Development of Error Consolidator Tool for On-Board Diagnostic Errors

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ABSTRACT
This paper presents the work for development of LabVIEW based automated script for OBD error consolidation. The OBD are long running test and are performed by multiple users to save time. As a result different error codes will be present in different files and then these need to be consolidated manually taking huge amount of time with the consideration of the human errors occurring. This tool will reduce these problems and the dependency on the resource is reduced considerably thereby increasing the productivity**.**

Keywords
On-Board Diagnostics (OBD), Electronic Control Unit (ECU), OBD Error Consolidator tool, LabVIEW development, reports**.**

1. INTRODUCTION
Today all the cars and trucks have the OBD systems built in it. The main question which comes to our mind while dealing the same as to why all the vehicles have the OBD systems built in it. The key issue which the world is facing now a days is the climatic change. The climate change is majorly due to the air pollution and air pollution has sources like automotive exhaust, industrial exhaust, burning of waste, and out of the above-mentioned exhaust from automotive is the major source of air pollution.

Then to counter all these problems the major countries came forward and formulated the Society of Automotive Engineers (SAE). The body formed various rules and regulations to avoid the complexities which the various automobile industries face. Then the organizations such as, Environmental Protection Agency (EPA), California Air Resource Board (CARB), and International Energy Agency (IEA) came forward and took some steps for the management of the emission standards.[8] These emissions standards were EURO I to VI. India also came forward with their own set of standards know as BHARAT STAGE (BS) to curb the pollutant level in the air.

Many countries started with the use of EURO VI emission standards. There are many differences in the regulations between US, EUROPE and the second chapter countries such as INDIA, CHINA, BRAZIL. As a result, the OBD components became very important for products.

The present and future emission regulations are to be met and this led to the vehicle technology being very complex and the failure dynamics are getting very difficult. So, this led the manufacturers to develop the tools such as On-Board Diagnostics (OBD) system. OBD is a computer-based system designed to monitor the performance of the engine components. [1]

The OBD tests performed are very long running tests as they are performed for days on run. This will create the possibility that the test reports formed will be in multiple records. Once the test is completed then the reports are to be manually consolidated to form the final report which is a very time-consuming task.

The tool which is developed for KPIT will help in the automatic consolidation of the reports without any manual intervention from the user and the task which takes about hours will be done in max 10-15 minutes depending on the type of test in OBD.

2. ON-BOARD DIAGNOSTICS
2.1 History
It all began in late 1960's when the LA government started requiring the emission control system for the 1966 model-based passenger vehicles. [2] The federal government then extended these controls in 1968 throughout the nation. So, they developed another body to regulate the emission control systems in the US, it was the Environment Protection Agency (EPA). The manufacturers need to maintain these standards and hence they turned to the electronically controlled fuel feed and such parts to control the fuel injection to the engine.[7] The Society of Automotive Engineers (SAE) then set standard diagnostic test. The EPA adopted these tests from the SAE and these tests are called as OBD test.

The Society of Automotive Engineers (SAE) developed the first stage of OBD standard during the late 1980's. [3] These tests were not suitable for all the model vehicles at that time. They were manufacture specific as the test developed for one company may not be true for the other company. They only provide the basic functionalities. They had some problems; such as: [1]

1. The connection between scan tool and ECU was not standardized. As a result, the generic scan tool was not useful for all vehicles.
2. The error codes were different and hence the generic tool design was not possible.
3. Details stored in ECU's were different for different manufacturers.

As a result, the SAE came up with the different approach to tackle the above given problems. They designed the OBD II in the year 1996 and it was applicable to all the cars made in and after 1996.They even included some of the hybrid and electric vehicles. Along with the basic features they came with some advanced features also.

Some of the features performed by OBD II scanners are as follows: [3]

1. Air Fuel Ratio, Freeze Frame Data
2. Battery and Engine performance
3. Oil Temperature and live reading
4. Coolant Temperature, Fuel Pressure
5. Online programming, ECU programming
6. ABS, Misfires, Battery information
7. Anti-brake Locking system, Air bags problems and
8. ey coding.

Hence OBD II systems are more user friendly as compared to OBD I with respect to repair technicians. OBD I only monitored the EGR, oxygen sensor, fuel injection and engine control module whereas OBD II monitors all the emissions related components. [1]

A basic OBD system consist of an Electronic Control Unit (ECU), which uses input from various sensors to control the actuators to get the desired performance. [4] ECU is the computer which controls the electrical part of the vehicle. [1]

According to [5], ECU is the control unit which is responsible for the performance optimization and control of the most part of engine. ECU optimizes engine performance based on data obtained from various sensors in the car. EU has issued regulations to ensure independent repair shops which can work without having to rely on the manufacturers.

2.2 Objectives of OBD:

The OBD system provides the information for the driver about the occurrence of the fault by the indication of the light provided on the meter.[6] The various regulations provided by the OBD system are as follows:

1. Promote the designing of better emission control systems
2. Helps in curbing emissions by identifying emissions control in need of repair.
3. For the complex electronic engine controls, it helps in the diagnosis and repair.
4. Work for the vehicle's life.

2.3 Functions of OBD:

OBD has many functions as to which some of them are mentioned here. [1]

1. Continuously monitoring
2. Fault indication
3. Fault storage
4. Taking appropriate action

OBD systems are used for keeping a check on the vehicle's emission controls and monitoring them continuously. There are two kinds of monitoring which are system monitoring and component monitoring. Once the fault has been detected it is indicated on the dashboard and then the fault is stored in the ECU in the form of Diagnostic Trouble Codes (DTC) and then according to the severity of the fault the necessary action is taken. [1]

The DTC play a very important role in determining the type of fault and its severity and even where it is specific. The figure below shows the DTC code breakup.

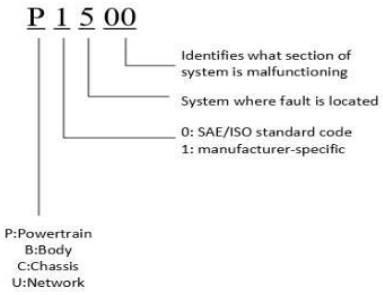

Fig 1: Diagnostic Trouble Code

3. TOOL METHODOLOGY

The OBD system continuously monitor all the electronic circuitry and the test being running are long in nature and time consuming. The reports generated are made in excel and then these reports are consolidated by the tool. The figure shows the proposed methodology for the tool.

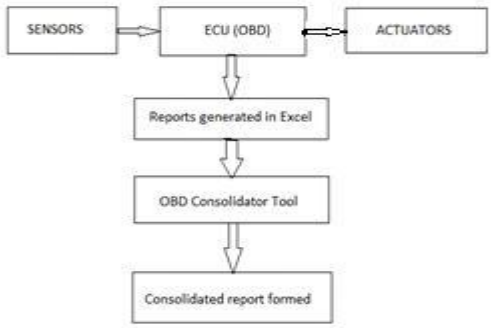

Fig 2: Proposed methodology for the working of the tool.

The sensors will send the data to the ECU which will transmit that to the actuators. Along with the test is performed on the ECU and the reports are formed in the Excel. These reports are needed to be consolidated since the reports are formed in different excel workbooks because OBD are long running tests and then this consolidation task is performed using the tool. The tool will help in the creation of the final consolidated report and it will copy each error code from original file only which is passed and if it fails then that will be considered accordingly and then it is pasted in the final consolidated report.

The tool has been developed in LabVIEW using property and invoke nodes. It has multiple sub VI's in the main VI which work accordingly to the task oriented to them and designed accordingly.

4. CHALLENGES IN THE CURRENT SCENARIO:

Currently majority OBD test are long running and to utilize the time efficiently and during non-working hours, these tests are executed by multiple users.

Hence for a single test we have multiple test reports generated on different locations, which needs to be consolidated manually to prepare a final test report. Also, errors which are failed in automatic execution, needs to be analyzed and the reports which is generated post analysis also need to be consolidated in the main final report. The various challenges with current process:

1. Multiple reports get generated for one test and consolidating all into a single report is a manual and time-consuming task.
2. This process requires special attention since we need to check each error and there are chances of human error.
3. Test report which is generated post analysis of the failed error is as per the error indices. Consolidation of all such errors indices in the main report is a tedious, cumbersome and error prone task.
4. If multiple users are executing the same test, there are chances that multiple error reports have same errors. When these reports are consolidated, there could be a chance that there are duplicate entries of the error which needs to be verified manually which is a time-consuming task.

5. OBD CONSOLIDATOR TOOL (USER INTERFACE):

The figure shows the main screen of the user interface for the OBD Report Consolidator Tool. "Select Report Files", "Remove Path" and "Select location to Save Consolidated Report" are the inputs. Based on the inputs from the user, consolidated_file_path shows the file name (.xlsx) along with the folder selected. After clicking on "Start the consolidation tool" button there will be a message displayed whether we want to continue to or not. If we click on "Yes", the tool starts and if "No" is clicked then the tool stops.

Once the tool starts consolidating it will detect the error indices present in all the files and sort accordingly to the indices in the ascending order.

Once the data is arranged in ascending way then the tool checks for the duplicates present in the data. If there are duplicates they got arranged in the same row and accordingly a check is done which of the following needs to be taken depending on the conditions met.

Accordingly, to this the data is reassured and the required errors are taken from the main files and pasted in the base file which will be the main file.

The tool after completing the required work will display the message, "Reports consolidated successfully."

If any of the error occurs relating to the selection of files, creation of base file, selection of a different file format or presence of any error which are not run completely, then in that case all the values will be considered accordingly and then necessary actions will be taken as depending on the user and the requirements of the user. For each of these a message is popped up accordingly.

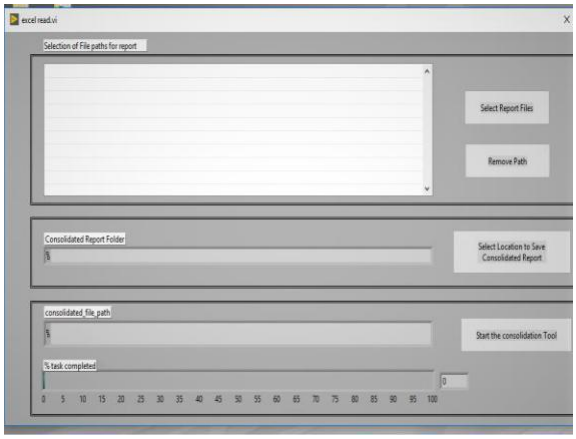

Fig 3: Front panel of the tool

6. WORKFLOW OF THE TOOL:

The flowchart shows the way how the tool is working:

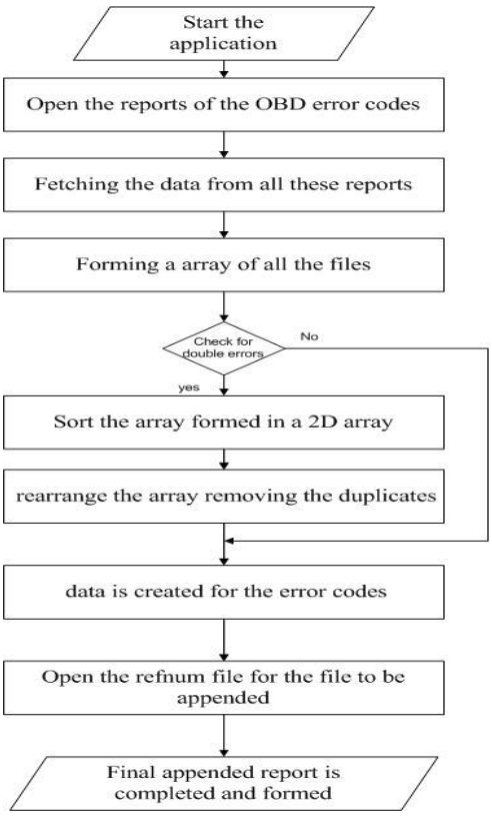

Fig 4: Workflow of the tool

7. RESULTS

The tool will consolidate the OBD test reports. This task which generally takes hours will be accomplished in just a few minutes with minimum errors.

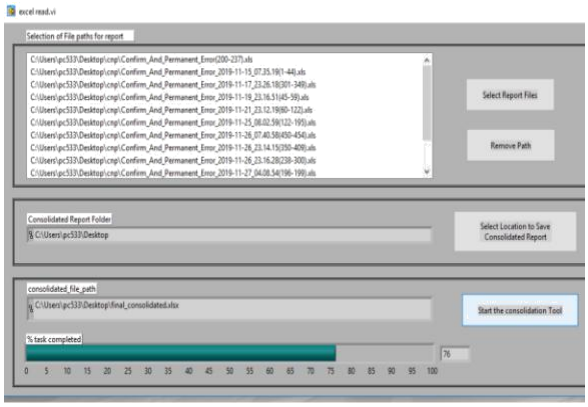

Fig 5: The working of the tool

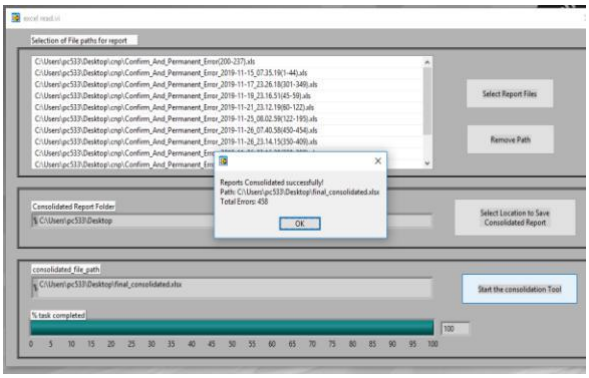

Fig 6: The result displayed

Table 1: The comparison of the tool

Parameter	Time taken manually	Time taken by tool	% effort saving
Report consolidation	6-7 hours	15-30 minutes	+90%

8. CONCLUSION

The objective of this work was to develop a tool that would consolidate the reports which was earlier done manually. The result shows that the tool has been successful in accomplishing the required goals.

The various accomplishments of the tool are as follows:

1. As reports consolidation is done through script, it will save manual efforts which is needed for report consolidation.
2. Report consolidation for the OBD test can be done in an easy and effective way.
3. Chances of redundant errors, missed errors in a report are less which will help improve the work.
4. Total savings of the effort as shown in the table 1 is more than 90%.
5. This in turn will reduce the cost as there will be less dependency on the resource.
6. The time taken would be reduced by a considerable value and that time could be used for other tasks.

The code cannot be provided because it is restricted with respect to the intellectual rights of the company where I did accomplish this project. The results are verified in KPIT.

9. REFERENCES

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