risk analysis in green supply chain using fuzzy AHP approach: A case study” have discussed about the basic use of fuzzy AHP approach to mathematically derive the results [4].B.R.Kirk in his paper quoted as “Microprocessors for everyday application” has discussed

about various everyday usage of a microprocessor and the various applications that require a microprocessor to perform their task [6].Gary Horlick in his paper quoted as “Introduction to microprocessor” has discussed about the basic information that we need to study in order to understand about the microprocessor and look upon its working in any application [7].M.J.Flynn in his paper quoted as “Basic Issues in Microprocessor Architecture" has discussed about the basic issues that are present in the current architecture of the microprocessor and the way of improving them [8].

Fuzzy AHP approach:

The AHP approach was developed in late 1970’s by professor Thomas L. Saaty. AHP is a framework that provides decision making algorithm for finding the best suitable alternative among many. It removes the ambiguity in the result which would occur if the decision had to be taken by human psyche when a problem faces complex decision problem. Fuzzy set theory used with the AHP method reflects the actual working of human mind for choosing an option. AHP is all about comparing various alternatives based on multiple factors in a hierarchical manner. Being a robust, reliable and faster tool for decision-making, it marked itself in various applications such as education [11], financial performance [12], qualitative selection problem [13], natural hazard risk evaluation [14], tourism [15], etc.

METHOLOGY:

A. ***Choosing factors upon which the relationship has to be established between alternatives***- Choosing the factors for comparison of both processors leads the process. The factors should be chosen such that they optimise the result in the best way possible. We have taken these four factors for comparing the two processors specifically, Haswell and Broadwell: Threading, Battery life, Throughput and Number of cores.

B. ***Constructing Fuzzy comparison matrix-*** The triangular relationship given by three variables x, y and z is given by:

$$\mu_m(a)= \begin{cases} 0 & a<x \\ (a-x)|(b-x) & x<=a<=y \\ (z-a)|(z-y) & y<=a<=z \\ 0 & a>z \end{cases}$$

We have taken five triangular membership functions with respect to five linguistic terms as follows for mathematical evaluation.

Linguistic scale for relative importance	Fuzzy Triangular numbers
Equally important	(1, 1, 1)
Weakly important	(1, 2, 3)
Fairly important	(1, 3, 5)
Strongly important	(5, 7, 9)
Very Strongly important	(8, 9, 10)

Table 1.1

C. ***Constructing Pair-wise comparison matrix***- After the construction of fuzzy comparison matrix, pair-wise comparison matrix is made in which all the factors are compared to each other using the fuzzy triangular numbers set for each linguistic term. This matrix reflects how important one factor is over the other. This matrix M[n][n] (where n is the size of matrix) is given as:

$$M = \begin{pmatrix} 1 & m_{12} \cdots\cdots\cdots\cdots\cdots\cdots m_{1n} \\ m_{21} & 1 \cdots\cdots\cdots\cdots\cdots\cdots m_{2n} \\ \cdots\cdots & \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ m_{n1} & \cdots\cdots\cdots\cdots\cdots\cdots 1 \end{pmatrix}$$

where $m_{ij} = (x_{ij}, y_{ij}, z_{ij})$, $m_{ij}^{-1} = (1/z_{ji}, 1/y_{ji}, 1/x_{ji})$

D. Calculation of Fuzzy Synthetic Extent-We calculate this factor by using equation(1), given by:

$$W_i = \sum_{j=1}^{m} A_p^j \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} A_{p_i}^j\right]^{-1}$$

…Equation (1)

where A^1_p, A^2_p, A^3_p ….. A^n_p are the fuzzy synthetic extent values of n entities.

E. ***Calculation of Fuzzy AHP weights-*** The weights for each alternative is computed hence-We calculate the w_i for two fuzzy numbers given by $w_1=(x_1,y_1,z_1)$ and $w_2=(x_1,y_2,z_2)$, using equation (1). $w_1(x_1,y_1,z_1)>=w_2(x_2,y_2,z_2)$ is defined as:

$$P(w_1 \geq w_2) = \sup_{x \geq y}[\min(\mu_{w_1}(x), \mu_{W_2}(x))]$$

…Equation (2)

We then calculate the degree of possibility of $(w_1>w_2)$by:

$$P(w_1 >= w_2) = \begin{cases} 1 & y1>y2 \\ 0 & x2>z1 \\ (x_1-z_2)/((y_2-z_2)-(y_1-x_1)) & \text{otherwise} \end{cases}$$

Assume that :

$f(A_i) = \min(A_i >= A_j)$ …***Equation (3)***

The minimum weight of w_i for all attributes is calculated by analysing all the values obtained in preceding steps. And finally the net weight is obtained:

$W = (f(A_1), f(A_2), f(A_3)……..f(A_n))$

…Equation(4)

F. ***To obtain an overall rating for the alternatives aggregate the relative weights of these factors-*** The weights obtained for both the alternatives is compared. The alternative with highest weight stands out and should be chosen further as the result. This approach gives the optimised result.

APPLICATION

Microprocessor is of paramount importance when it comes to computer systems. There are a decent number of microprocessors to choose from and one can compare two processors on the bases of a lot of factors but that is a complex decision problem given a lot of factors. A vague human decision can be replaced by an optimised choice by applying fuzzy logic with AHP approach.

In this paper, we have assumed the two processors, Broadwell and Haswell as alternative A_1 and A_2. The best out of these two processors is chosen upon the most suitable factors (threading, battery life, throughput and number of cores taken as f_1,f_2,f_3 and f_4 respectively). The hierarchy of factors is shown in figure 1.

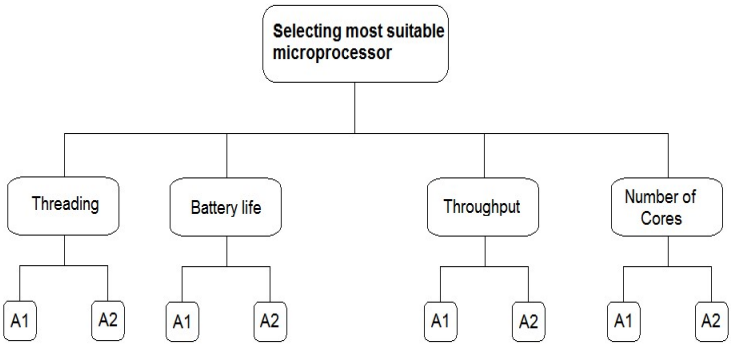

Figure 1

	F_1	F_2	F_3	F_4
F_1	(1,1,1)	(1,2,4)	(1/4,1/2, 1)	(1/4,1/2, 1)
F_2	(1/4,1/2, 1)	(1,1,1)	(1/5,1/3, 1)	(1/5,1/3, 1)
F_3	(1,2,4)	(1,3,5)	(1,1,1)	(5,7,9)
F_4	(1,2,4)	(1,3,5)	(1/9,1/7, 1/5)	(1,1,1)

Table 1.2

Applying Equation (1)

W_1= (0.06, 0.16, 0.46)

W_2=(0.04, 0.09, 0.26)

W_3=(0.20,0.51, 1.24)

W_4=(0.08, 0.24, 0.67)

By equation (2)

$P(W_1 \geq W_2) = 1$, $P(W_1 \geq W_3) = 0.42$,

$P(W_1 \geq W_4) = 0.8165$;

$P(W_2 \geq W_1) = 0.7334$, $P(W_2 \geq W_3) = 0.128$, $P(W_2 \geq W_4) = 0.538$;

$P(W_3 \geq W_1) = P(W_3 \geq W_2) = P(W_3 \geq W_4) = 1$;

$P(W_4 \geq W_1) = P(W_4 \geq W_2) = 1$, $P(W_4 \geq W_3) = 0.6351$

By equation (3), we have

$f(F_1) = \min P(W_1 \geq W_2, W_3, W_4) = \min(1, 0.42, 0.8165) = 0.42$

$f(F_2) = 0.1283$; $f(F_3) = 1$; $f(F_4) = 0.6351$

Therefore, W=(0.42,0.1283,1,0.6351)

By normalisation, the weight vectors with respect to the decision criteria F_1,F_2,F_3,F_4 are obtained as using By equation(4) , W = (0.19, 0.058, 0.458, 0.29).

Similarly all the factors are compared with respect to both the alternatives and the results are obtained as follows

F_1	A_1	A_2
A_1	(1,1,1)	(1,2,4)
A_2	(1/4,1/2,1)	(1,1,1)

Table 1.3 W= (0.67, 0.32)

F_2	A_1	A_2
A_1	(1,1,1)	(1,3,5)
A_2	(1/5,1/3,1)	(1,1,1)

Table 1.4 W = (0.70, 0.29)

F_3	A_1	A_2
A_1	(1,1,1)	(1,2,4)
A_2	(1/4,1/2,1)	(1,1,1)

Table 1.5 W= (0.67, 0.32)

F_4	A_1	A_2
A_1	(1,1,1)	(5,7,9)
A_2	(1/9,1/7,1/5)	(1,1,1)

Table 1.5 W= (1, 0)

Main Factors affecting selecting the best microprocessor					
	F_1	F_2	F_3	F_4	Alternative Priority Weight
Weight	0.19	0.058	0.458	0.29	
Alternative					
A_1	0.67	0.7	0.67	1	0.7647
A_2	0.32	0.29	0.32	0	0.2242

Table 1.7

RESULT

The fuzzy AHP approach that we used gives a clear picture of the best microprocessor to be chosen for educational or personal use. By looking at the results stated in table 1.7 A1 i.e., Broadwell has a total weight of 0.7647 and A2 i.e., Haswell lags behind with the weight of 0.2242.This approach marks the Broadwell (i5-5th gen) as the winner over many factors that can help an individual decide over the microprocessors. This result is in the favor of the latest i5 processor by Intel corporation as it has enhanced battery consumption efficiency, enhanced throughput, enhanced thread processing and greater number of cores. This approach has helped us derive this result which can be trusted.

CONCLUSION

This section concludes the result being derived by the fuzzy AHP approach for finding out the best microprocessor available in the market for educational and personal use. Broadwell is stated as the winner by this approach and hence can be trusted for its use in computers. The final answers are biased towards the Broadwell processor which is also the latest among the two microprocessor being compared in this research paper. This research paper has buzzed out the confusion in choosing the best microprocessor available in the market for educational and personal use by deriving out the winner between the two using the Fuzzy AHP Approach.

REFERENCES

1. W.H.Denis “Book on Electronic component and systems”, published by Butterworth & Co, 1982 , page-204-215.
2. F.Tirado, A.Bautista,R.Hermida,A.Sotelo,J.Septien and D.Mozos “Microprocessor instruction for undergraduate students”, Journal of Elsevier Science Publishers B.V, Volume-4,1988, page 265-272.
3. Steve Heath “Book on Microprocessor architecture and systems”, Published by Butterworth-Heinemann Ltd, 1991, page 259-266.
4. Sachin Kumar Mangla, Pradeep Kumar and Mukesh Kumar Barua “Risk analysis in green supply chain using Fuzzy App”, Journal of Resources Conservation and Recycling, Volume-104, 2015, page 375-390.
5. Michael.J.Debenham “Book on Microprocessor” , Published by PERGAMON INTERNATIONAL LIBRARY , 1979, page 62-66
6. B.R.Kirk “Microprocessor for everyday application”, Journal of Microelectronics and reliability, volume-14, 1975, page 377-378.
7. Gary Horlick “Introduction to microprocessor”, Journal of Talanta, Volume-28, 1980, page 487-502.
8. M.J.Flynn “Basic Issues in microprocessor”, Journal of Systems Architecture, Volume-45, 1999, page 939-948.
9. Andrew Colin “ Book on Programming for microprocessor”, Published by Butterworth & Co, 1979, page 124-129.
10. Electrical Research Association “ Book on Engineering microprocessor system”, Published by PERGAMON INTERNATIONAL LIBRARY, 1979, page 35-69.
11. Kausalya, Reddy at el., “Analytical Hierarchy Process approach – An application of engineering education”, Journal of Matehamtica Aeterna, Volume-2, 2012, Page 861-878.
12. Shaverdi, “Application of fuzzy AHP Approach for Financial Performance Evaluation of Iranian Petrochemical Sector”, Journal of Procedia Computer Science By Elsevier, Volume-31, 2014, Page 995-1004.
13. Ribeiro “Application of the analytic hierarchy process method with absolute measurement in qualitative selection problem”, Journal of Systems And Gestao, volume- 11, 2016, Page 270-281.
14. Xiao Yang,“Application of a triangular fuzzy AHP approach for flood risk evaluation and response measures analysis”, Journal of Natural Hazards by Springer , Volume-68, 2013, Pages 657-674.
15. Wen-Hsiang Lai “An application of AHP approach to investigate tourism promotional effectiveness.”, Journal of Tourism and Hospitality Management, Volume 19, 2013, Pages 1-22.