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Introduction

Mobile phones are no longer limited to voice conversations and texting; they have evolved into multimedia-rich devices that are the hub of its user's social life. These new mobile devices integrate not only voice, texts, multimedia and productivity applications, but high-quality still and video cameras.

Today's user demands that these applications be integrated into one high-performing mobile device. Thus, it has become a priority for mobile handset manufacturers to meet these raised expectations by providing one mobile phone solution to attract customers and profit.

OMAP-DM5x: Making your camera phone do more

By 2013, approximately 45 percent of all camera phones will be 8 megapixel or above (*iSuppli*, July 2009). Designing with the right camera phone solution makes it quick and easy to get a new product to market. The OMAP-DM5x family of multimedia coprocessors from Texas Instruments (TI) allows designers to quickly bring accelerated imaging performance to mobile phones, with the ability to support up to 20-megapixel sensors and 720p H.264 video camcorder functionality.

OMAP-DM5x: Making your camera phone do more

The push is on to deliver a better user experience by incorporating traditional consumer electronic features into handsets. Specifically, camera phone users desire advanced digital still camera features as well as an integrated video camcorder with playback. In addition, the mobile device needs to include important imaging features similar to those found in high-end, standalone digital still cameras, including:

- Face tracking
- Red-eye removal
- Image stabilization
- Auto scene detection
- *Perfect moment* technology
- High ISO noise filter
- Video stabilization
- Video noise filter
- Standard NTSC/PAL TV out

All of these features are integrated into a single OMAP-DM5x coprocessor, capable of delivering up to 20-megapixel images with less than two seconds of shot-to-shot delay. With the high performance of OMAP-DM5x coprocessors, camera phone designers will be able to deliver the user experience consumers demand in a cost-effective and efficient manner.

The features listed above are becoming standard in high-end digital still cameras and are quickly migrating into camera phones. This paper will examine each feature and how TI brings each to life in the OMAP-DM5x family of coprocessors.

Red-eye reduction

Nothing is more disheartening than capturing the perfect picture and then discovering that everyone in the photo has red eyes. With the right software, red eyes will no longer be a concern on camera phones. The OMAP-DM5x coprocessor incorporates red-eye removal software that automatically detects and corrects any red eyes in the picture, independent of the orientation of the face. The camera phone user will be able to capture the best possible picture without any action or time-consuming photo editing.

Image stabilization

Blur in a picture can sometimes be caused by the natural motion of the user's hand as they take the picture or record a video. With image stabilization, the blur can be removed to provide crisp, clear photos, even if the camera is accidentally bumped or moved while taking a picture. Blur can also occur when the subject is in motion. By using motion-triggered image stabilization for still pictures, OMAP-DM5x coprocessors automatically evaluate the scene content and adjust the shutter speed and gain setting to counteract any motion in the scene.

When a user is recording video, translational video stabilization is available in both preview and video capture modes and provides a robust algorithm for a wide range of scene content and object sizes. This real-time stabilization removes the effects of a shaky hand and/or motion caused by walking.

Automatic face detection and tracking

The majority of photos taken today are of one or more people. With face detection and tracking software, a camera is able to recognize the subject of the photo and give priority to that portion of the photo, making sure that the face is properly focused and that the exposure setting is optimal.

The OMAP-DM5x family of coprocessors includes the ability to do face tracking, allowing the camera phone to track up to 10 faces as small as 1/16 of the frame at a 30 frames-per-second (fps) update rate. The OMAP-DM5x will display boxes around the faces in the preview frame of the camera phone, allowing the user to view where the camera is focusing. The centermost face is identified and tracked with a yellow box in the preview screen. This information is then used by the OMAP-DM5x coprocessors to prioritize that region for autofocus and autoexposure processing. This capability ensures an improved customer experience; never again will a great photo be missed because the camera was not focused on the subject's face.

Perfect moment technology with temporal bracketing

Temporal bracketing allows users to capture multiple, successive photos taken very closely together. TI's *perfect moment* technology for temporal bracketing will allow camera phone users to capture just the right photo. For example, if the user is at a sporting event and wants to capture the exact moment that a long-jumper lands in the pit or that a kicker kicks the ball, using *perfect moment* technology would allow them to take a series of six photos bracketed around that event: three images before receiving the capture command, one image at the moment of the command and two images after the command. The user would then be able to view all six photos and choose the exact photo they were hoping to capture.

The OMAP-DM5x coprocessors' *perfect moment* technology will make sure that users never miss the perfect shot. Using hardware-only processing allows the quickest and most efficient processing of images. *Perfect moment* technology is available on OMAP-DM515 and OMAP-DM525 coprocessors.

Perfect moment technology with OMAP-DM5x



Auto scene detection

With auto scene detection, a camera phone is able to automatically recognize what is in the scene and then determine what internal settings to use to get the best possible picture. No longer does the consumer have to manually set the appropriate scene or hope that the automatic setting delivers the best image quality.

For example, when taking pictures at the beach, most people do not take the time or even know to switch to “beach mode” on their camera, and then are frustrated when their pictures are overexposed. With auto scene detection, the camera phone would automatically recognize the beach setting and intelligently set the phone to “beach mode” without any action on the user’s part. The camera phone is able to intelligently recognize foliage or a bright sky that can affect the white balance of the picture and will produce the best color possible. Backlighting can be detected and corrected automatically, without any intervention from the user.

TI’s OMAP-DM5x coprocessors support a multitude of scenes so that even a novice camera user can capture the best possible picture. TI supports portrait, landscape, snow/beach, night portrait, backlit, sport and macro . With such a variety of scenes, OMAP-DM5x coprocessors deliver the best quality picture in all situations.

Noise filter CMOS sensors inherently have noise problems in low-light conditions. An ISO filter removes the CMOS noise to deliver brighter scenes as well as keeping details in low light. TI's OMAP-DM5x coprocessors include an adjustable noise filter that can be set from 1 to 3200 ISO equivalent, delivering the best possible image even in the lowest light settings.

Video noise filter CMOS noise is also a problem when recording video, the same as it is in still images. Using a spatial and temporal noise filter allows OMAP-DM5x coprocessors to deliver a crisp picture when recording scenes in low light. With improved performance in low light, the motion-adaptive 3-D noise filter also improves compression by as much as 25 percent. With this improved compression, higher quality video conferencing applications are possible. Automatic bit savings are realized when a higher quality picture with less noise is compressed, because bits are not wasted in noise compression.

720p camcorder With the trend in camcorders moving to HD-quality video, camera phones are moving in the same direction. TI is responsive to these market changes and has engineered the OMAP-DM5x to include the ability to deliver 720p resolution H.264 video camcorder functionality at 24 fps. Great video quality is obtained using the same video stabilization technology discussed previously to reduce the jitter and motion blur associated with video recorders.

The OMAP-DM5x coprocessors' camcorder function includes video preview and record as well as video playback. With 720p H.264 resolution, the OMAP-DM5x will allow the camera phone user to take high-quality HD videos and then play them back on demand. OMAP-DM5x coprocessors also support DVD-quality 30-fps video capture and playback of other popular codecs such as MPEG-4.

OMAP-DM5x coprocessors To be able to integrate all of the features discussed above – red-eye reduction, image stabilization, face tracking, *perfect moment* technology, auto scene detection, noise filters and 720p camcorder functionality – requires a high-performance solution. TI's OMAP-DM5x family of imaging and video coprocessors delivers the performance and quality needed to integrate these and other features into a camera phone to meet users' demands. TI's expertise in this market is demonstrated by the more than 100 million OMAP-DM coprocessors that have been shipped and can be found in numerous mobile phones in the market today.

TI's industry-leading imaging and video technology has been integrated into OMAP-DM5x coprocessors to deliver the highest quality user experience available today for mobile phone applications. A high-performance ARM9 microprocessor as well as TI's advanced image signal processor (ISP) technology and dedicated video coprocessor enable OMAP-DM5x coprocessors to support up to 20-megapixel sensors and 720p H.264 camcorder functionality. OMAP-DM5x coprocessors deliver high-quality still images with low shot-to-shot delays of less than two seconds for high-megapixel images, giving users the experience of high-end digital still cameras.

The OMAP-DM5x family of coprocessors includes a complete software package preintegrated by TI, which enables quick and efficient development for new or existing camera phones. A variety of memory configurations and feature sets are available to meet the needs of every mobile handset (Table 1), while flexible interfaces allow OMAP-DM5x coprocessors to support a multitude of sensors and controls, including:

- CMOS sensor interfaces
- Signal conditioning circuits
- Power management
- Mobile DDR-SDRAM
- Shutter, iris and autofocus motor controls

OMAP-DM5x coprocessors deliver a seamless interface to application and baseband processors via SPI, host port interface (HPI), I²C and parallel interfaces, minimizing design time and cost. OMAP-DM5x coprocessors operate side by side with OMAP media processors or directly with baseband modem processors to deliver high-quality imaging and video functions. An integrated standard TV-out interface allows mobile handset customers to use a composite or S-video cable to view the mobile handset display on a TV screen, allowing easy sharing of content with a group of people.

	OMAP-DM510	OMAP-DM515	OMAP-DM525
Still image support	Up to 8 megapixels	Up to 12 megapixels	Up to 20 megapixels
H.264 camcorder performance (encode and decode)	720p @ 24 fps		
Universal MPEG-4 decode	WVGA @ 25 fps		
Universal H.264 decode	WVGA @ 25 fps		
H.264 encode	WVGA @ 25 fps		
JPEG capability	Up to 90 megapixels per second		
Host interfaces	SPI, HPI, I ² c, parallel		
Camera interfaces	Serial parallel		
Memory	Includes 128-Mb stacked mDDR	Includes 256-Mb stacked mDDR	Includes 256-Mb stacked mDDR
Display/TV-out	Composite/S-video		
Package	8 x 8 mm ² BGA, 0.5-mm ball pitch		

Table 1. OMAP-DM5x coprocessor family features

All OMAP-DM5x coprocessors have the same footprint, allowing scalability between parts. The right coprocessor can be used to deliver the right performance for the market segment the camera phone is targeting. Only minor software changes are needed to upgrade between the different coprocessors, giving designers an easy way to remix offerings, as well as optimizing software reuse across designs.

***Making your
camera phone
do more***

With the ease of design as well as high-performance offerings of the OMAP-DM5x family of coprocessors, TI's solution can help bring a full-feature, high-quality camera phone to market quickly. Camera phone users are demanding the same features they see in their digital still camera such as red-eye reduction, face tracking, noise filters, image stabilization, auto scene detection and camcorder capability. OMAP-DM5x imaging and video coprocessors are a robust, proven solution that can help you meet consumers' expectations and deliver a high-performance solution to market quickly and easily.

***For more
information***

Please visit www.ti.com/omapdm5x-wp.

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