APPLYING VIDEO TEST AUTOMATION TO AUTOMATE MULTIMEDIA VERIFICATION WITH EMBEDDED LINUX SW

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WHO AM I?

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- Company: Renesas Design Vietnam

- Career: 10 years experiences in embedded software development (both software development and verification)
  - Development for Multimedia framework on Real-time OS
  - Development for Multimedia plug-in for Android Stagefright on R-Car software platform
  - Development and verification for In-vehicle software platform
  - Development for test automation solutions of In-vehicle software platform
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Renesas Design Vietnam Co., Ltd. (RVC) was founded in October 2004, as one of the main design centers in Renesas group.

Business line: Design of semiconductor for both hardware and software.
AGENDA

- Introduction about Video Automation Test
- Achievement with Video Automation Test Development
- The approach for Video Automation Test
- How to apply Video Automation Test with Fuego
- The future plan
### LEGEND

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAT</td>
<td>Video Automation Test</td>
</tr>
<tr>
<td>Fuego</td>
<td>Fuego is <strong>a test framework</strong> specifically designed for <strong>embedded Linux testing</strong>.</td>
</tr>
<tr>
<td>HDMI</td>
<td>(High-Definition Multimedia Interface)</td>
</tr>
<tr>
<td>Ref data</td>
<td>Expected video playback output</td>
</tr>
<tr>
<td>VAT PC</td>
<td>The PC used to launch VAT</td>
</tr>
<tr>
<td>VAFT component</td>
<td>An application used to control VAT PC from Fuego</td>
</tr>
</tbody>
</table>
INTRODUCTION ABOUT VIDEO AUTOMATION TEST
INTRODUCTION ABOUT VIDEO AUTOMATION TEST

THE MOTIVATION

- **The Video Manual test:**
  - Testers will observe and judge the video's quality by human eyes.
  - The test result is unreliable.

- **Big problem:**
  - The video testing results are based on the tester's feeling/spirit/experience/healthy.

- **DEMAND:**
  - Need to automate video testing to make the reliable test results, NOT depends on Human Feeling.
  - Replace “human role” by “MACHINE ROLE.”

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INTRODUCTION ABOUT VIDEO AUTOMATION TEST

POPUP THE IDEA

- The Video Automation Test IDEA:
  - Tester **selects** test cases for test execution
  - Tester **checks** the report from automation judgment
  - The test result is: **NOT depend on tester’s feeling**

Tester **selects** test cases for test execution
Tester **checks** the report from automation judgment
The test result is: **NOT depend on tester’s feeling**
INTRODUCTION ABOUT VIDEO AUTOMATION TEST
TRANSFORM IDEA TO SOLUTION

- The workflow

1. **<request playing video>**
2. **<inform VAT PC to be ready>**
3. **video out**
4. **<capture video out and analyze>**
5. **Passed / Fail**
6. **<receive test report>**

Tester

- **<select test cases>**
- **<receive report from VAT and judge>**
- **VAT PC**
- **Target board**
- **PCs for Test**
INTRODUCTION ABOUT VIDEO AUTOMATION TEST
TRANSFORM IDEA TO SOLUTION

- Devices connection

Fuego PC

VAT PC 1

Target board 1

Target board 2

Target board 3

VAT PC 2
ACHIEVEMENT WITH VIDEO AUTOMATION TEST
VIDEO CODEC AND RESOLUTION

- Support Codecs: MPEG2, MPEG-4, H.264, H.265 (HEVC), VP8, VP9

- Support video resolutions: 176x144, 352x288, 352x480, 352x576, 640x480, 720x480, 720x576, 1280x720, 1920x1080, 2048x1080, ..., 3840x2160
ACHIEVEMENT WITH VIDEO AUTOMATION TEST
USE-CASES

- Supported video/movie playback use-cases:
  - Simple video/movie playback
  - Sequence video/movie playback
  - Repeat video/movie playback
  - Loop input stream and play
ACHIEVEMENT WITH VIDEO AUTOMATION TEST

VIDEO AUTOMATION TEST PERFORMANCE

- With VAT PC specification
  - OS: Ubuntu 14.04
  - HW: Intel(R) Core(TM) i5-3570 CPU @ 3.40GHz, 8GB DDR3-1333 MHz RAM, 500GB HDD
  - Video input signal: HDMI 2.0
  - Performance: can adapt video playback on target board up to FHD@60fps, UHD@30fps
ACHIEVEMENT WITH VIDEO AUTOMATION TEST
HUMAN TEST VS AUTOMATION TEST

Impact of Video Automation Test:

Compare the test run time:

❖ **Manual Test:**
  - Video length (E.g.: 4 mins)
  - Run test + fill report: ~\(4 + 2\) mins

❖ **Automation Test:**
  - Video length (4 mins)
  - Auto Run test + auto report: ~\(4 + 3\) mins

Total: ~7 mins (1.16 times comparing with manual test)

Compare the productivity:

❖ **Manual Test:**
  - 1 person / 1 board / 1 day: 50 TCs

❖ **Automation Test:**
  - VAT PC / 1 board / 1 day (24-hours): ~150 TCs (utilize overnight testing)
THE APPROACH FOR VIDEO AUTOMATION TEST
THE APPROACH FOR VIDEO AUTOMATION TEST

- Video automation test is developed to detect **issues** during video playback:
  1. Frame skip
  2. Frame delay
  3. Frame mismatch
  4. Video Playback not smooth
THE APPROACH FOR VIDEO AUTOMATION TEST

FRAME SKIP

- Definition: frame is IN (A) but NOT IN (B)

Target board

frames sequence in test stream (A) : f1 f2 f3 f4 f5 f6 f7 f8 f9 f10

frames sequence in video output (B) : f1 f2 f3 f4 f6 f9
Frames skip list: f5 , f7, f8, f10
THE APPROACH FOR VIDEO AUTOMATION TEST
FRAME DELAY

- **Definition**: frame appears more than **one** time

**Target board**

frames sequence in **video output** (B) : f1 f2 f2 f3 f4 f5 f6 f7 f8 f8 f8 f9 f10

Frames delay list: f2, f8, f8

frames sequence in **test stream** (A) : f1 f2 f3 f4 f5 f6 f7 f8 f9 f10
THE APPROACH FOR VIDEO AUTOMATION TEST

FRAME MISMATCH

- Definition: frame contains video out which is different from Ref data

Target board

Video content

MISMATCH

Expected Video content

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THE APPROACH FOR VIDEO AUTOMATION TEST
FRAME MISMATCH - CONT

- **Definition**: frame contains video out which is different from Ref data
THE APPROACH FOR VIDEO AUTOMATION TEST
PLAYBACK NOT SMOOT

- **Definition:** lag video playback
- **Calibration:** Video playback judgment feature is calibrated along with tester judgment

Target board → video out → Tester

Tester observes and judges:

- smooth
- smooth
- NOT smooth
- NOT smooth

VAT PC <analyze> → Tester <observe and judge>

Fuego PC <judge>
### THE APPROACH FOR VIDEO AUTOMATION TEST

#### TOOLS SUPPORT VIDEO AUTOMATION TEST DEVELOPMENT

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Frame skip</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Frame delay</td>
<td>OpenCV, FFmpeg</td>
</tr>
<tr>
<td>3</td>
<td>Frame mismatch</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Playback not smooth</td>
<td>Self development algorithm</td>
</tr>
</tbody>
</table>
THE APPROACH FOR VIDEO AUTOMATION TEST
THE REPORT SCHEME

Final report:
1. Playback is smooth or NOT smooth
2. Video frames mismatch or NOT

Report:
1. Frame skip list
2. Frame delay list
3. Mismatch video frames list

Tester

Fuego PC

VAT PC

Target board

Fuego

Ref data
HOW TO APPLY VIDEO AUTOMATION TEST
HOW TO APPLY VIDEO AUTOMATION TEST TARGET BOARD

- DO NOTHING
HOW TO APPLY VIDEO AUTOMATION TEST
FUEGO PC

- Install Fuego on UBuntu PC
- Install the VAT component to communicate Video Automation Test from Fuego side
HOW TO APPLY VIDEO AUTOMATION TEST

VAT PC

- Install the Video Automation Test on VAT PC
- Install Open Source Software: OpenCV, Ffmpeg, Gstreamer
HOW TO APPLY VIDEO AUTOMATION TEST
HARDWARE CONNECTION

- Connect VAT PC, Fuego PC, target board to same network
- Connect HDMI cable from target board to VAT PC
1. Thank to the Fuego - Automated test framework for the LTSI project.

2. Thank to the Open Source Software (E.g. ffmpeg, ffprope, OpenCV, …)
3. Independent on OS of target board
CURRENT VIDEO AUTOMATION TEST STATUS

NEED IMPROVEMENT POINTS

1. So strictly compare since **NO threshold** in comparison
CURRENT VIDEO AUTOMATION TEST STATUS

NEED IMPROVEMENT POINTS

2. Video signal

- Analog Signal
- Digital Signal
CURRENT VIDEO AUTOMATION TEST STATUS

NEED IMPROVEMENT POINTS

3. Automation test video/movie playback only.
THE FUTURE PLAN

ACTION ITEMS

1. Support threshold

Ref data

video out

VAT PC

Human Test

Machine Test

Match

Mismatch
2. Support more Video signal types: Digital, Analog
THE FUTURE PLAN

ACTION ITEMS

3. Support Automation test video/movie playback and Record Video
### THE FUTURE PLAN

**ACTION ITEMS**

- Summary improvement plan

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Current Support</th>
<th>Future Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Comparison method</td>
<td>Threshold: NO</td>
<td>Threshold : YES</td>
</tr>
<tr>
<td>2</td>
<td>Video signal type</td>
<td>Digital : YES</td>
<td>Digital : YES</td>
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<tr>
<td></td>
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<td>Analog : NO</td>
<td>Analog : YES</td>
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<tr>
<td>3</td>
<td>Use-cases</td>
<td>Video playback: YES</td>
<td>Video playback: YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Record Video: NO</td>
<td>Record Video: YES</td>
</tr>
</tbody>
</table>
CONCLUSION
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- By combination between the Fuego and the Open Source Software, Renesas could make a Video Automation Test for Linux platform.

- Thanks to the Video automation test, could reduce the testing workload and get the reliable results

- Eagerly, processing the future plan
THE END

THANK YOU VERY MUCH!
What is Fuego?

- Fuego is a test framework specifically designed for embedded Linux testing. It supports automated testing of embedded targets from a host system, as it's primary method of test execution.
- Fuego consists of a host/target script engine, with a Jenkins front-end, and over 50 pre-packaged tests, installed in a Docker container.
- Tim Bird gave a talk introducing Fuego, at Embedded Linux Conference in April 2016, and LinuxCon Japan 2016

Fuego = (Jenkins + abstraction scripts + pre-packed tests) inside a container