Streaming solution IP - Camera

By Ralf KILGUSS
Imaging Technical Marketing Section Manager
STMicroelectronics
Email: Ralf.Kilguss@st.com

Streaming solutions are growing faster as expected! Why this is happening? Some of the reasons for example are epidemics like SARS, visual meetings which don't need traveling or security/surveillance cameras. So what is an IP – Camera? In the past we heard PC – Cam as well as Web-Cam. But there is a big difference in how they are working. In the reality both terms have been related to PC – Cameras but Web - Cam were wrongly named in combination with the PC. PC - cameras are USB connected cameras. Purpose or mostly used with standard software supplied by the OS for video conferencing and video chatting. In terms of surveillance technology there are two systems available one is the old technology like the CCTV cameras based on CCD technology and using analog transmitting (PAL/NTSC), newer ones using CCD or CMOS transmitting digital. If we looking now into the technologies of these two systems we will figure out that CMOS has big advantages for this market. First of all CMOS cameras don't need different voltages. That means the power supply is much easier to design (single source). Secondly the biggest advantage is integrated timing and ADC which means the image output is already digitized, which helps a lot for the overall cost of these systems. For low light performance CMOS technology from STMicroelectronics is getting close in performance as we are using low light optimized pixel technology. Further more sensors can do already some of the algorithm of preprocessing to help the video processor performance.

Coming now to the overview of a true Web – Cam or so called IP – Camera. The IP – Camera will never be a replacement for PC – Cameras but for home security home surveillance more suitable. The reason is following. If we want to stream video or video and audio over the internet we need at least something like a streaming server. If we are looking into PC based systems we will find that this kind of systems have the need that the PC is powered on 24h which means that it is a waist on energy, it generates a lot of noise and it also will slow down the performance of the system if we want to use the system further more for private use in the household. A true IP – Cam instead is build on an embedded streaming server this means the camera has his own streaming server build in which means doesn't need any further use of a PC any more. Just plugged into the Ethernet (Hub) or using wireless Ethernet is already enough to work.

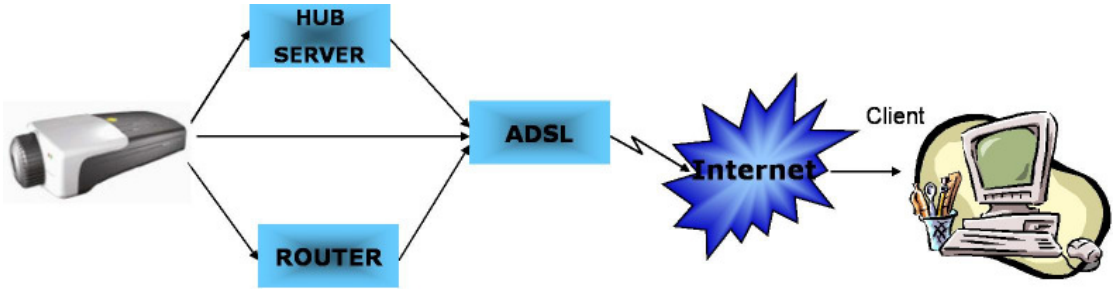

Figure 1: Block diagram IP – Camera SOHO concept

Looking into Figure 1 we will see that there is only one PC in use at the client side nothing else. But coming to the advantages of this system, the client can be everywhere on the world. As long there is an Internet connection available the camera can be watched and controlled. Looking into the future of this solution we will figure out that this solution is more useful as expected. Having for example children at home but need to go out of the house for talk to the neighbors makes worries for the most parents. As mobile phones are getting more options in terms of data communication as well as the speed increase there could be a possibility in the future that the camera will generate an alarm by motion detection or by noise detection which could send a SMS or directly call the cell phone and streams the video to it. The same concept is done for the time being in the office where no one will watch the apartment. Other usage could be pointing the camera into the front door and if someone rings the door the camera will call the video phone which allows you to open the door.

From the technical point of view STMicroelectronics works together with Taifatech Inc. (www.taifatech.com.tw) to generate a true turn key solution ready for MP. Customers only need to modify their user interface of what they want to show in the client browser, if not they can use the default and can go right away for MP. The solution we provide is based on our STv0676 (coprocessor) and our VGA sensor VV6501. This kit is a well known and proven platform which allows streaming video thru USB as well as a so called "Digiport". The Digiport in which we use this solution is an 8 bit data and 2 bit control bus which allows transferring the data parallel to any embedded system. The maximum clock speed is 1.5MHz which can be interpreted as being maximum 1.5MByte data per second. This allows transferring easily 30fps (frames per second) thru this.

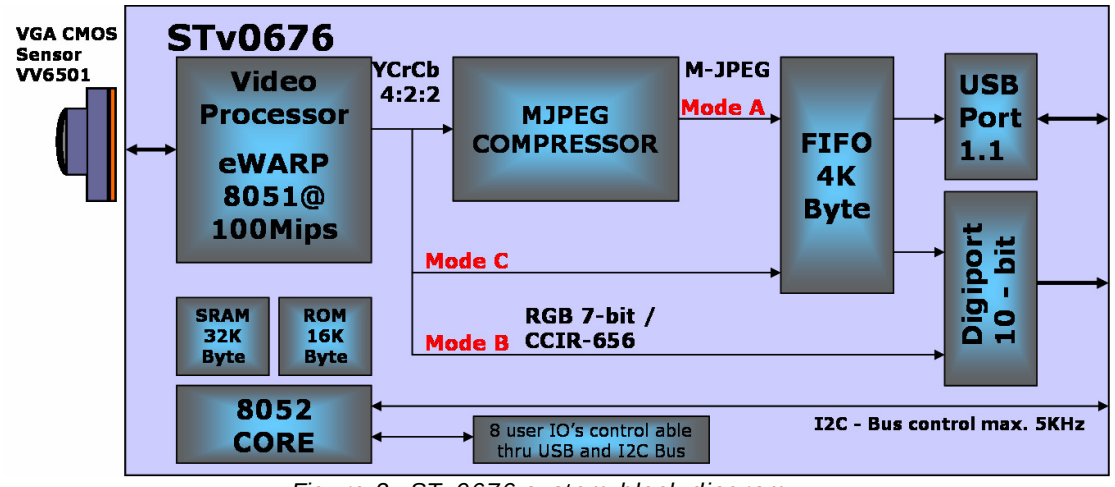

Figure 2: STv0676 system block diagram.

Figure 2 shows the block diagram of this solution on the left side we see the Video Processor which is connected directly to the sensor and will control all

functions which are necessary for the Image processing as there are things like Auto White Balance (AWB), Auto Exposure (AE), colour shifting matrix, exposure zone weighting, defect pixel correction, colour models calculations. The STv0676 can work in different modes to get image data out of the system.

1. **MODE A**
   STv0676 is in USB mode and will stream the image data directly to the USB port through the FIFO.

2. **MODE B**
   STv0676 is in Master Mode and can stream CCIR-656, YCrCb, and RGB 7-bit each colour to the Digiport. Master mode means that STv0676 will clock the data based on the selected frame rate. In this mode it can be used to attach an external TV-decoder and stream directly to TV.

3. **MODE C**
   STv0676 is streaming RGB24, YUV and MJPEG to the Digiport thru the FIFO. The limitation in this mode will be 1.5MHz data clock but system will be in slave mode external controller will control all the data transfer.

To use STv0676 in an embedded environment means using our system in Mode C. Data can now read out from the STv0676 in an asynchronous mode which leaves enough flexibility for the Master MCU to do other work. One of the cores for this solution is of course the FIFO of 4KByte. The size seems not really big as we are talking about big amount of data, but the Video Compressor (VC) will help on this. The VC has the ability to get setup to a dynamic compression ratio selection. This means that the VC based on the fill factor of the FIFO will make a decision of the compression ratio. For example is the MCU reading faster and the FIFO is running low than the VC will compress less. In case the MCU will read slower and the FIFO is running over the VC will based on this compress as much as possible. But all this will not prevent for FIFO overrun or under run. Is FIFO empty an empty signal will occur is the MCU too slow to read the data the FIFO will overrun without warning as the Video stream cannot stop. In reality this is a real seldom case as the data rate can get calculated. Let us look inside the data amount. Based on the VGA resolution we will get following calculations.

Bayer pattern per frame:
640 x 480 = 307,200 (Pixel)

YUV per frame:
307,200 x 2Bytes = 614,400Bytes / 1024 (KBytes) = 600KBytes.

Streaming 30fps for example in uncompressed mode would mean that we have a data amount of ~17.58Mbytes/second. So the only way to come to a decent data rate is by compression. As the JPEG compression is a dynamic compression there is no way to 100% predicting any size. For example you want to compress one frame by a factor 10:1 that means the VC tries to achieve this ratio but reality will be that sometime the scene allows to achieve this easily sometime it is getting impossible. But one thing we can say that the calculated amount is not just to divide by 10 on the calculator. Therefore the VC has a kind of dynamic adjustment based on this and therefore we have build in 4KByte FIFO to stabilize. The compression our VC can do is around 80:1 maximum but frankly spoken compression ratios around 30:1 is acceptable going higher in compression will make too much compression noise which will be not acceptable. So the amount of data we need to transmit based on 30fps@VGA will be 600KByte/sec.
Now after we have the knowledge about the imaging side lets look into the system diagram.

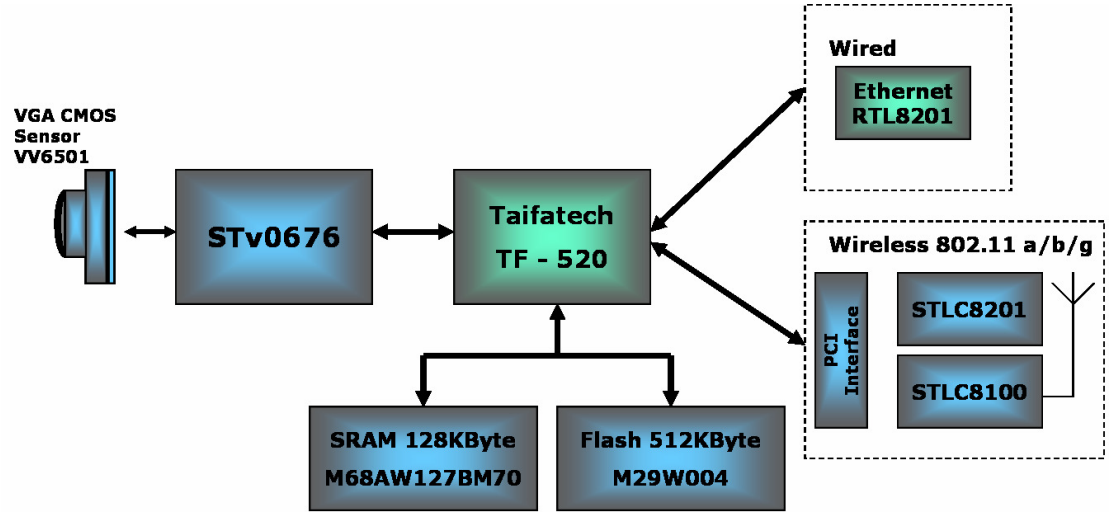

Figure 3: IP – Cam system block diagram

The system is pretty much strait forward. The image get captured from the sensor thru the Stv0676 than get processed by it and stream MJPEG directly to the TF – 520. The TF – 520 is single chip IP servers which just need memory as well as an Ethernet PHY everything else is integrated like PCI interface, MAC and special IP for the TCP/IP stack handling. If the design is done wireless we just connect a miniPCI WLAN card to the system and exchange the firmware and we are ready for the wireless solution.

For the roadmap there are further developments planed. One of the developments are same feature including audio, than further more going to higher resolutions possible 2MPixel which will enable digital zooming and making storing pictures and still streaming in 30fps VGA over the internet. We believe that the IP – Cam will have a great future beside the USB cameras and we will continuously work on solution which can simplify our life.