Title	Hardware-Efficient JPG Decompression on an Embedded Multi-Core picoMIPS Architecture
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Aims/research question and Objectives

The hardware and energy efficiency of embedded processor is important in mobile electronics which are powered by batteries. New mobile applications require high performance while long battery life in mobile devices requires energy efficiency and hardware efficiency. These demands lead to a multi-core hardware-efficient picoMIPS architecture.

The aim of this project is to design an embedded multi-core picoMIPS architecture, which is used for JPEG Decompression. The design should be as small as possible in terms of hardware resources but sufficient to implement the JPEG decompression. Main objectives are listed below:

1. **Background research on JPG decompression**
   It is already known that the inverse discrete cosine transform (IDCT) algorithm is an important part for JPEG decompression. However, more researches are needed to find out how the completed JPG decompression works on the picoMIPS architecture.

2. **Design a simple picoMIPS.**
   This is the first step of the design part. Design a simple picoMIPS based on the knowledge learned from the course Digital Systems Synthesis and Embedded Processors. For this step, the algorithm is not important.

3. **Modify the picoMIPS to implement discrete cosine transform (DCT) algorithm.**
   DCT is a stage of the JPEG compression. Maybe it is not needed for decompression. However, it might be much easy to learn begins with DCT rather than IDCT. In addition, it is possible to modify IDC algorithm to IDCT algorithm. Besides, the DCT and IDCT can be both implemented in the picoMIPS architecture. Thus, it is possible to achieve both JPEG compression and JPG decompression based on choices such as switches on the Altera Board. This is one potential improvement when all the tasks are finished.

4. **Modify the picoMIPS to implement DCT and inverse DCT(IDCT) in a multi-core context**
   As mentioned above, IDCT may be enough for JPEG compression. This will be based on how long it takes for previous works and the discussion with the project supervisor. The main task of this step is to achieve multi-core design.

5. **Modify the pocoMIPS to achieve JPG decompression**
   Complete and improve the whole design for JPEG decompression. IDCT is only a stage of the JPEG decompression. Whether this project is to finish this stage or the whole stages will be determined on the real timescales and discussion with the supervisor.

6. **Minimise the picoMIPS architecture.**
   The design will be modified as small as possible but sufficient to implement the required algorithms. This step may be in the front of step 5. It will be determined by the learning in step 1 and discussion with supervisor in the future.

7. **Improve the whole design**

Summary of proposed research and analysis methodology

The design of this project will start from the picoMIPS structure. ModelSim will be used to simulate each module built during this project and to show its functions. Altera Quartus will be used to synthesis each module to gain the statistics and RTL diagram. Besides, the process of the project will be shown to the supervisor weekly to avoid going wrong direction too far away.

The first step is to learn from the source codes of the picoMIPS in the university notes website and built a picoMIPS architecture. The algorithm for this processor can be just a simple function such as add. A testbench will be written to test and simulate the whole architecture. Figure below shows an example picoMIPS architecture. There may be modifications to minimise the design in the future.

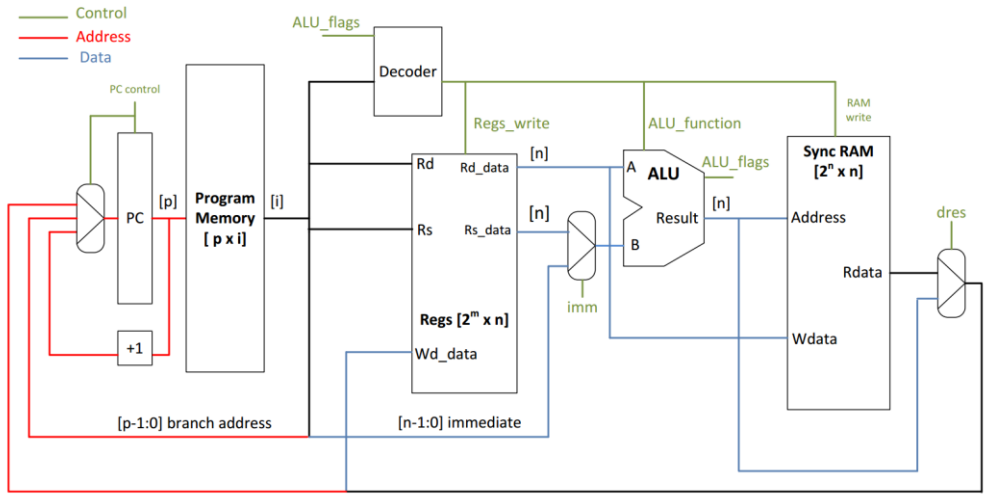


Figure 1: An example picoMIPS architecture [1]

The second step will be to achieve the discrete cosine transform (DCT) algorithm, which is a stage to achieve JPEG compression. A testbench will be written to check the implementation of the algorithm. The third step will be to achieve the inverse discrete cosine transform (IDCT) algorithm, this step is similar to the second step. Therefore, their simulation results can be used to check for each other.

The next step will be to achieve the multi-core implementation of the picoMIPS architecture. The synthesis statistic can be used to make a comparison with the single core architecture. After it, the total design will be modified to be as small as possible but sufficient to implement both DCT and IDCT algorithms.

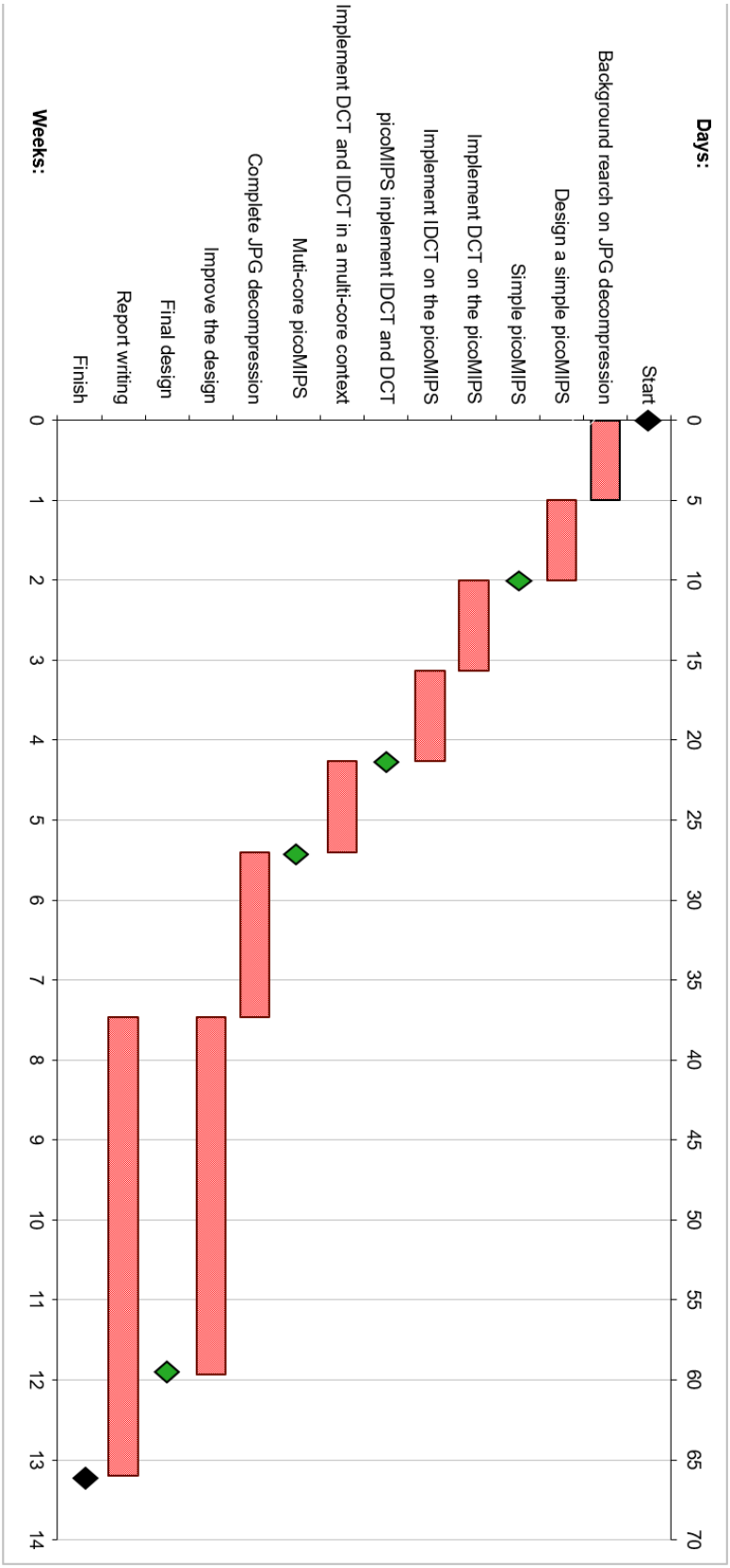
The next step is to modified the picoMIPS to achieve JPEG decompression. As the exactly structure for JPEG decompression is not yet known, details about this step will based on the learning on this area later. At present, it is known that the DCT and IDCT algorithm has relationship with JPEG compression and decompression.

The final step is to modified the design as small as possible but sufficient to implement the required algorithms. This is also one of the aim of this project. Normally, this part will take most of the time of this project. The exactly time will be based on how long it cost for the steps above.

Reference

[1] K. Tom [2014] “Energy-efficient many-core processor architectures,” University of Southampton, Electronics. Online available: https://secure.ecs.soton.ac.uk/notes/elec6234/1516/9pmipsapp.pdf [05/05/2016]

Research plan – Gantt chart or Pert chart



Ethical statement

Images used in this project will come from my own mobile phone and be built by myself. No source pictures such as human pictures will be used. Therefore, this project does not have ethical issues relating to human data.

Besides, in order to avoid bring misunderstanding to others, it is necessary to ensure the quality and integrity of the project. Therefore, the process of the project will be shown to the supervisor weekly. With the help of the supervisor, the project can be achieved one goal by one goal and will not go to a wrong direction too far away.

If this project will be implemented in the future, there will be several implications based on the direction of the development of the project work. Firstly, mobile electronics are one of the most possible products in the future. It is necessary to ensure the legal aspect of the product such as electrical safety and energetic efficiency. Besides, the function of imaging processing may also bring some ethical issues such as copyright problem.

Legal and commercial aspects

Commercial aspect:

Firstly, the final product of this project will have a huge market demand. JPEG format is the compression standard for the digital images, which are widely used in the popular websites such as Google, Facebook and Baidu [2].

Secondly, the feature of the research is essential to related electronics in the future. Mobile phone for example, more functions and long battery life needs an energy and hardware efficient processor, which is also one of the aims of this project.

Legal aspect:

The final product of this project need pass several testing to ensure features below:

1. Electromagnetic Compatibility
2. Electrical Safety
3. Energetic Efficiency
4. Environment friendly

In order for the hardware used in this project to fulfil the afore mentioned requirements, it needs to have obtained certain certificates such as the CE mark and GS mark.

Reference

[2] Alexa Top 500 Global Sites. http://www.alexa.com/topsites, retrieved May. 2016.