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The Merger of Powered TI DSP DM642 into Education and Research of Radio and Electronics on Faculty of EEIT SUT

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Abstract

There is presented use of DM642 EVM in the education process. For that purpose is done the implementation of DCT-based video-encoder and hybrid DCT/DPCM video-encoder. Demonstrations are implemented with use of C code with TI image processing library includes so it is easily understandable. The structures of the encoders are lightly recognizable for students frequenting the courses Analog and Digital Television, Digital Image Processing and Encoding so some routines could be lightly modified.

Introduction

The goal of the 1st part of this contribution is to give basic information of education organizing in Radio and Electronics on the faculty of EEIT with focusing on specialization in Audio and Video Technique. In the 2nd part of this contribution are presented the plans which we have with the merger of DM642 EVM based on powerful digital media processor TMS320DM642 into education and research on our department. Herein is briefly described hardware solution of workstation created for own application software development in the field of stationary images and dynamic video sequences encoding in real time working under installed system software Code Composer Studio 3.0 with DM642 EVM. Within separate parts are described own software solutions and implementations of:

- DCT Based Codec core as a demonstration tool in the subject DIPE
- MPEG-2 codec core as a demonstration tool in the subject ADTS.

At last there are presented concrete obtained selected results and formulated some ideas how to utilize them within research activities.

Master's programme in Radio and Electronics

At EEIT SUT Bratislava in Radio and Electronics Master's programme are accredited three specializations:

- Radio-Comnunication Technique
- Audio and Video Technique
- Medical Electronics

The courses in Audio and Video Technique with marked courses Digital Image Processing and Encoding (DIPE), Analogue and Digital Television (ADTV) are listed in Fig. 1.

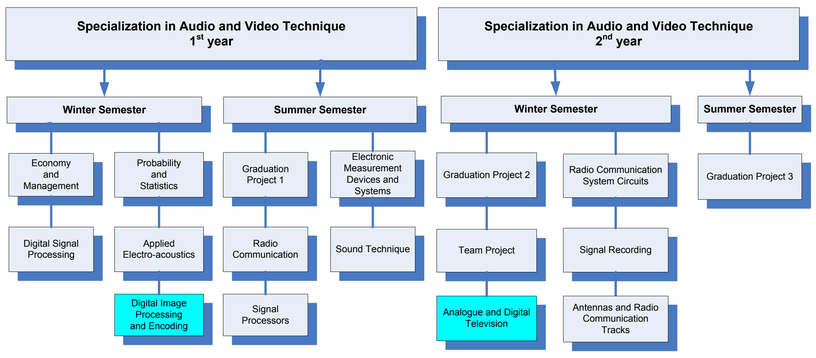


Fig. 1. Specialization in Audio and Video Technique in Radio and Electronics at EEIT SUT Bratislava

Current HW & SW in Labs for DIPE & ADTV

For each course (DIPE and ADTV) is designated own laboratory. Capacity of labs is 10 students for each. Students are split in five pairs. Each pair has own workstation equipped with video input card and installed software for image processing (UnivDIP), (Fig. 2). The exercises are small projects focused on according issues. The solutions are in the form of plugin library for UnivDIP. For plugins development is used Borland Builder 5.

Software used in exercises was built within our department with help of foregoing students in diploma and DIPE/ADTV courses, (Fig. 3).

a) **b)**

Fig. 2. Laboratory for DIPE (a) and ADTV (b) courses

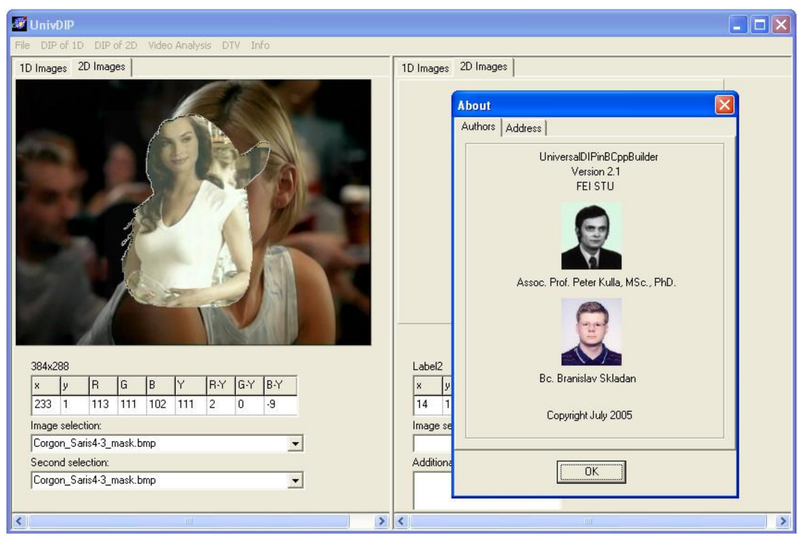


Fig. 3. Present development system software used in DIPE and ADTV

DM642 EVM merger into education

The DM642 EVM is a development board that enables evaluation of a design with the DM642 Digital Media Processor which is based on TI's successful line of C64xx DSPs. It is designed to work with Code Composer Studio software tools connected through a JTAG emulator. Board features include:

- 32MB of SDRAM + 4MB of linear flash memory
- 2 video decoders + 1 video encoder
- RS-232 UARTs, 100Mb ethernet
- AIC23 stereo codec
- numerous video inputs and outputs with support for HDTV

For use of the video processing card DM642 EVM was created the workstation based on personal computer (P4 2.4GHz, 512MB RAM) as shown in Fig 4. Supplementation of the JTAG boundary to host computer, required by DM642EVM, is done by XDS510 PCI card. Video-sequences are acquired by a camera in PAL standard connected directly with DM642 EVM video input. The processed video-sequence could be viewed on the connected preview screen to corresponding DM642 EVM video output.

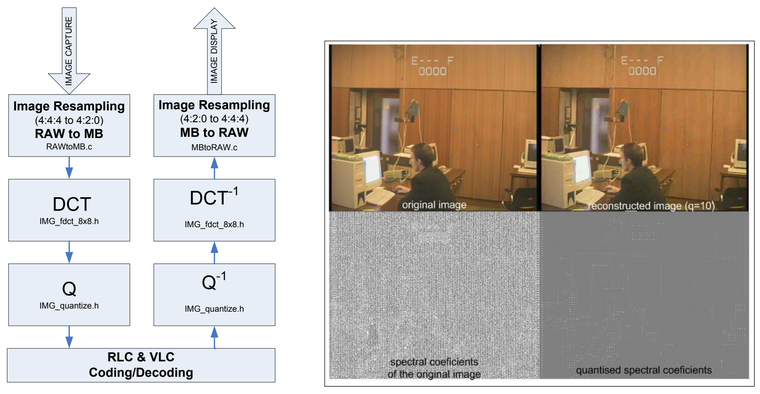
Fig. 4. Workstation composition

Universal project template for video processing was created. It contains only routines for DSP configuration and video capture/video display, so it spares time when new application is developed. User then only inserts own algorithms. Blank project template consists of the three tasks: video input task, processing task, video output task. In processing task is shown how should be a new code inserted.

Demonstrations of Compression Techniques

Students are in successive steps charged with lossy compression techniques for intraframe and interframe redundancy elimination. For intraframe redundancy elimination is developed demonstration of DCT based codec, for interframe redundancy elimination are developed demonstrations based on MPEG2 codec structure (various types of motion compensation, shown how are I, P, B frames created, influence of the GOP structure on the image quality).

Program which demonstrates the function of DCT-based codec consists of one loop (Fig. 5). The loop processes image slice of 45 macro-blocks length. There are used some routines from TI´s image library. The steps of encoding process are displayed on connected monitor in the way as shown in Fig. 6.



a) **b)**

Fig. 5. a) DCT-based codec block diagram b) Visualization of the encoding process on the connected monitor

For implementation of the MPEG-2 video encoder is used the project template which is described in previous section. Processing task includes two parts: frame reordering with encoding process control and frame encoding. The flow diagram of the MPEG-2 video-encoder implementation is in figure Fig. 6. Frame encoding is further divided into three subroutines according to associated frame type (I, P and B) by control routine. The outlines for I, P, B frame encoding with the frame examples are in figures Fig. 7 – 9.

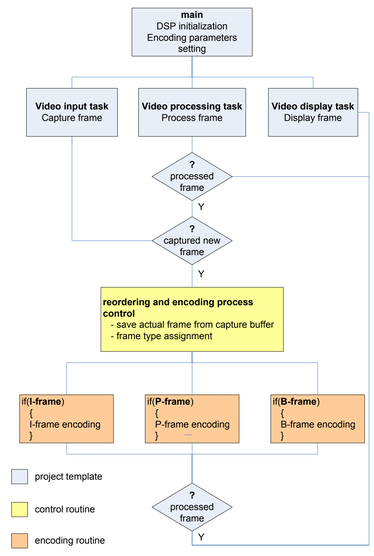


Fig. 6. Flow diagram of the implemented MPEG-2 video-encoder

```
I Frame Encoding    (pointer to corresponding frame,
                     pointer for VLC encoded frame,
                     pointer to display buffer)
{
 for (i < number of slices)
   {
   for (j < number of MB's in the slice)
      {
       DCT transform;
       quantization;
       RLC encoding;
       VLC encoding;
       save VLC encoded frame;

       <for the need to display encoded frame is done decoding>
       dequantize;
       inverse DCT transform;
       save decoded frame to buffer;
      }
   }
}
```

a) **b)**

Fig. 7. a) Outline for I-frame encoding b) Example of I-frame

```
P Frame Encoding    (pointer to reference frame,
                     pointer to corresponding frame,
                     pointer for VLC encoded frame,
                     pointer for VLC encoded vectors,
                     pointer to display buffer)
{
 for (i < number of slices)
   {
   for (j < number of MB's in the slice)
      {
       motion estimation (reference ←corresponding);
       motion compensation
       save VLC encoded motion vectors;
       subtract motion compensated from corresponding frame;
       differential frame DCT transform;
       quantization;
       RLC encoding;
       VLC encoding;
       save VLC encoded differential frame

       <for the need to display encoded frame is done decoding>
       dequantize;
       inverse DCT transform;
       sum up reference frame;
       save decoded frame to display buffer;
      }
   }
}
```

a) **b)**

Fig. 8. a) Outline for P-frame encoding b) Example of P-frame

```
B Frame Encoding    (pointer to previous reference frame,
                     pointer to corresponding frame,
                     pointer to next reference frame,
                     pointer for VLC encoded vectors,
                     pointer to display buffer)
{
 for (i < number of slices)
   {
   for (j < number of MB's in the slice)
      {
       motion estimation (previous reference ←corresponding);
       motion estimation (corresponding ←next reference);
       save VLC encoded motion vectors;

         <for the need to display encoded frame is done decoding>
       motion compensation
       save decoded frame to display buffer;
      }
   }
}
```

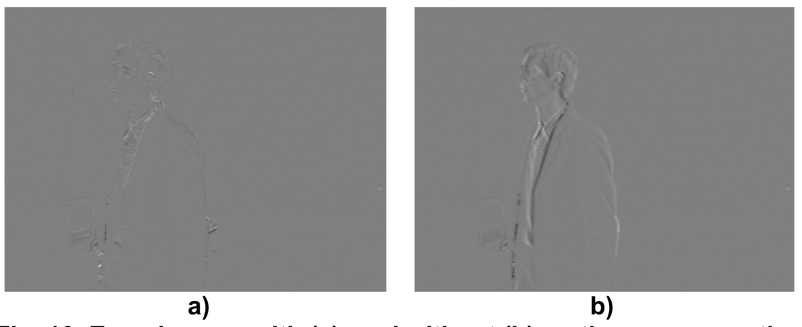
a) **b)**

Fig. 9. a) Outline for B-frame encoding b) Example of B-frame

DM642 EVM merger into research

Research concerns on the video lossy compression techniques. Special pursue is taken in minimizing encoded video bit-rate and improvement of the subjective image quality.

New motion estimation techniques are searched which ensure lower video bit-rate. It is well known that if better motion estimation algorithm is used, the lower count of bytes is needed for error image encoding as shown in Fig. 10. The secondary result is in better image quality of B-frame.



a) **b)**

Fig. 10. Error images with (a) and without (b) motion compensation

The aim in image quality improvement is to figure out the method which takes off the blocking artifacts in the encoded video with low bit-rate. The major of now used techniques in blocking artifacts elimination still have problems in blurring the object edges. When new algorithm would be developed the subjective image quality would increase. Then the bit-rate should be taken to lower values without cardinal image quality losses.

Implemented MPEG-2 video-encoder structure will be used to verify the quality of new motion estimation algorithms and artifacts reduction filters.

Conclusions

Brief description of the designed workstation for digital image and video processing is given. Modern Texas Instruments DM642 media processor is used to get a powerful processing system DM642 EVM. With help of Code Composer Studio tools were implemented demonstrations of lossy video compression techniques as DCT-based video encoder and MPEG-2 video encoder. Shortly described encoders with selected outputs are used in DIPE and ADTV courses and in our research within compression techniques improvement.

Acknowledgement

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