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Post silicon validation of In-Vehicle Infotainment ECU

Veeresh Ambe[1], Shailesh Keshkamat[2]

[1]*Veeresh Ambe, M Tech Student, Dept. of Electronics and Communication, Gogte Institute of technology, Belgaum*
[2]*Shailesh Keshkamat, Professor, Dept. Of Electronics and Communication, Gogte Institute of Technology, Belgaum*

Abstract - *Millions of Automotive ECUs are produced every year. If a defective ECU, after being installed in a car and sent out of the production location, needing to be replaced creates a situation which is cost intensive as well as logistically difficult to execute, not to mention time and resource consuming. Here we present a methodology to validate the peripherals in the ECU before it leaves the production environment. We consider the IVI (In-Vehicle Infotainment) Electronic Control Unit (ECU) as an example. The IVI ECU consists of among many other peripherals HDMI (High-Definition Multimedia Interface) etc. A methodology to test all the HDMI transceiver is presented.*

Key Words: **IVI, ECU, HDMI**

1. INTRODUCTION

A typical IVI (In-vehicle Infotainment) ECU (Electronic Control Unit) consists of various peripherals one of which is HDMI. During the manufacture of the IVI ECU various mechanical, electrical and structural faults may arise which lead to the peripheral failing to operate at its optimum. Hence it is productive to test and validate these peripherals before leaving the production area.

Various schemes to evaluate the peripherals are available. We choose schemes which provide a qualitative evaluation of the said peripheral and provide a conclusive result which can be compared with a threshold value to decide if the test has passed or failed. This helps in reduction of the test time as well as helps the technician in charge of production to determine with a single result if the ECU has to be re-fitted in the production area.

The different schemes for the evaluation of the different peripherals are listed below.

1.1 Validation of HDMI transceiver

HDMI (High-Definition Multimedia Interface) is a proprietary audio/video interface for transmitting uncompressed video data and compressed or uncompressed digital audio data from an HDMI-compliant source device, such as a display controller, to a compatible computer monitor, video projector, digital television, or digital audio device. HDMI is a digital replacement for analog video standards.

A typical IVI ECU consists of a HDMI transceiver which transmits video to a HDMI enabled TFT (Thin-film transistor) display through a HDMI connector populated on the IVI ECU board. The testing of the HDMI transceiver involves connecting the HDMI connector to a HDMI enabled video capture card which can capture video in different HDMI formats. The captured video is then broken down into its constituent video frames and then compared with the original video frames using an algorithm called SSIM (Structural Similarity) which determines an index value for the each of the constituent frames in the test video. These individual index values are then averaged to arrive at a single value which then be compared with a threshold value. The test passes if the averaged SSIM index value if larger than the threshold value and fails if it is lower. Based on this test result the production centre technician can determine if the ECU needs to be replaced.

1.2 Test setup

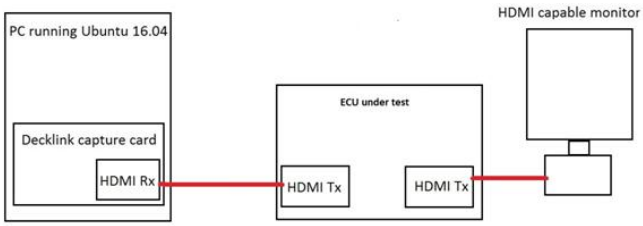

Fig -1: Test setup for HDMI transceiver validation

The test setup used to test the HDMI transceiver is as shown in Fig 1. It consists of two HDMI connectors which can transmit HDMI video simultaneously to the two connectors. One of the connectors is connected to a HDMI enabled monitor/TV to observe the test video being transmitted. The other connector is connected to the video capture card which is fitted onto a PC running Ubuntu 16.04.

The IVI ECU is running a customized version of Android. The communication between the PC and the ECU is established over a USB (Universal Serial Bus)

3.0 connector. ADB (Android Debug Bridge) commands are used to communicate with the ECU.

2. Test procedure

The test begins with the a python script running on the Host PC initiating the test by sending ADB commands to the ECU to initiate the transmission of the HDMI video. Simultaneously the Host PC also initiates the recording/capture of the video via the HDMI capture card by executing a program code residing in the Host PC. This program stores the captured video in a raw pixel format. The python script then executes another program code which combines the raw pixels into the constituent picture frames of the video. The last step the script performs is to calculate the SSIM index value for each of the constituent picture frames by comparing it with the reference test video frames. It then determines a single SSIM value by averaging the SSIM values calculated in the previous step. The test result is published if the averaged SSIM value is greater than a pre-determined threshold value.

The test video transmitted by the IVI ECU is shown in Fig 2.

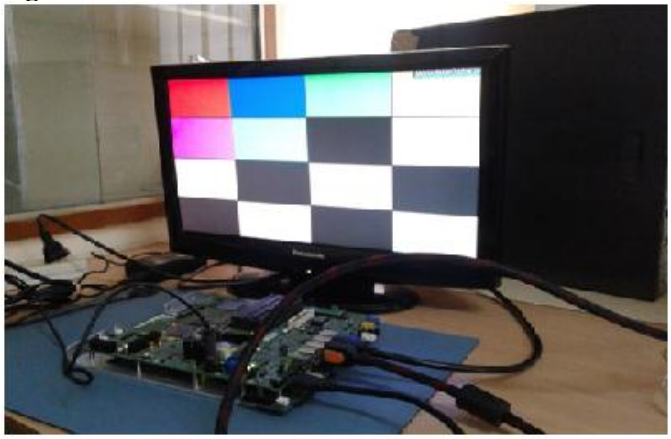

Fig -2: Test video transmitted by IVI ECU

3. CONCLUSIONS

SSIM is chosen for validation of the transmitted video since it provides a qualitative as well as a quantitative result. A SSIM value of 1.0 indicates that the reference and captured video frames are exactly similar. Any value between 0.0 – 0.99 indicates that the video frames are not the same. The closer the value to 1.0 the more similar are the two video frames. MSE (Mean-squared error) can also be used but two very dissimilar pictures can have the same MSE value but different SSIM values as shown in Fig 3. Hence SSIM is a better alternative to MSE.

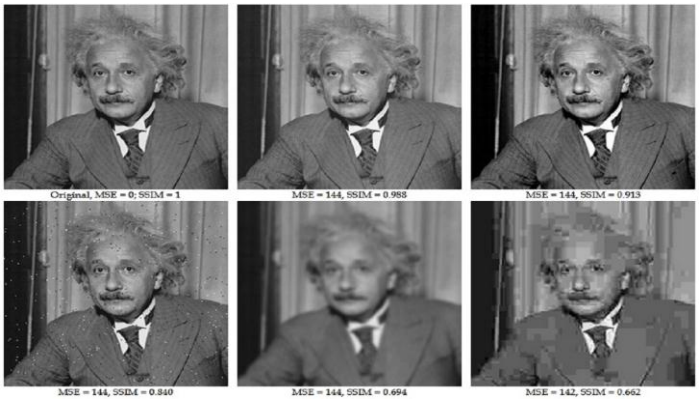

Fig -3: Comparison of SSIM and MSE algorithms

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