SYNOPSIS

1. Name of the College	**:**D. Y. Patil College of Engineering & Technology. Kolhapur**.**
2. Name of the Course	**:** M. Tech (Electronics and Telecommunication)
3. Name of the Student	**:** Mansing Balaso Chavan (ME20606560)
4. Date of Registration	**:** 12th January 2021
5. Name of the Guide	**:** Prof. Dr. Mrs. S. V. Sankpal
(PG Recognition No. & Date)	: SU/PG/AFFI/RECOG/8295 dated 04/12/2004 SU/PG/AFFI/RECOG/8946 dated 27/10/2010
6. Proposed Title	**:** Enhancement of PLC and HMI Automation Quality for the Paralleling Systems
7. Place of Work	**:** Department of Electronics & Telecommunication Engineering. D. Y. Patil College of Engineering & Technology, Kolhapur

8. Introduction:

There was a time, not so long ago, when many of the products purchased by businesses and consumers were manufactured in large factories employing hundreds or even thousands of workers. Such factories were more productive and profitable than earlier manufacturing methods because of mechanization.

Personal computers were introduced in the 1980s. That is when industrial automation peaked. Industrial automation is that when you use automated control like Programmable Logic Controller (PLC), Computer Numerical Control (CNC), and Remote Terminal Unit (RTU) etc. They help in controlling industrial processes and machinery, replacing manual intervention and dangerous assembly operations, which are automated. It Increases productivity. Automated processes can be executed faster. It Decreases operational costs. Automation can result in reduced costs for labour and quality assurance of the cost of goods sold can decrease dramatically. It increases Product quality. Automated processes can consistently produce high-quality output. It Decreases routine process parameter checks. Because automated processes can monitor and adjust their own process parameters, there is less need for humans to perform these tasks. It gives Safety at work place. Industrial robots can handle jobs that are dangerous for humans, thereby increasing workplace safety.

Cummins Technologies developing PLC and HMI software for the Cummins Power generation Group abroad. Cummins Technologies receive Input documents from the Project Engineer (PE) electronically like Electrical drawings, Block diagrams, Sequence of operation, Part list, etc.

Software Engineer (SWE) follows the standard process of PLC and HMI development. SWE test the PLC and HMI together on Simulator with help of Peer and PE. Once it gets finalize with PE, SWE releases the Software for the FAT and actual commissioning on site.

It is a standard process, but we face many issues in every stage of the project development. Issues increase the rework, troubleshoot time. This affects the Software quality.

There is no specific tool for time measurement for PLC and HMI Software development which causes unclear target dates for Peer review, PE review, and Software Delivery date. Mismanagement in time for individual items in PLC and HMI software. Poor quality of work. Sometimes missed deadlines, results poor work relationship.

Currently HMI development is complete Manual process which takes lots of time and Human intervention causes Human errors and time. This may cause rework of HMI and sometimes online technical support to the Site Engineer (i.e. Rework of HMI). Similarly, there is no project tracking method which can help developer and well as Peer to track the project according to the timelines. Cummins Technologies used to do daily morning hurdles which are not effective sometimes due to many reasons like availability, tracking with timelines, clarity about work etc. So, there is need of improvement of quality of HMI.

9. Relevance:

PLC and HMI software development is a critical time in the life cycle of an industrial automation project. It follows design/development and proceeds Testing/commissioning. The PLC and HMI development team ‘deploys’ the applications they have written and tested with the customers into the plant’s systems and hardware.

This proposed work will be useful for PLC and HMI development team to deploy the PLC and HMI development, testing, and project estimation.

10. Literature Review:

1. Effective use of special purpose KJ language processing

(David L. Hallowell, Black belt, Motorola's Six Sigma Research institute)

KJ Analysis is a method of developing insight into themes and relationships among issues. It helps drill from high-level issues at one level of context (usually abstract or vague) to a more detailed set of common, reusable statements. KJ is particularly useful in software because people tend to state problems as abstract characteristics they do not like as opposed to making data-based statements about what they need. KJ is helpful in creating a flow-down of information leading to solid requirements at an appropriate level of context.

KJ can be used effectively in Six Sigma projects. And Six Sigma practitioners can benefit by a proper understanding of the approach.

2. Kansai Affinity Cluster for Affective Product Design

(Anitawati Mohd Lokman; Kamalia Azma Kamaruddin**)**

In recent years, product emotion and affective design has received encouraging attention from the industry as well as academia all over the world. Several methods and tools exist and used to assist the process of evaluating users' emotional experience, and the proceeding associated procedure. Previous studies involving the assessment of emotion have seen different ways used to represent verbal description of the subjective emotion. Most of them set their basis on several keywords that somehow fit to describe the study domain. However, these have led to many cases of poor semantic dimension, since a good reference for affinity of words does not exist. This research aimed to develop a full-range of emotional keywords and their affinity cluster using KJ Method.

3. Automatic Generation: A way of ensuring PLC and HMI standards

(Petter Falkman; Erik Helander; Mikael Andersson)

Preparing an automatic production system takes a lot of time and to be able to decrease this time virtual simulation studies are used more and more frequently.

However, even if more work is performed in a virtual environment a problem is still that the same work is done more than one time in different software tools due to the lack of integration between them.

The present paper presents a case study that investigates how a newly developed tool called SIMATIC Automation Designer can be used to close the gap between the mechanical design and the electrical design. SIMATIC Automation Designer is Siemens software that can generate PLC code and HMI screens. The result shows that by generating PLC code and HMI screens automatically, it is possible to get the same structure and naming standard in every PLC and HMI project. This will ensure a corporate standard and will be a quality assurance of the PLC code and HMI screens.

4. Applying model checking to industrial-sized PLC programs

(Borja Fern´andez Adiego, D´aniel Darvas, Enrique Blanco Vi˜nuela, Jean-Charles Tournier)

Programmable logic controllers (PLCs) are embedded computers widely used in industrial control systems. Ensuring that a PLC software complies with its specification is a challenging task. Formal verification has become a recommended practice to ensure the correctness of safety-critical software but is still underused in industry due to the complexity of building and managing formal models of real applications. Finally, two real cases studies of CERN PLC programs, written mainly in the ST language, are presented to illustrate and validate the proposed approach.

5. Visualization of PLC programs using XML

(M. Bani Younis and G. Frey)

Due to the growing complexity of PLC programs there is an increasing interest in the application of formal methods in this area. Formal methods allow rigid proving of system properties in verification and validation. One way to apply formal methods is to utilize a formal design approach in PLC programming. However, for existing software that must be optimized, changed, or ported to new systems there is the need for an approach that can start from a given PLC

program. Therefore, formalization of PLC programs is a topic of current research. The paper outlines a re-engineering approach based on the formalization of PLC programs. The transformation into a vendor independent format and the visualization of the structure of PLC programs is identified as an important intermediate step in this process. It is shown how XML and corresponding technologies can be used for the formalization and visualization of an existing PLC program.

6. An Argument for Automated PLC Testing (Mark Leitheiser, Southern New Hampshire University)

Manual testing of our PLC software is time consuming. When changes in the PLC software are required the original integrity of the system may be compromised when these changes are implemented. A change to the PLC software should warrant a full manual software retest to ensure the changes do not break existing software behavior. Unfortunately, manual retesting is time consuming and expensive. For these reasons, the software testing suffers. The retest may only be partially completed or skipped entirely. In absence of a full retest, uncertainty exists on the impact of the change and creates risk. The issues of risk, cost, and time all spawn from the fact that testing is performed manually. What if a PLC software retest could be performed automatically? What if it could report that the change was successful as well as report where the software failed from its original design? Other software industries utilize automated software testing to accomplish these goals. This automation comes with several benefits. Since it is automated, it can perform a more rigorous and less error prone retest in less time than manual testing alone. It improves quality by attenuating the impact of introducing new bugs into the system which may be catastrophic. It is for these reasons that other software industries find automated testing worth the investment and is something our software team should explore.

7. Testing Trends in 2017: A Survey of Software Professionals (Dimensional Research (2017). 2018 IEEE AUTOTESTCON, IEEE AUTOTESTCON, 2018)

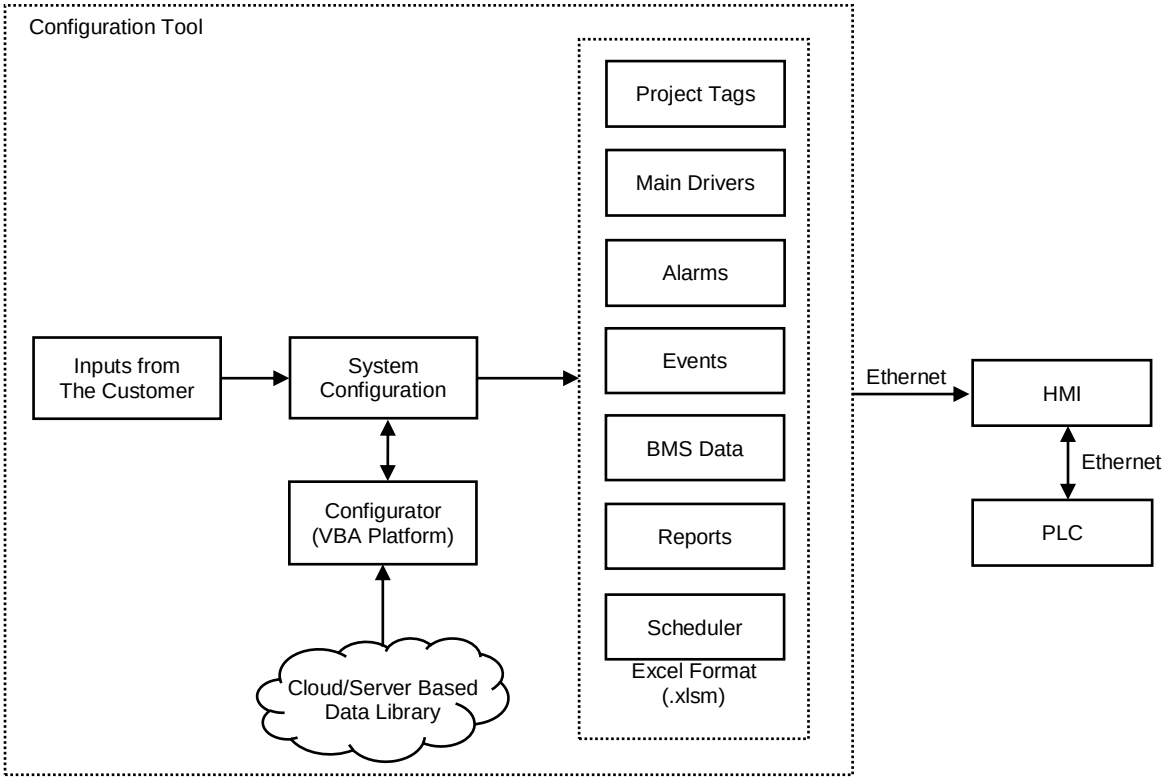
Throughout the history of software development, change has been constant. New technologies, methodologies, and tools constantly evolve to help development teams build better software. However, one thing that has not changed is the pressure on these teams to release high quality software under very tight timelines. Testing remains key to achieving this goal. This research investigates trends in testing with modern development teams. What are teams doing to adopt new development approaches including agile, Continuous Integration, Continuous Delivery and DevOps? What is the role of cloud? What is going well and where is there room to improve? This report, sponsored by Sauce Labs, is based on a survey of 732 technology professionals responsible for the development and quality of web and mobile applications. The goal of this global survey was to understand current trends in software testing. To allow for trend analysis, certain questions were repeated from prior surveys conducted with the same audience each year at this time for the past two years.

11. Proposed Work:

Proposed work to reduce PLC and HMI automation software design effort and improve PLC and HMI automation software design quality. This work proposes to enhance PLC and HMI automation software design quality and process for Cummins Technologies parallel systems.

12. System Block diagram and working of system:

I. Configurator tool:



Working of the System:

This is a VBA-based tool which will help Automation Engineer to generate the Tags, Drivers, Alarms, Events, Third-party communication data like BMS, etc automatically. Currently, this is manual work that needs more time and the possibility of human errors.

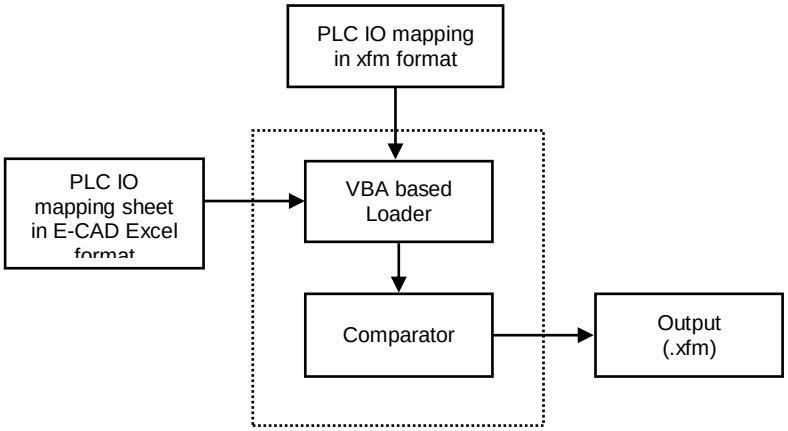
The automation Engineer needs to enter the System configuration into the VBA-based interface. System Configuration will process the data using the Cloud/Server-based library. The tool will take inputs and using Data Library generate the HMI inputs. Using Ethernet communication, we can download the data into HMI for further HMI development.

Normally SW Engineer need 8-10 hours to generate Project Tags, Main Driver sheet, Alarms, MODSL, Scheduler and Trend manually.

Using configurator 1.0, We generated in 5 minutes for the standard items in the project. Non-standard items created Manually

Configurator 1.0 saving time and improving quality in the HMI development.

II. IO Mapping Comparison Tool:



Working of the System:

By using this tool, we can generate two different E-CAD Excel and PLC IO List, which we can compare and generate the IO mapping section automatically for the PLC.

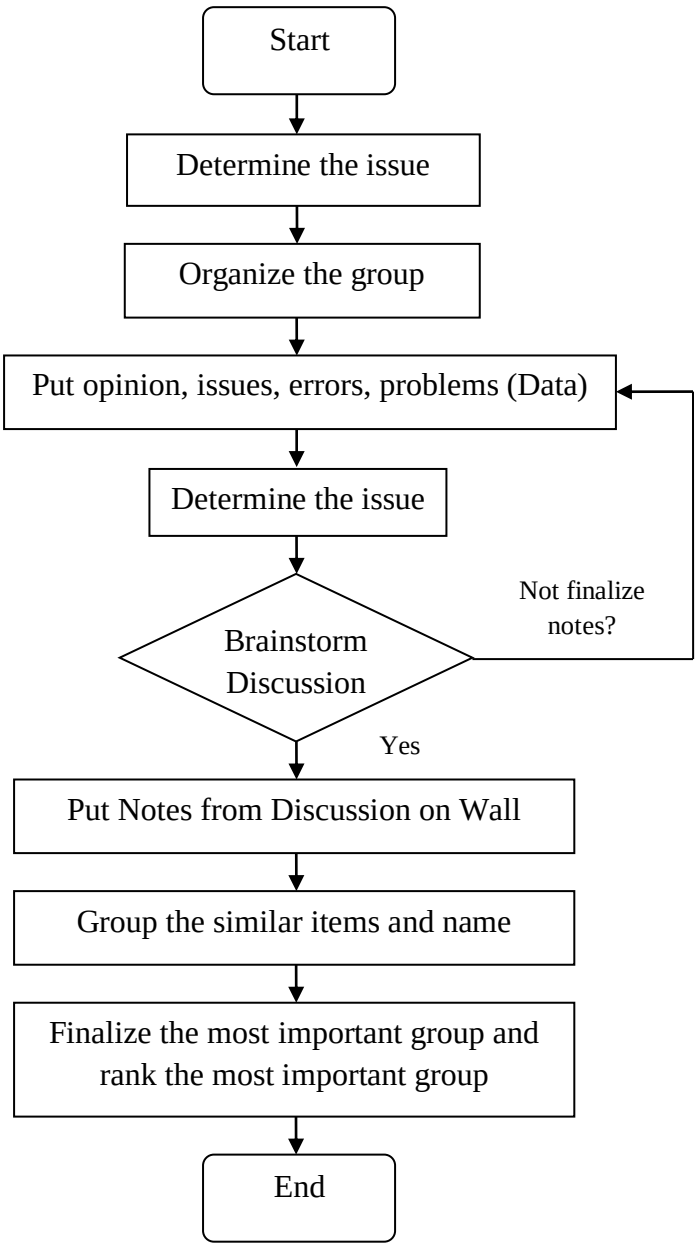
We have E-CAD files. The automation Engineer needs to take this file and compare it with PLC standard template IO mapping and generate the required IO mapping for the system. The tool will take inputs from the PLC IO mapping sheet from E-CAD and IO mapping template from PLC thru the VBA base loader. It will compare as per system requirements and generate an IO mapping section for the PLC.

III. Review Checklist:

Review Checklist used to better organize your entire PLC and HMI Software Development and to verify, easily, your most important tasks. It has been designed to reduce errors and ensure consistency and completeness in carrying out Software development.

13. Scope:

This work proposes, using KJ methodology techniques to find genuinely accountable technical issues to solve problems in the existing system. The operational steps of this technique are shown below:



14. Methodology:

Selecting an appropriate, proven methodology is important step in many research endeavours to evaluate the performance of propose work. We will create simulation model. The design steps in simulation model are as below:

1. **Goal of System:** There are tasks like HMI development, PLC Input-output mapping, comparison with the given inputs, process follow-up as per inputs and standard procedure in which proposed work can do automation which will reduce the time, human errors and increase the quality of the work.
2. **Evaluation Technique:** After research and discussion, 'KJ technique' an idea-generating the prioritizing technique for the genuine problem detection in the system, named after its inventor, Jiro Kawakita. It is commonly used within project management and allows large numbers of ideas stemming from brainstorming to be sorted into groups, based on their natural relationships, for review and analysis.
3. **Simulation Performance:** Using Configurator Tool, we can generate various HMI parameters in very short duration with compare to traditional method.

   Using *Software Estimation Tool,* we can calculate time for PLC and HMI Software development effectively.

   Software Check list tool used to better organize your entire PLC and HMI Software Development and to verify, easily, your most important tasks.

   PLC and HMI Tag comparison and error detection tool will help developer, Commissioning Engineer as well as in troubleshooting in future on error detection on Inputs and Outputs on the field.

14. Facilities Available and Requirements:

- Schneider PLC development tool: Unity Pro XL Version 11.1
- Indusoft HMI development tool: Indusoft Web Studio Version 7.1
- MS VB Version 7.1
- MiniTab Version 19.0
- MS Office Version 18.1903.1152.0

15. Expected Date of Completion: 22nd March 20222

16. Approximate Expenditure: Yearly OPC Server License charges to the Organization.

17. References:

[1] David L. Hallowell, "Effective use of special purpose KJ language processing" Six Sigma Advantage, Inc. has more than 20 years' experience as an engineer, manager and Master Black Belt, As Digital's representative to Motorola's Six Sigma Research Institute.

[2] Anitawati Mohd Lokman; Kamalia Azma Kamaruddin, "Kansai Affinity Cluster for Affective Product Design" 2010 International Conference on User Science and Engineering (i-USEr)

[3] PetterFalkman; Erik Helander; Mikael Andersson, "Automatic Generation: A way of ensuring PLC and HMI standards" International Conference on Emerging Technologies and Factory Automation (ETFA), Toulouse, France, 2011

[4] Borja Fern´andezAdiego, D´anielDarvas, Enrique Blanco Vi˜nuela, Jean-Charles Tournier, "Applying model checking to industrial-sized PLC programs" IEEE Transactions on Industrial Informatics, Dec. 2015

[5] M. Bani Younis and G. Frey, "Visualization of PLC programs using XML" Proceedings of the 2004 American Control Conference, Boston, MA, USA July 2004.

[6] An Argument for Automated PLC Testing (Mark Leitheiser, Southern New Hampshire University)

[7] Testing Trends in 2017: A Survey of Software Professionals (Dimensional Research (2017). 2018 IEEE AUTOTESTCON, IEEE AUTOTESTCON, 2018)

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