Real Time Image Transfer over WLAN for Rear View Systems in Automobiles

WHITE PAPER

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The need for rear parking aids using a camera on automobiles is on a rise as they help in eliminating the blind spot at the rear and acts as a supplement to the existing rear view mirrors. An AT Kearney market analysis projects this market to grow at 15% (CAGR) to reach a size of $1.6 billion by 2005.

This white paper describes a wireless solution, using WLAN (IEEE 802.11b), for a rear view system to help in parking the vehicle or while driving in reverse. It also explains the requirements, design and architecture, inclusive of both hardware and software, to develop such a solution.
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**Introduction**

Most of the rear view solutions available in the market today are wired solutions i.e., a camera at the rear transmits data through a cable to the display near the driver. A wired solution as an after market product adds to the cost, and is cumbersome.

A better alternative is to transmit the images wirelessly using WLAN (or IEEE 802.11b). It provides a fairly high bandwidth of up to 11 Mbps and importantly, once the wireless gateway is installed in the car, it provides for future feature enhancements. A solution with WLAN gives an image of size 640x480 pixels at the driver console. The image transmission rate will be 30 frames per second (fps). MPEG4 will be used for encoding and decoding the images. It would require a Transmit and a Receive module. The Transmit module will contain an Omnivision camera, a TI DSP for encoding and a transmitter; conversely, the Receive module will have a display, a TI DSP for decoding and a receiver. The board can be designed such that the Transmit and Receive modules can be used interchangeably by simply using the corresponding modules.

<table>
<thead>
<tr>
<th>System</th>
<th>CAGR 95-05</th>
<th>Market Size 05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collision warning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Parking/blind spot</td>
<td>15%</td>
<td>$1.6</td>
</tr>
<tr>
<td>• Distance warning</td>
<td>22%</td>
<td>$1.8</td>
</tr>
</tbody>
</table>

The advantage of a WLAN solution is that it reduces wiring costs in the vehicle and also provides for future enhancements.

**Description**

The rear parking aids help the driver in primarily watching the far rear of a vehicle when driving reverse.

So, the proposed wireless solution should ideally satisfy the following requirements:

- Real time transmission of video images (in color, though resolution might not be critical)
- Point-to-point wireless transmission
- Display for watching the space in the far rear of a truck when driving reverse/ parking
- If the system is to be fitted in a lengthy truck or a recreational vehicle (RV), the transmission should cover the typical distance of 30 meters
- System should meet the automotive standards
There will be no requirement for audio transmission.

A solution to meet the above requirements will consist of the following components:

1. A camera
2. An image encoder
3. Transmitter & Receiver
4. An image decoder

A display for showing the captured image

For demonstrating a prototype, the display and decode system could be replaced by a laptop having a wireless LAN card.

A Wireless LAN (WLAN) is a flexible data communication system implemented as an extension to or as an alternative for, wired LAN. Using electromagnetic waves, WLANs transmit and receive data over air, minimizing the need for wired connections. WLAN (IEEE 802.11b) provides a bandwidth of 11 Mbps and a high range. If a WLAN gateway is installed in the vehicle, it can be used for multiple purposes.

**Video encoding and decoding**

To get a reasonably good picture, an image size of 640x480 pixels would be required. The recommended mode of compression to get such an image at 30 frames per second would be MPEG4, for which DSPs from TI are recommended.

**Product architecture**

The system will have two components to it viz., hardware and software. Both architectures are described separately in the following sections.

**Hardware architecture**

The hardware will consist of a Transmit and a Receive module. Each of these modules will be implemented with dual PCBs, with one acting as the mother board, and the other as the RF daughter card. The mother board and the RF daughter card are designed to work both as a Transmit and as a Receive module.

The board will have two connectors, connecting to the camera module. The recommended camera module is Omnivision – OV7620.

**System level validation environment**

The prototype system is shown below. It includes a Transmit module and a Receive module.
Real Time Image Transfer over WLAN for Rear View Systems in Automobiles

**Figure 2: Transmit and receive module**

**Mother Board Details**

- Camera CMOS Sensor
- TI DSP MPEG$ Algorithm
- FPGA
- 8 bit to 24 bit RGB
- RGB to YUV
- 4:4:4 YURV to 4:2:0 YUV
- DSP Interface Block
- Dual Port SDRAM Controller
- MCU Interface
- Micro-Controller
- Boot Flash
- TI WLAN chipset 802, 11b MAC Baseband
- SDRAM
- LCD Panel Connector
- External RF Interface Card Connector

**Figure 3: Mother board block diagram**
Functional description

Image captured by the camera will be transferred to FPGA in RGB format. The FPGA converts the RGB signal to YUV format and the output will be stored in one of the banks of the dual bank SDRAM. The YUV image stored in SDRAM will be compressed to MPEG4 format by a TI DSP and the compressed image will be stored in the other bank of SDRAM. On the receive module the same DSP will be used for decoding. The microcontroller which interfaces with the SDRAM over external bus retrieves the compressed image and transfers the image to TI WLAN chipset (Baseband controller) over PCMCIA interface. The WLAN chipset will transmit the compressed image over RF using Transmit module. On the Receive module ACX-100 will be used as receptor of compressed image and sent.

RF Daughter card details

The RF Daughter card basically includes the RF and IF ICs to handle the WLAN data conversion. It also has a power amplifier module. The Block diagram of the RF board is as below:

![Figure 4: RF Board]
Software architecture

The software for the system will consist of a number of blocks.

The following software modules need to be developed:

1. Video encapsulation and transmission protocol management
2. Boot up and initialization code
3. Porting of micro kernel
4. MPEG 4 encoder and decoder

- **MPEG-4 Encoder**: WIPRO’s IP MPEG-4 Encoder code will be optimized on a TI DSP for real-time performance for 640 by 480 size video at 30 frames per second.
- **MPEG-4 Decoder**: WIPRO’s IP MPEG-4 Decoder code will be optimized on a TI DSP for real-time performance for 640 by 480 size video at 30 frames per second.
- **PC Decoder for Demo**: WIPRO has a stand-alone PC demo for MPEG-4 video decoding which will be enhanced for taking inputs over wireless channels.

5. **WLAN 802.11b**
   - Video encapsulation and transmission
   - MAC and SME
   - PCMCIA driver
Conclusion
An integrated wireless solution as described above would help in capitalizing on the increasing need for rear parking aids and collision avoidance systems. Since Wipro owns the IPs for WLAN, USB and MPEG4 software stacks, a cost effective solution can be developed to suit customer needs and the market.

Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Wipro</td>
<td>Wipro Technologies</td>
</tr>
<tr>
<td>TI</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receiver-Transmitter</td>
</tr>
<tr>
<td>BT</td>
<td>Bluetooth</td>
</tr>
<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
</tr>
<tr>
<td>WLAN</td>
<td>Wireless LAN or IEEE 802.11b</td>
</tr>
<tr>
<td>DSP</td>
<td>Digital Signal Processor</td>
</tr>
<tr>
<td>N/A</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>TBD</td>
<td>To Be Defined</td>
</tr>
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</table>

Reference
http://www.wlana.org

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About Wipro Technologies

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