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

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WHO AM I?

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

THE MOTIVATION

- The Video Manual test:
  - Testers **observe and judge** the video’s quality by human eyes

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

![Diagram showing video testing process](image)

- Tester observes and judges the video quality.
- Video output from the target board.
- Results: *OK* or *NG*.
INTRODUCTION ABOUT VIDEO AUTOMATION TEST

THE MOTIVATION

- The Video Manual test: Testers observe and judge the video's quality by human eyes

- Test result is unreliable

DEMAND:

- Need to automate video testing, to make the reliable test results, NOT depends on Human Feeling

- Replace “human role” by “MACHINE ROLE”
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. <select test cases>
2. <request playing video>
3. <inform VAT PC to be ready>
4. <capture video out and analyze>
5. <inform VAT PC to be ready>
6. Passed / Fail
7. <receive report from VAT and judge>
8. <receive test report>
9. <select test cases>
10. <request playing video>
11. <capture video out and analyze>

PCs for Test

Tester

Target board
INTRODUCTION ABOUT VIDEO AUTOMATION TEST
TRANSFORM IDEA TO SOLUTION

❖ Devices connection

Fuego PC → VAT PC 1 → Target board 1
Fuego PC → VAT PC 2 → Target board 2
Fuego PC → VAT PC 2 → Target board 3

Board farm
ACHIEVEMENT WITH VIDEO AUTOMATION TEST
VIDEO CODECS AND RESOLUTIONS

- 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 duration:

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

- **Automation Test:**
  - Video content duration (4 mins)
  - Auto Run test + auto judge result + 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 on target boards:
  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)

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

Target board

`video out`
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

![Diagram showing video content mismatch between Target board and Video Automation Test (VAT) PC.](image)

- Target board
  - Video out

- VAT PC
  - Video content
  - MISMATCH

- Ref data
  - Expected Video content
THE APPROACH FOR VIDEO AUTOMATION TEST
FRAME MISMATCH – CONT.

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

Target board

video out

VAT PC

Video content

MATCH

Expected Video content

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
### 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><img src="https://via.placeholder.com/150" alt="OpenCV" /></td>
</tr>
<tr>
<td>2</td>
<td>Frame delay</td>
<td>OpenCV</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

Report:
1. Frame skip list
2. Frame delay list
3. Mismatch video frames list
HOW TO APPLY VIDEO AUTOMATION TEST
HOW TO APPLY VIDEO AUTOMATION TEST
TARGET BOARD

- DO NOTHING

Video Out
HOW TO APPLY VIDEO AUTOMATION TEST
FUEGO PC

- Install **Fuego** on Ubuntu PC
- Install the **VAT component** to control Video Automation Test from Fuego side
- Compose video TCs
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
CURRENT VIDEO AUTOMATION TEST STATUS

STRONG POINTS

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 OSes/Open platform on target board
4. Day and Night running

24/7 service for the test run demand (*)

VAT supports Continuous Integration (CI) well
CURRENT VIDEO AUTOMATION TEST STATUS

NEED IMPROVEMENT POINTS

1. So **strictly** comparison since **NO** threshold in comparison

Match

Mismatch

Ref data

Human eyes

video out

VAT PC
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

Mismatch

Match
THE FUTURE PLAN
ACTION ITEMS

2. **Support** more Video signal types: Digital, **Analog**

![Analog Signal](image1.png) ![Digital Signal](image2.png)
THE FUTURE PLAN

ACTION ITEMS

3. Support Automation test video/movie playback and Record Video
### 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 Analog: NO</td>
<td>Digital: YES Analog: YES</td>
</tr>
<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>
DEMONSTRATION
CONCLUSION

- By combination between the Fuego and the Open Source Software, it could make a Video Automation Test solution to replace the Human role by the Machine role.

- Thanks to the Video automation test, it could reduce the testing workload and get the reliable results.
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 many pre-packaged tests, installed in a Docker container.
- Tim Bird (an enthusiasm Sony developer) gave a talk introducing Fuego, at *Embedded Linux Conference in April 2016, and Linux Conf Japan 2016*

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