Optimizing Accuracy of the Variety Bitspaces for Weather Forecasting for Early Flight Safety

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Abstract. Different types of images when testing will give different results. Between still images and moving images requires speed and accuracy in the computation process. This is due to the availability of time in processing which tends to narrow at any time along with environmental changes. Retesting of processors that have been built through previous research requires the selection of new image data and processes. The selection of the new image refers to a different image and has never been used before. Next, for the new process by applying gaussian filtering selection. The results of the initial stage in testing some new images obtained that the bitspace adder/sub 32 bit (single-operand) accuracy value for cloud image data test without selector was 97.91% in the first cycle and without using filters block. While the architecture with the least significant bit method only produces an accuracy of 0.01% so that there is a very significant difference in accuracy, amounting to 97.90%. The last result if using filters block, the accuracy value is 98.75% at the first cycle with using filters block.

1. Introduction

Production of the correct answer at the right time (timing correctness) is one of the key factors in a system conceptualized to improve the reliability of the rapid changes (e.g., changes in cloud image conditions). This concept is known as a just in-time system or real time system. Timeliness or time delay to produce an answer from a process influences the results of the computation process within the available time period. Timeliness of answers comes out for each system, depending on changes in the image where the system works, which varies from a very short to a long-time span. The failure of a system (or subsystem) to produce the right answer within the available timeframe has the potential to pose risks that threaten the success of other systems, such as flight continuity.

To remind back that the approach to meet the deadline on timely computation systems is classified into two groups: first, the software group, for example, the level of the operating system that focuses on developing systems Rate Monotonic Scheduling, (Lehoczyk et al., 1989), Non-preemptive, (Jeffay et al., 1991; Parks, Lee, 1995), Earliest Deadline First (EDF), Stankovic et al., (1998), Increase Reward Service (IRIS), Dey et al., (1993), Imprecise computation, Liu et al., (1991); and second, the level of the hardware group that seeks through the processor clock speed or by enlarging the size of the granulation operation with k-bit, Real time arithmetic unit, Mora-Mora et al., (2006), MSB-First Interval-Bounded Variable-Precision Real Time Arithmetic Unit, Yusrilla K Kerlooza et al., (2010) and Priority based computation: An Initial study result of paradigm shift on real time computation, Sukemi et al., (2017).

So many approaches have been taken to show that software and hardware solutions have not been dealt with in a timely end-time system. Although some new scheduling techniques have been found. In addition, there are still several publications from this group that have not yet been implemented and there are still several research fields that do not support each other.

Increasing the 'clock' in a processor aims to do a quick calculation by minimizing the average value of deadlines for a task in a process [1]. This deviates from the main purpose of a real-time system that attempts to meet the time frame of each task. However, the most important thing from all of real-time system is predictability, not the speed with which it has a very relative meaning. Predictability is defined as a functional certainty and temporal behavior of each task, which should be as so deterministic as possible so they are quite able to meet the system specifications. Each quick calculation will greatly assist in the fulfillment of a short quarte timeframe, but a quick calculation predictability alone cannot guarantee a real time system. A real-time system could work correctly only if there are no timing failures. However, the failure of timing will occur in varying range of time when the system is experiencing overloaded conditions (due to changes in environmental conditions) so that the system must be reset the task sequence that must be done to respond to these changes.
Degree of accuracy is determined by the limited of time available to achieve a real time or just in-time system [2]. Therefore, restrictions or ranges from the results of calculations must be able to provide answers in the decision-making process. However, the reality is that the determination of the accuracy of the results of arithmetic calculations generally cannot be done before the calculation itself is completed. So, the calculation process can be vulnerable as a result of failure if there is insufficient available time. In addition, selection of such factors timing, accuracy and precision is needed to set the system to meet the real-timeliness goal. Until now, there is no mechanism that can play the selector function represented by the hardware or software assigned to it selecting. Every selection doing would consider the parameters of time, accuracy and precision so that the real-time system achieves its target [3].

This paper, retest the processor that has the ability as a voter above and is named as a variable bitpace processor that has been previously built by Sukemi et., Al [4]. First approach, researchers do the filtering process on the moving cloud image and potentially cause extreme weather. The image of the cloud used came from the South Sumatra Province Meteorology, Climatology and Geophysics Agency (BMKG) which it had recorded earlier. Recording performed for 12 hours of cloud movement, from cloud imagery to good weather conditions to extreme weather. Images recorded on BMKG are stored in a special application and can be copied in the format as desired.

Many factors determine the pattern of cloud imagery that affects good weather to extreme weather, such as season, wind speed, and humidity. All of these factors, have not been considered in this research so that the pattern of cloud imagery taken at this time only refers to the conditions of time taken, namely August 2018. This image will be filtered on the proposed filter design in the study so that the optimization of the bitspace processor variable increases. The initial hypothesis can logically be estimated that optimization increased because before filtering the optimization level ranged from 97.91%. This number is obtained from the process of bitspace processor whose image input is entered without going through the filtering process. The filtration process requires a minimum system to reduce the error rate of the cloud image described in section 2.

2. Cloud Image Filtering Process

![Figure 1. Filters block system and it algorithm](image)

The image modification is done through scaling stages. The scaling is done that the image can be represented in a more compact form, so it requires less memory and computational time.
The scaled image must be of good quality. The scaling process can be done using an interpolation method that uses the average value of an image region to represent the region. Digital image is an array that contains real and complex values represented by a certain row of bits. An image has a matrix consisting of rows (N) and columns (M). At the coordinates (x,y) the values contained in the coordinates are f(x,y), which is the magnitude of the intensity or color found on the pixel in that point. If the value of x,y and the amplitude value of f are finite and have a discrete value, it can be said that the image is a digital image. A digital image be written in a matrix, equation 1.

\[
f(x,y) = \begin{bmatrix}
f(0,0) & f(0,1) & \cdots & f(0,M) \\
\vdots & \ddots & \ddots & \vdots \\
f(N-1,0) & f(N-1,1) & \cdots & f(N-1,M-1)
\end{bmatrix}
\]

Furthermore, the gray image is formed, with each pixel having one layer whose intensity values are in the interval 0-255, with this intensity, the values of pixel in the gray image can be represented in the matrix to facilitate the calculation process in the next operation. The value of the intensity of gray image is calculated from the intensity of the image of Red Green Blue (RGB) using equation 2.

\[
Grayscale = ((Red \times 0.299) + (Green \times 0.587) + (Blue \times 0.114))
\]

The next process, which is convolution, is a sum operation of multiplication with operating notation (*), which multiplies an image with a mask or kernel. Convolution of 2 function \(f(x)\) and \(g(x)\) is defined as follows:

\[
h(x) = f(x) \times g(x) = \sum_{x=-\infty}^{\infty} f(x) g(x + u, y + v)
\]

where:
- \(f(x,y)\): original image;
- \(h(x,y)\): Linier-position invariant operator;
- \(g(x,y)\): result image convolution;
- \(x, y, u dan v\): position of points in the image.

The final process of filter block content is a Gaussian filter that is used to blur images or eliminate noise [5]. This screening process is for refining images that appear slightly opaquer to be used in the next process. It also aims to produce a true image edge. If this process is not used then the detection of fine lines will also be detected as an edge. The Gaussian filter used is a 2-dimensional filter with the following equation:

\[
G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}
\]

where \(G(x,y)\) Gauss matrix elements in position \((x,y)\), \(\pi = 22/7, e = 2.71828182846, \sigma\) is the standard deviation value =1[6]

3. Cloud Image Process by Variable Bitspace Adder

The bitspace variable embedded in the processor design is compiled based on the width of the data bits that are synchronized with the width of the data input in figure 2.

The initial step before processing into bitspace adder, the cloud image will be processed first by selecting the optimal filters block to obtain the lowest noise level image. This paper proposes a model for selecting the cloud image and is a further step from previous research [3]. The filtering block is built with several 3x3, 5x5 to 9x9 matrix filter options arranged in parallel.

For the initial stage of designing this filter block, each filter is connected to a different input and output path to produce a cloud image with a low noise level than before. In addition to the task which has the function selector, the variable bitspace component is also designed as accuracy arithmetic adder part built to achieve degree of accuracy despite the fact that the computational process is not completed.
Figure 2. New variable bitspace adder

The Accuracy obtained from the new variable bitspace adder device uses equation 6:

\[
A_j(t)_{ars-range} = \left[ 1 - \frac{\sum_{i=1}^{n} f(x)_{upper} - \sum_{i=1}^{n} f(x)_{lower}}{\sum_{i=1}^{n} f(x)_{upper}} \right] \times 100\%
\]  

…(6)

where; \(A_j(t)_{ars-range}\): accuracy \(j\) at a certain time \((ns)\); \(f(x)_{upper}\): upper limit computing value; \(f(x)_{lower}\): lower limit computing value [7].

4. Result and Discussion

Table 1. The results of processing cloud data using a 5x5, 7x7 and 9x9 Gaussian filters

| Time (WIB) | Cloud Image | Cloud image on matrix |
|-----------|-------------|-----------------------|
| 00.00     | ![Image](image1.png) | ![Image](image2.png) | ![Image](image3.png) |
| Processing time | 00:00:00.1 485852 | 00:00:00.2 448149 | 00:00:00.3 814585 |
| 03.00     | ![Image](image4.png) | ![Image](image5.png) | ![Image](image6.png) |
| Processing time | 00:00:00.1 179827 | 00:00:00.2 466881 | 00:00:00.3 954657 |
| 06.00     | ![Image](image7.png) | ![Image](image8.png) | ![Image](image9.png) |
| Processing time | 00:00:00.1 483496 | 00:00:00.2 437346 | 00:00:00.4 409039 |
Table 2. The results of time consumption data using a 5x5, 7x7 and 9x9 Gaussian filters

| Processing time | matrix 5x5 (millisecond) | matrix 7x7 (millisecond) | matrix 9x9 (millisecond) |
|-----------------|--------------------------|--------------------------|--------------------------|
| 0:00            | 1485852                  | 2448149                  | 3814585                  |
| 3:00            | 1179827                  | 2466881                  | 3954657                  |
| 6:00            | 1483496                  | 2437346                  | 4409039                  |

It was obtained that the speed of the 5x5 matrix filtering process was faster processing time than the 7x7 and 9x9 matrices due to the fewer number of matrices, but for accuracy in reducing the 7x7 and 9x9 matrix noise higher.

The cloud image results from this filters block will be processed lastly at bitspace adder, to determine the accuracy of real-time computation that is time-limited. The resulting accuracy is in the form of a regression value from the average accuracy obtained by the computational time function.

![Figure 3. Accuracy over a period of time](image)

5. Conclusion

Placement of the filters block the adder variable bitspace adder architecture creates optimal time and guarantees the accuracy of predictability about 0.85%.

6. Future Work

The time for taking cloud images should be taken from several rainy and dry seasons during normal and extreme weather.

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REFERENCES

[1] Stankovic, J.A., Spuri, M. and Ramamirtham, K. “Deadline Scheduling for Real-Time Systems : EDF and Related Algorithms,” Kluwer Academic Publishers (Kluwer International Series in Engineering and Computer Science), 1998.

[2] Mora-Mora, H., Mora-Pascual, J. and Garcia-Chamizo, J.M. “Real-Time Arithmetic Unit,” Real-Time Systems Springer Science + Business Media, LLC; DOI 10.1007/s11241-006-8753-x, 2006, pp. 53-79.

[3] Sukemi, Ratna AAP., Sudibyo H. “Priority based computation: A Study of paradigm shift on real time computation,” Computational Intelligence and Cybernetics (Cyberneticscom), 2012 IEEE International Conference on Digital Object Identifier, Bali, Indonesia. Pp. 129-132, Juli 2012.

[4] Sukemi, Ratna A.A.P, and Sudibyo H., “Variable Bitspace of Variable Precision Processor,” Journal of Advanced in Information Technology, Academy Publisher, Vol. 5 No. 2 2014, pp. 65-70.

[5] H. S. Javadi and H. R. Mahdiani, “Efficient utilization of imprecise blocks for hardware implementation of a Gaussian filter,” Proc. IEEE Comput. Soc. Annu. Symp. VLSI, ISVLSI, vol. 07–10-July-2015, pp. 33–37, 2015.
[6] T. Ohtani, Y. Kanai, and N. V. Kantartzis, “A 4-D subgrid scheme for the NS-FDTD technique using the CNS-FDTD algorithm with the shepard method and a gaussian smoothing filter,” *IEEE Trans. Magn.*, vol. 51, no. 3, pp. 3–6, 2015.

[7] Sukemi, “Development of the arithmetic unit bitspace adder/sub real time architecture for optimal performance”, Desertation of Doctoral Program, Universitas Indonesia, 2016.