AVM
Around View Monitor System

Introduction
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DWECC AVM Technologies
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About AVM

What is AVM?

AVM is an Intelligent Parking Assistance System that processes images from 4 super wide-angle lens cameras, providing a top-view of the vehicle and the surroundings from a bird’s-eye view.
About AVM

What is AVM?

Output Images
About AVM

Main Technology - AVM Image Processing

Step 1
Angle Correction

Step 2
Homographic Conversion

STEP 3
Arrangement

STEP 4
Image Stitching

STEP 5
Post processing

Process Completed
About AVM

Main Technology - Angle Correction

- Process that corrects radial distortion of the original wide-angle lens cameras into distance images.
- Process Parameter sources – Lens & Sensor Specification
  - Sensor : CIS Output Resolution, CIS Pixel Size
  - Lens : Projection Type, Focus Distance, Central Light coordinates

Distorted Image  |  Distance Image

Angle Correction
About AVM

Main Technology - Homographic Conversion

- Process that corrects the viewpoint of the distance images. (Homography)
- Process Parameter Sources – Over 4 Symmetrical Reference Points of Distance Images.
- Modeling the distance of reference points as SVD Decomposition, applying in homographic conversion process.
About AVM

Main Technology - Image Stitching

- Combining corrected images into one. (Image Stitching)
- Image combination using each plane’s true position.
About AVM

Main Technology - Post Processing

- Brightness Control
- Inter-Channel Balancing
- GUI Application (ROI, Vehicle Icon, View-modes)
Technical Specification

Hardware - ECU Block Diagram (Current Prototype)

- 4 super fisheye analog camera
- Video Output
- Head Unit (Touch Screen)
- NTSC
- Video Decoder
- Video Encoder
- FPGA (AVM Processing Engine)
- DDR2 128MB
- EMIF
- MICOM
- CAN
- CAN Network
- Commands from Navigation Unit (View Mode)

AVM ECU
Technical Specification

Hardware - FPGA

- DDR2, 128MB 16bit I/F
- MIG
- Resource Priority Encoder
- Capture Line buffer
- Display Line buffer
- AVM Line buffer
- HOST IF buffer
- BT656 encoder YUV422 sampler
- High performance AVM engine
- BT656 decoder YUV422 sampler YUV444 converter

Video In

Processed results (P, X, Y)

RAW entries for pixels

HOST EMIF I/F

FPGA Internals

Video OUT
Technical Specification

Software - Firmware Flow Chart

1. Power On
   - MCU Initialization
     - Peripheral Initialization
       - Board Initialization
       - Power Module
       - PLL
       - Pin Configuration
       - Interrupt
       - UART / I2C / SPI / Memory
       - FPGA
       - Video Decoder
       - Encoder
       - CAN controller
       - USB controller

2. Normal Operation?
   - Yes
     - Upload INF
     - Command from Head Unit?
       - Yes
         - Change Display Mode
       - No
         - No
   - No
     - Camera Calibration

No
Technical Specification

View Modes - 14 View Modes (Prototype)
Technical Specification

View Modes - 2.5D View

DWECC’s AVM post processing technology enables a unique view-mode that provides the 2.5D view which allows driver to have better vision of the rear side of the vehicle.

This view mode presents the outstanding image processing technology which allows customers to have wider range of choice in different view modes.
Technical Specification

View Modes - W.A.V (Wrap Around View)

| 2D AVM Limits          | - No images other than plane-view  
<table>
<thead>
<tr>
<th></th>
<th>- Image distortion of standing objects</th>
</tr>
</thead>
</table>
| Solution               | - Mapping the AVM spherically from the ground  
|                        | - Adding objects in reference of the incidence angle |

- [FujitsuTen] Near-field Top View can NOT identify vehicle and pedestrian
- [Flexible Eye Point] can identify pedestrian
- [DWECC]
Technical Specification

**Calibration - Process**

1. **Spec. Acquisition**
   - Camera, Vehicle, Screen, Space

2. **Image Acquisition**
   - Image Class

3. **Pattern Recognition**
   - Info

4. **Lens Image Correction**
   - Corrected Image

5. **Homography**
   - Plane Image

6. **Image Stitching**
   - Plane Image

7. **Image Output**
   - Calibration Validation
**Technical Specification**

**Calibration - Smart Calibration 1.0**

<table>
<thead>
<tr>
<th>Calibration</th>
<th>Correcting errors occurred by physical installation deviation and/or camera specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart Calibration</td>
<td>Automated calibration with minimum involvement of installer or operator</td>
</tr>
</tbody>
</table>

**Smart Calibration 1.0**
- Automatic Calibration by PC software

*Before* → *Calibration* → *After*
## System Development

### Product Range

<table>
<thead>
<tr>
<th>Res.</th>
<th>Model</th>
<th>CAMERA</th>
<th>CPU</th>
<th>FPGA</th>
<th>MEMORY</th>
<th>Calibration</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>DWA-2004</td>
<td>VGA (300,000pix)</td>
<td>MICOM</td>
<td>Spartan 6</td>
<td>FPGA memory - DDR2 1Gb X 1</td>
<td>PC</td>
<td>Pre-production</td>
</tr>
<tr>
<td></td>
<td>DWA-3004</td>
<td>VGA (300,000pix)</td>
<td>DSP</td>
<td>Spartan 6</td>
<td>FPGA memory - DDR2 1Gb X 2</td>
<td>DSP or PC</td>
<td>PROTO#1</td>
</tr>
<tr>
<td>HD</td>
<td>DWA-4004</td>
<td>HD (Over 1.3M)</td>
<td>MICOM</td>
<td>Spartan 6</td>
<td>FPGA memory - DDR2 1Gb X 2</td>
<td>PC</td>
<td>In Dev</td>
</tr>
<tr>
<td></td>
<td>DWA-5004</td>
<td>HD (Over 1.3M)</td>
<td>DSP</td>
<td>Spartan 6</td>
<td>FPGA memory - DDR2 1Gb X 2</td>
<td>DSP or PC</td>
<td>In Dev</td>
</tr>
</tbody>
</table>

DWECC AVM models shown above are reference platforms we provide customers for testing.

The actual product will be customized depending on customer’s control interface, UI and/or system communication method.
System Development

Product Range

DWA-2004 (MICOM+FPGA(SD))

- CPU: 32-bit MICOM, FPGA
- DDR2 1Gb X 1
- View Mode: 4EA
  1) AVM+Front Live
  2) AVM+Rear Live
  3) AVM+Left Live
  4) AVM_Right Live
- Video Output: composite (720x480)@30fps
- Camera: VGA, 1/4", FOV 190°(H)
- PC SMART Calibration
System Development

Product Range

DWA-3004(DSP+FPGA(SD))

- CPU: Digital Media Processor DSP, FPGA
- DDR2 1Gb x 2
- View Mode: 11EA
  1) AVM + Front Live
  2) AVM + Rear Live
  3) AVM + Left Live
  4) AVM + Right Live
  5) Front Wide View
  6) Rear Wide View
  7) AVM + Left Rear Corner
  8) AVM + Right Rear Corner
  9) 2.5D BEV (Bird's Eye View) REAR
  10) 2.5D BEV (Bird's Eye View) FRONT
  11) 3D bird's eye View.....
- Video Output: composite (720x480)@30fps
- Camera: VGA, 1/4”, FOV 190° (H)
- Auto & PC SMART Calibration
System Development

Product Range

DWA-3004 (MICOM+FPGA(HD))

- CPU: 32bit MICOM, FPGA
- DDR2 1Gb X 2
- View Mode: 11EA
  1) AVM + Front Live
  2) AVM + Rear Live
  3) AVM + Left Live
  4) AVM + Right Live
  5) Front Wide View
  6) Rear Wide View
  7) AVM + Left Rear Corner
  8) AVM + Right Rear Corner
  9) 2.5D BEV (Bird’s Eye View) REAR
  10) 2.5D BEV (Bird’s Eye View) FRONT
  11) 3D bird’s eye View.....
- Video Output: composite (720x480)@30fps
- Camera: VGA, 1/4", FOV 190°(H)
- PC SMART Calibration
System Development

Product Range

DWA-4004(DSP+FPGA(HD))

- CPU: Digital Media Processor DSP, FPGA
- DDR2 1Gb x 2
- View Mode: 11EA
  1) AVM + Front Live
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  3) AVM + Left Live
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  10) 2.5D BEV (Bird's Eye View) FRONT
  11) 3D Bird's Eye View....
- Video Output: composite (720x480)@30fps
- Camera: VGA, 1/4", FOV 190°(H)
- Auto & PC SMART Calibration
System Development

Development Plan

Step 1
AVM(SD)
In Production 2011.Jan

Step 2
AVM(HD)
Not Implemented 2012.Mar

Step 3
AVM(SD) ASIC
Cost Competitiveness Improvement 2012.Jun

Step 4
Ethernet Camera
2013 In Development (Government Funded)
1Gbps Synchronous Ethernet
Video Information Communication

Not Implemented 2012.Mar
System Development

Development Plan - Automotive Synchronized Ethernet Solution

AVM ECU
32bit Master ECUs
ITS Fusion
Network Master Logic

High Reliability & Capacity

Synchronous Ethernet [Mass data transfer & control Network]

High Capacity Information Processing
Intelligent Safety

Real-time Control
Control BUS (CAN, FlexRay)

Audio & Multimedia
DIS

Gateway
Automotive Sensors
Automotive Control
DWECC AVM Technologies

Implementation - AVM + Parking Sensors

- Combination of AVM and PAS
- Cost competitive
- More Information Provided
- Safer Parking

PAS (Parking Assist System)

AVM

4ch Camera
DWECC AVM Technologies

Implementation - AVM + Automotive DVR

1. AVM Live Video output for driver – Surround view of commercial vehicles allow drivers to prevent accidents occurred by blind-spots.
   - When lane changing
   - When door open
   - Reduction of Blind-spots

2. Accident recording – 2-channel In-car blackbox records the AVM video constantly to record the surroundings during the accident.
   - 5 cameras – 2 channel recording
   - Direct view of accident for analysis. (Better angle view)

1. DVR Monitor Output for Driver – Driver can select either AVM or other cameras for live view while driving. (Accident or Crime Prevention)
   - When lane changing
   - When door open
   - Reduction of Blind-spots

2. The use of 4-channel mobile DVR allows the user to connect 3 additional cameras around the vehicle or connect AVM cameras directly to the device.
DWECC AVM Technologies

**Smart Calibration 2.0**

DWECC Software Engineering Team developed the first version of Smart Calibration which helps installers to instantly calibrated the AVM output image without a need of an expert. Smart Calibration 1.0 is a PC based software which needs RS232 and USB connection to the AVM ECU module.

Smart Calibration 2.0 is in final stage of development that can be done by the module itself without PC connection. This enables the user to control and calibrate the AVM when camera position or angle is changed.
Checking vehicle status with Android smart phone & i-phone anywhere!

This feature will work with Wifi.
Thank You