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## UNDERSTANDING HMI TESTING

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In today's world, infotainment systems are required to provide seamless connectivity. Image provided by QuEST Global

While testing an HMI is a very complex task, it is not possible to automate it completely.

The automotive industry is operating in a world that demands much more than vehicles for transportation. It must deliver highly efficient machines with an even higher level of interface for various systems in the vehicle. Newer and more advanced Human Machine Interface (HMI) solutions ensure an increasingly advanced in-vehicle experience, and that is today driving state of the art In-Vehicle infotainment (IVI) features in the automotive industry.

In today's world, infotainment systems are required to provide seamless connectivity with mobile device app features and also operate intuitively, flawlessly and intelligently. A modern vehicle needs to communicate various functionalities - commands for safe driving, personalized in-vehicle digital systems - and also offer advanced connectivity options - like V2X (Vehicle to Everything), predictive maintenance and OTA (Over the Air) updates - to the driver that will essentially

make driving experience a two-way communication. While this raises expectations of innovation, there are challenges that need to be addressed before the HMI aspect of in-vehicle functionalities can be declared fit and efficient, while being intuitive and contextual as well.

### ENSURING A HEALTHY INTERFACE

A fine balance needs to be maintained between the driver and the in-vehicle functionalities. The human interface with the machine's capabilities need to be easy to manage, decipher, navigate and also be accurate for graphics and sound acoustics etc. That is a basic requirement, and now there is innovation that should deliver an HMI experience that is more advanced in many ways. While aesthetics is a big part of the HMI design, easy functionalities and high efficiency is the bigger bit.

By some measures, while they deliver diverse functionalities in entertainment, the IVI system is perhaps the most complex system in the vehicle. They are needed to support multiple input/output facilities, multiple connectivity functions and touchscreens. They naturally need to process large amounts of data as well, and this actually changes the entire equation. It goes without saying that HMI needs to be the most robust part of the in-vehicle systems. And for that to hold, testing plays a critical role in its engagement readiness.

In order to be compatible with multiple displays of various sizes & types and connections, the IVI needs to be a distributed system to ensure they support all facets of system interaction - command and control, AV source transport, data and diagnostics.

### THE TEST CHALLENGE

As the number of interfaces increase, the testing environment becomes more complex. With multiple user interfaces, testing needs to cover all possible interfaces and stimuli, and the system will need to track each input, and capture data of fail to ensure resolutions and no repeat failures. Various mobility devices and operating systems need to be a part of the integrated commu-



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nication system in vehicle, and it goes without saying that for increased features, the number of test scenarios would increase too.

The biggest challenge, however, is about the User Interface (UI) and design of the HMI - its easy navigability, and harmony with other in vehicle design elements. Ideally, it should be as easy as one or two clicks for the driver to reach the UI screen, and derive data required. The challenge comes from the new features that need to be tested to perfection. In case there are really complex animations involved in IVI, it will be usually tested by recording video and checking frame by frame. The testing needs to ensure clarity of screen, smoothness of animations, clarity of audio, complete interoperability of new innovative functionalities, and networked devices.

#### THE LIMITATIONS OF MANUAL TESTING

While testing an HMI is a very complex task, it is not possible to automate it completely. While diagnostics on some systems like media and mobility can be automated, in HMI testing, the best ratio that can be achieved is about 60 percent. The trend is moving into a Computer Vision based testing, with extensive use of Artificial Intelligence (AI) and Machine Learning (ML). There are some OEMs who are developing ML and AI friendly specifications for testing and automation that will allow creation of test cases from specifications. The scripts that can be generated using this helps to reduce efforts of testing by two levels, but most effort will then go into the preparation of specification itself. With time, this complexity will only increase as there could be around 40 languages supported by a single system. Even though AI and Optical Character Recognition (OCR) technology can be used for system language testing, it will succeed only if that intelligence can be brought into the test automation framework.

Clearly, both manual and automated testing have their advantages. As a starting point, manual testing has higher advantages since the specifics of functionalities being tested are often not very precise. We can switch to automated testing process once the IVI features are fine-tuned for testing and all specifics are appeased.

#### AUTOMATION TRENDS IN HMI TECHNOLOGY

There are several interesting new trends in automated HMI testing technologies. Increasingly, Robotic Process Automation (RPA) is becoming a part of HMI

testing these days. There are companies that are betting on Robotic Arms that support automated testing. They provide some APIs used for automation - something like a camera setup with a robotic arm, that can detect a button and will be used instead of a human touch, swipe or pinch on the screen. Even today, a robotic pressure sensitive arm is needed to test a 3D touch enabled screen that is currently available only in few iPhone models. Very near in the future this will be available for IVI as well. Even for the normal display without 3D-touch, pressure applied to the screen should be controllable to ensure the screen does not crack under pressure. This demands the need of a sensitive robotic arm for automation of IVI testing - one that is sensitive to the different functionalities of the system.

It is unlikely that any time in the near future, HMI testing can be completely automated. It is very difficult to achieve a robust automation setup during the Engineering Version (EV) and Design Version (DV) phases, where the IVI system is evolving. Usual practice is to build the automation framework during these phases and deploy in Production Version (PV) phase and continue using it during and after the PV through Start of Production (SOP) and until end of life of the IVI testing. Recent advancement of AI and ML along with robotics helps the companies in bringing the automation down the line largely into DV phase effortlessly. AI and ML helps the automation team to adapt the requirement changes in the device during the DV and PV phases into their system much easily and with lesser effort. It actually makes business sense to automate the design version, because changes are inevitable during this phase which can be tested and delivered with less effort of using AI. Employing ML along with AI will ensure the accuracy of the graphics usage. Verifying the graphics in DV phase is not a must, though this will ensure less changes in graphics in further phase of the system. The PV also see many changes in terms of system requirements but will be more robust in nature and so automation will give more test coverage.

So, if automation is taken up from the design stage, the first couple of months the testing needed will be largely manual, and hoping for some strides in the field of automated testing in HMI, we can expect automation to take the upper hand in subsequent stages.

Clearly, HMI testing is on a path of innovation and with features getting smarter, better and much more intuitive. Testing them will be a challenge that technologies of the future will need to deal with, on priority. 🚗

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