AUTOMATED TRANSFORMATION APPROACH FROM USER REQUIREMENT TO BEHAVIOR DESIGN

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ABSTRACT

System design is an important process in the development of any type of computer related system and a process of gathering user requirement of the system that will be developed. System design is important in software development because it assists the developer to develop a system according to what are required by the user. One of main components in system design is Unified Modeling Language (UML) diagram. UML diagram is use as a model to show all important functions, process, flows, actors, classes that related to the system that will be built. This research is focusing on two types of diagram from behavior diagram which are Use case diagram and Activity diagram. Many developers have come out with a tool to help the analyst to draw the diagrams in the computer. Tools like Rational Rose, Lucidchart, UMLet are an example of the tool that have been developed. This step is still not preferred by system analyst because drawing use case diagram and activity diagram takes time and it must be done manually. Model Transformations is one of new finding in system design that intended to ease system analyst in modeling system design. This process is very useful in helping the analyst to reduce time in drawing use case and activity diagram. In this paper, we propose an approach to automatically transform user requirement into behavior model (Use Case diagram, Activity Diagram) and to develop a tool that will enable the transformation of the requirement into behavior model.

Keyword: *Model transformation (MT), UML model, System Design.*

1. INTRODUCTION

In developing a system or software, one of the most important things to do besides coding is design. System design is one the most important things to do before the coding phase is done. System design is the process where the software analyst gathers all requirements about the system that will be built. Requirements are important to software analyst for the development of a system. When all the requirements have been gathered, the software analyst will create models to make it easy to understand the functions and workflows of the system. Normally the analyst will use Unified Modeling Language (UML) since it covers all aspects of the system that will be built. The main parts in system design are using the UML. UML is important to guide the developer for keeping track on flow of the software project that will be built. The commonly used UML diagrams are such as Use Case, Activity Diagram and Class diagrams. Use case and activity diagrams used to model the behavioral aspect of the system, whereas, class diagrams represent the static design of a system [9]. According to Fahad [5], in creating a use case, there is no procedure to define interaction between actors and use case. Another issue stated by him is time issue in creating use cases because preparation to create use case diagram for any requirement requires much time depending on the size of the system. Tao et. al [17] again stated that an automated support for the transition from use cases to activity diagrams would provide significant, practical help.

The knowledge on Computer Science field is increasing days by days. Many researchers have found a new founding in many types of area. It is also including model transformation. Model transformations are a central component in model driven engineering practices [14]. Model transformation is defined as the automatic generation of a target model from a source model, according to a transformation definition that consists of a set of transformation rules that together describe how a model in the source language can be transformed into a model in the target language [12]. Many researchers are interested in model transformation. Many have come with tools, approaches, methods, and techniques. As an example, Fanchao et.al [6], have come out with a method to transform Data Flow Diagram (DFD) to UML Activity Diagrams (UML-AD) and many more. Currently, there are researches on Model Transformation from Requirement to Use Case diagram, Use Case description to Activity diagram and Use Case to Sequence Diagram and many more. However, the existing research are based on only one specific output and not comprehensive as it should be because it only converts the requirement into one specific Unified Modeling Language (UML) diagram at a time.

As what has been mentioned before, our objectives are to propose an approach and develop a tool to automatically transform user requirement into behavior model (Use Case diagram, Activity Diagram). Our project is called RETRANS which stands for Requirement Transformation Approach. This paper will present the development of the tool. We will explain related fields that related to our project in section 2. Section 3 will describes the methodology we used in developing our tool. Section 4 will discuss about our proposed approach and section 5 is about results of our project. The conclusion is summarized in our last section.

2. LITERATURE REVIEW

A. UML

According to Riaz [16], UML can be defined as a blueprint of a software where it is used to detail the artifacts in the system, to document and construct. The Unified Modeling Language (UML) is widely used today for modeling complex system. UML is crucial part in system design. It is important because it is used to show the flow of the system that will be built.

According to Barrera et. Al [2], UML consists of 14 types of diagrams. The diagrams can be divided into 3 categories that are Structure Diagrams, Behavior Diagrams and Interaction Diagrams. Jayeeta et. Al [9] state that use case and activity diagrams model the behavioral aspect of the system that will be built. Tao et.al [17] defined use cases are commonly used to structure and document requirements while UML activity diagrams are often used to visualize and formalize use cases, for example to support automated test case generation.

Brian et al. [3] have conducted a study that examines seven UML components and addresses three key questions. The study was done by doing a survey on 182 respondents. The questions are:

1. To what extent are these UML analysis components being used and for what purposes?
2. Do differences in the levels of component use and the reasons for these differences reflect the apparent complexity of the language?
3. How successful is UML in facilitating communication within software development teams?

However, they are focusing only on the first question because we want to know how much Use case diagram and Activity diagram being used. UML supports the software development entire process, but, owing to the size of the software system is bigger and bigger, complexity enhances unceasingly, manual drawing modeling is more and more troublesome [20]. The complexity is because the functional requirements are subjective and different people can come up with different understanding.

B. MODEL TRANSFORMATION

Kleppe [12] defined Model Transformation as the automatic generation of a target model from a source model, according to a transformation definition that consists of a set of transformation rules that together describe how a model in the source language can be transformed into a model in the target language.

Model transformation can be separate into two types of essential activities that are endogenous transformation and exogenous transformation [4]. Model transformation is the core of model driven development (MDD) [13]. Brian [3] defined Model-driven development (MDD) as an approach to software development in which models become essential artifacts of the development process, rather than merely serving an inessential supporting purpose. Model transformations can be used for various tasks in model-driven development, e.g. for modifying, creating, adapting, merging, weaving or filtering models. Despite its diversity of tasks that Model Transformation (MT) can do, it's often created manually [15].

Developers have tried to overcome complexities with different kinds of methodologies and technologies and one of the latest approach is Model transformation approach or Model Driven Engineering (MDE) specifically [19]. Many tools, technique and approaches have been developed and discovered in Model Transformation area. Varro et. al [18], have developed the VIATRA (Visual Automated Model Transformations) framework. This framework is a transformation-based verification and validation environment to improve the quality of systems designed within the Unified Modeling Language by automatically checking consistency, completeness and dependability requirements. Afreen et. al [1], has presented an approach to automatically transforming Semantics of Business Vocabulary and Business Rules (SBVR) Software requirements to UML. The approach takes Software requirement in SBVR syntax as an input and generate visual representation of class diagram attributes. Transformation rule has been employed to automatically transformed instance of the source metamodel into an instance of the destination metamodel.

There are many more researches that have been done and still on going for Model Transformation. Among all approaches that has been stated here, none of them have a solution to transform user requirement into use case diagram and activity diagram.

C. NATURAL LANGUAGE PROCESSING (NLP)

NLP was originally distinct from text information retrieval (IR), which employs highly scalable statistics-based techniques to index and search large volumes of text efficiently. Jim et. al [10], state that there 2 goals in computational natural language processing: 1) to create computational representation model (e.g., a knowledge base or a database schema) of the world; 2) to exploit those relationship to understand and generate language as appropriate to some set of tasks. Gobinda [7], states that applications of NLP include a number of fields of studies, such as machine translation, natural language text processing and summarization, user interfaces, multilingual and Cross Language Information Retrieval (CLIR), speech recognition, artificial intelligence and expert systems, and so on. There are four standard NLP including Part-Of-Speech tagging (POS), chunking (CHUNK), Named Entity Recognition (NER) and Semantic Role Labelling (Ronan et.al, 2011).

3. METHODOLOGY

In order to achieve this research objectives, there are 3 phases need to be implemented. The phases are: 1) Gathering and analyse information and data involving Model Transformation and Unified Modelling Language; 2) Modelling RETRANS approach to automatically transform the requirement into behaviour model using Unified Approach (UA); 3) Develop and evaluate the RETRANS tool. First phases focused more on understanding the area related with the objectives of this research. This phases are done to understand clearly what are the components and information regarding Model Transformation and UML. Second phase in this research is to create and produce model for the propose approach to automatically transform the requirement into behaviour model using Unified Approach. Unified Approach establishes a unifying and unitary framework around their works by utilizing the Unified Modelling Language (UML) to describe, model, and document the software development process [8]. Last phases is to develop and evaluate RETRANS tool. The process of development and evaluation will be repeated until the tool is showing the correctness or almost identical output as in manual UML drawing process and time taken to complete the process of generate use case diagram and activity diagram.

4. REQUIREMENT TRANSFORMATION INTO BEHAVIOR (USE CASE DIAGRAM AND ACTIVITY DIAGRAM) APPROACH

In this research, we propose new approach to transform user requirement into behavior diagrams (use case diagram and activity diagram) called RETRANS. RETRANS stands for REquirement TRANSformation approach. RETRANS is divided into 3 phases. First Phase is Requirement phase; second phase is Use Case Diagram generation and lastly Activity Diagram generation. The approach is as in figure 1.0 below. The approach is called RETRANS that stands for Requirement Transformation. RETRANS approach plays an important role in tool development of this research. In this research, Java library are used to generate each output. For use case diagram library, the components are actor and use case. Use case class library will be used after the detection of the keywords from the requirement. The keyword will first detect the actor and use cases for the requirement, and the library will generated the diagram by connect the actor and use cases from the keywords. For activity diagram, the process will take part after the use case diagram has been generated. The system will specify each use case that involved in the use case diagram. Then, it will generated the activity diagram by connect each components inside the class library (activity). In achieving this, Natural Language Processing technique will also be applied as the process. Natural Language Processing tool that has been used in this research is Stanford POS Tagger by Stanford Natural Language Processing Group.

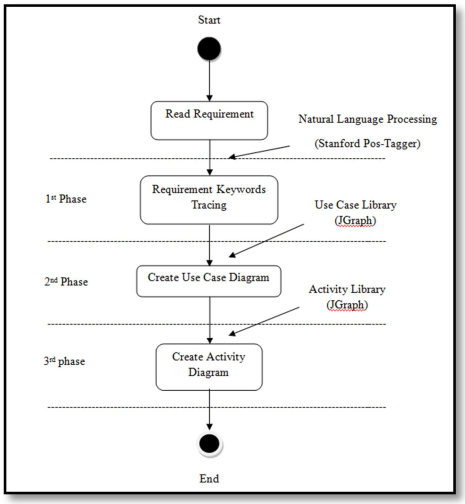

Figure 1.0 - RETRANS Approach For Automatic Transformation From Requirement.

5. RESULTS

RETRANS tool has been developed using JAVA programming language. The tool is tested using two test cases that contains simple user requirement. The results of the tool are use case diagram and activity diagram that automatically generated based on the test cases. This research is using black box testing to check if the process of generating use case diagram and activity diagram from user requirement contains error or not. There are three main functions in RETRANS tool. They are Tagger button, Use Case button and Activity button. There are four main panels which are Input panel, Output panel, Use case Input panel and Activity diagram Input panel. Figure 2.0 (in Appendix) shows the user interface of RETRANS tool. The proposed tool is an enhancement of the initial user interface as discussed in Kamarudin et al. [11]. Figure 3.0 (in Appendix) shows the inputs in each panel. The inputs in Activity diagram panel are same as the inputs in Use case input panel because each use case diagram has different activity diagram and it works as main activity where the user can add other activity later. Figure 4.0 (in Appendix) below shows the result of use case diagram. The inputs from Use case input panel are used to generate the diagram. For Activity button, it directs the user to the interface that contains the result of activity diagram that automatically generated by the tool. The interface is shown in Figure 5.0 (in Appendix) below.

A test case studies were used to evaluate the results. Figure 6.0 shows the test case that has been used. 15 students that already familiar with Unified Modeling Language (UML) are assigned to be the respondent to evaluate the tool. The evaluation is done to ensure the results from the tool are almost similar with the result from manual ways. The steps of evaluation process are as below:

1. A test case that contains simple requirement is given to the respondent.
2. The respondent has been asked to draw use case diagram and activity diagram based on test cases given.
3. The respondent then is asked to use the tool by using the test cases as an input.
4. The result of both ways will be compared.

The test case used is a simple user requirement where it already has an answer format. In the answer format, it contains 5 use cases and similarity test is done by comparing the answers from similarity test with the answer format. Figure 7.0 shows the graph of similarity percentage for similarity test. As shown in the graph, the result for using RETRANS tool is 100% similar to answer format while manual ways is 97.30% similarities. The result shows that the result from both ways is almost identical with answer format. Second test is done for time taken test. Time taken test is done to measure how much time taken by the respondent to complete the test by using the manual ways and using RETRANS tool. Minute unit is used to measure the result. Line chart in Figure 8.0 shows the result. The result shows that average time used when using RETRANS tool is 2 minute and 6 second while using manual ways is 7 minutes and 37 second. By using the RETRANS tool, the analyst can save almost 5 mins and 30 seconds. The results shows that RETRANS tool can help software analyst to save more time from drawing use case and activity diagrams and can focus more on developing the software and system.

6. CONCLUSION

In this paper, we present about our proposed approach in transforming the requirement into UML diagram (use case and activity diagrams). We have also developed and evaluated our RETRANS tool that used to prove our proposed approach. An experiment has been done to compare between using RETRANS tool and by using manual ways to find similarities percentage and time taken for both ways. The result shows that, by using RETRANS tool, the result is almost 100% similar with answering format and average time taken by using RETRANS tool is 2 minute and 6 second, almost 6 minutes faster than using manual ways. The approach will help software developer reducing their time in design process. This tool can be used to generate use case diagram and activity diagram by students who just learn about use case diagram and activity diagram, as a comparison with diagrams done by them. This tool also can help software analyst to save more time from drawing use case and activity diagrams and can focus more on developing the software and system.

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APPENDIX

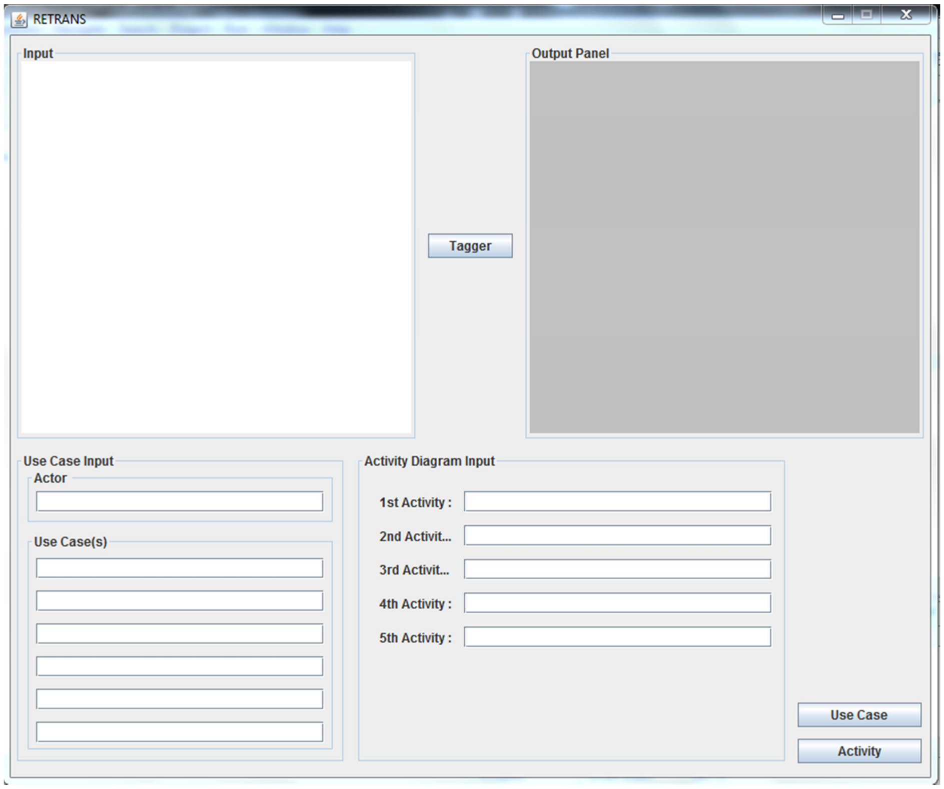
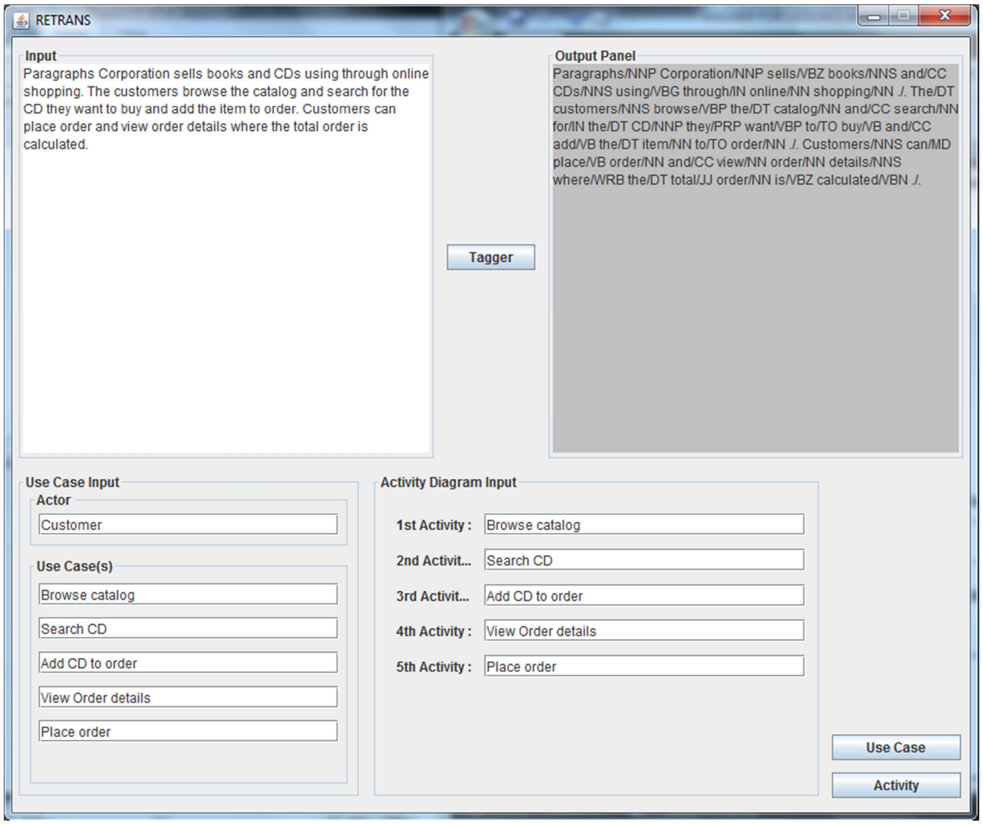


Figure 2.0 - User Interface For RETRANS Tool



Input: Paragraphs Corporation sells books and CDs using through online shopping. The customers browse the catalog and search for the CD they want to buy and add the item to order. Customers can place order and view order details where the total order is calculated.

Output Panel: Paragraphs/NNP Corporation/NNP sells/VBZ books/NNS and/CC CDs/NNS using/VBG through/IN online/NN shopping/NN ./. The/DT customers/NNS browse/VBP the/DT catalog/NN and/CC search/NN for/IN the/DT CD/NNP they/PRP want/VBP to/TO buy/VB and/CC add/VB the/DT item/NN to/TO order/NN ./. Customers/NNS can/MD place/VB order/NN and/CC view/NN order/NN details/NNS where/WRB the/DT total/JJ order/NN is/VBZ calculated/VBN ./.

Actor: Customer

Use Case(s):
Browse catalog
Search CD
Add CD to order
View Order details
Place order

1st Activity : Browse catalog
2nd Activit... Search CD
3rd Activit... Add CD to order
4th Activity : View Order details
5th Activity : Place order

Figure 3.0 - Inputs In 4 Different Panels

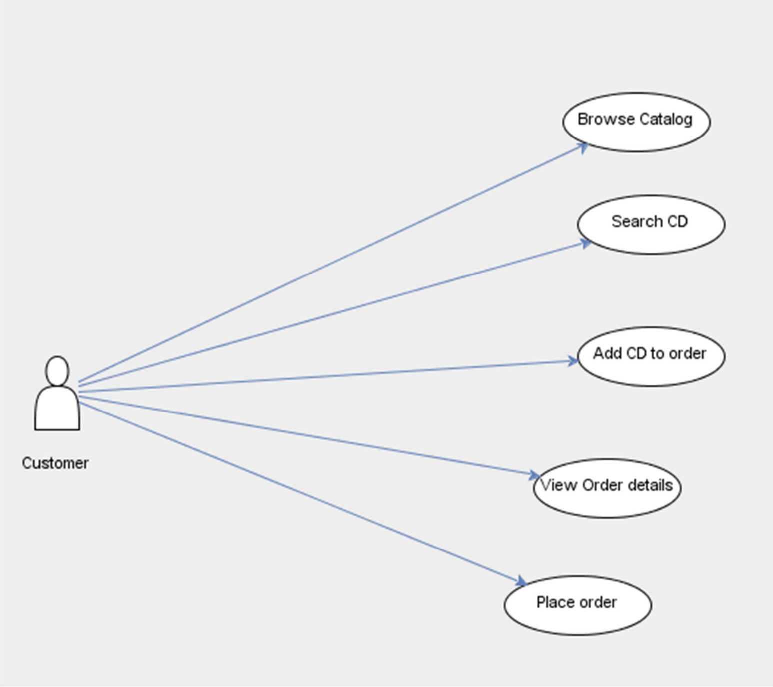


Figure 4.0 - Result Of Use Case Diagram Generated From RETRANS Tool

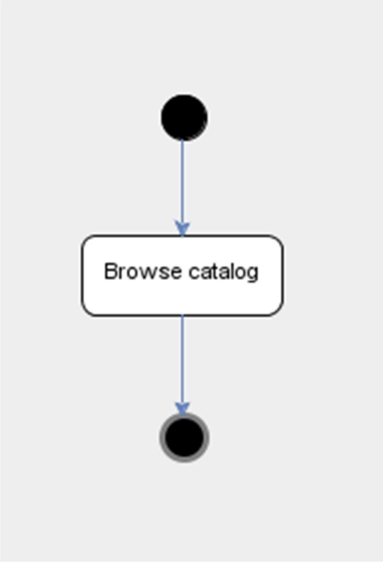
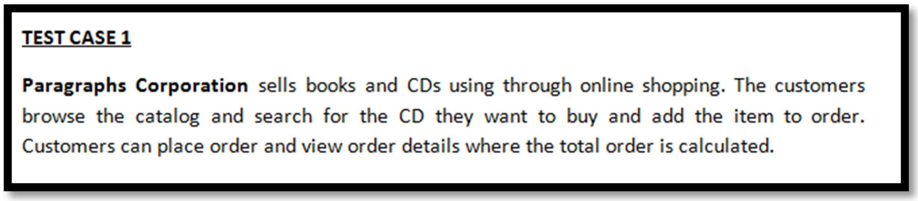


Figure 5.0- Result Of Activity Diagram Generated From RETRANS Tool



TEST CASE 1

Paragraphs Corporation sells books and CDs using through online shopping. The customers browse the catalog and search for the CD they want to buy and add the item to order. Customers can place order and view order details where the total order is calculated.

Figure 6.0 Test Cases

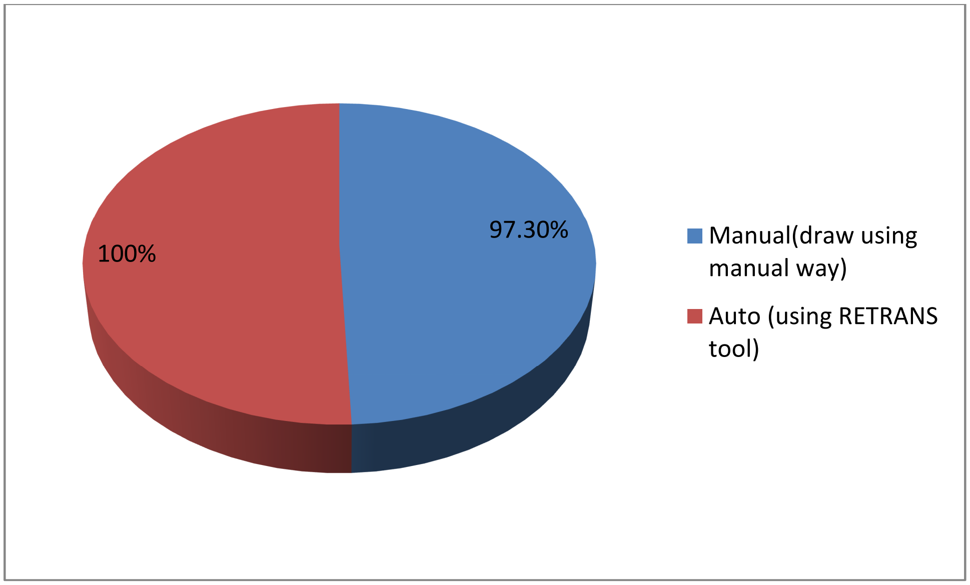


Figure 7.0 Similarity Percentages For Similarity Test

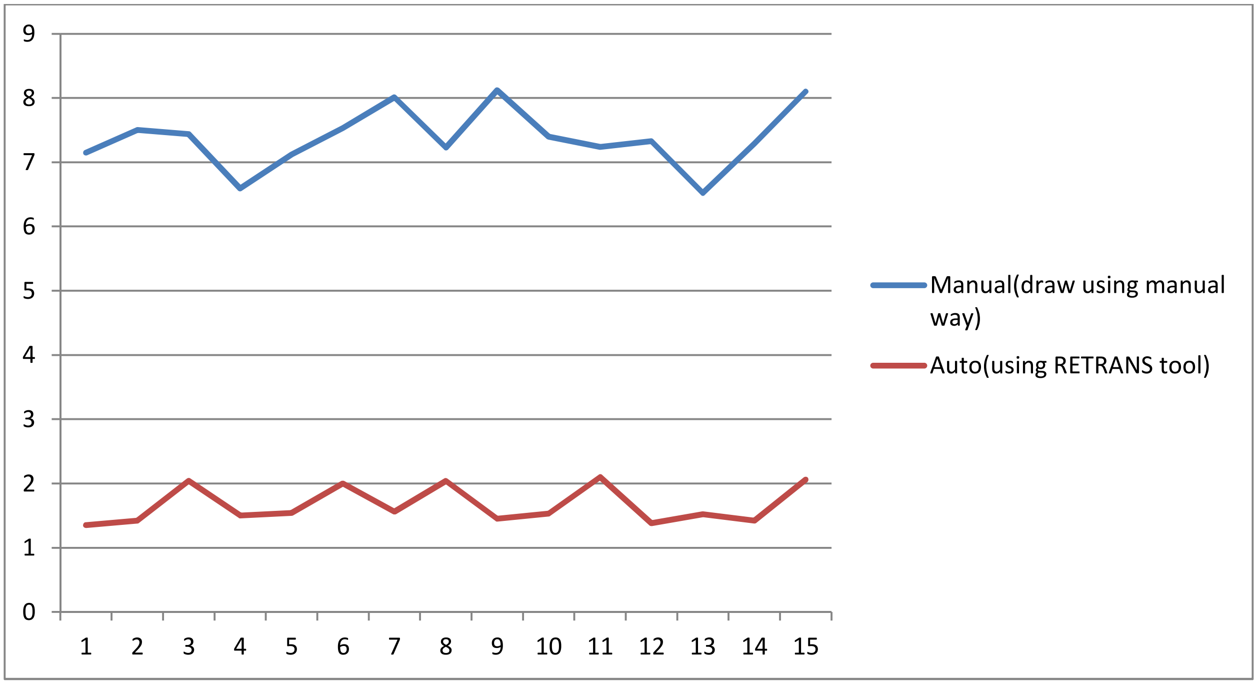


Figure 8.0 Time Taken For Both Ways In Line Chart