SURVEY ON FINITE AUTOMATA CONSTRUCTION

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Abstract - **In theoretical foundations of computer science many problem are solved and efficient algorithm is designed for finite automata and are used in many fields for solving complex problem. Various forms of finite automata comes likes deterministic finite automata, non-deterministic finite automata, push down automata and so on. The study of automata and its accepted languages illustrated and conversion of non-deterministic finite automata to deterministic finite automata with algorithmic approaches are found. Thus using various finite automata algorithm, size and time complexity is reduced using various techniques. Programming languages are used for constructing various forms of finite automata and to accept binary input string. This paper intended to study different approaches of finite automata construction.**

Keyword - **Finite automata, deterministic finite automata (DFA), Non deterministic finite automata (NFA).**

I INTRODUCTION

Computation is a process of taking some input and performing required operation to produce output based on algorithm. Finite automata requires input as a string from input tape thus the input tape is divide into cells and each cells will have one input symbol. The read head reads one symbol at a time and moves the pointer to next symbol. Finite automata contain set of states and move transition depends on input symbol. In finite automata, non-deterministic finite automata is a finite set of state with one start state and set of accepting state. It allows 0, 1 or more transition from a state for same input symbol. Deterministic finite automata consist of finite set of states and finite set of input tape. It allows transition from state with different input symbol not with same input symbol.

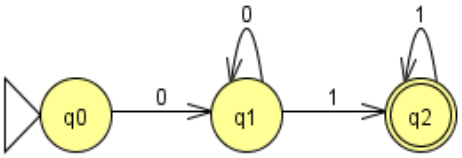

Fig 1.1 Deterministic finite automata

In this automaton Fig 1.1, there are three states: q0, q1, and q2 the automaton takes a finite sequence of 0s and 1s as input where q0 is start state, q1 is intermediate state and q2 is final state. Each transition moves for input string either 0 or 1, In Fig 1.1 DFA moves from q0 to q1 and q1 to q1 (self-loop) for 0 as input symbol and transition moves from q1 to q2 and q2 to q2 (self-loop) for 1 as input symbol.

II A BROAD VIEW ON FINITE AUTOMATA CONSTRUCTION

Finite automaton is used in various fields in solving complex problem using algorithms and different techniques. In the following section review of different finite automata approaches are given.

A. ALGORITHMIC AND PROBLEMATIC APPROACH BASED ON NFA AND DFA

Himanshu Pandey et al, [8] In order to reduce the problem of minimal non deterministic finite automata

creation the size of non-deterministic finite automata are reduced using LR rotation rule. In proposed work new LR rotation rule is constructed to minimize state of non-deterministic finite automata. The complexity of kameda wiener algorithm is reduced by emerging the states using LR rotation algorithm. Size of non-deterministic automata is reduced proposed algorithm is most time consuming which replaces the LR rotation rule. Vishal Garg , Anu [17] addresses the deterministic finite automata minimization as important problem based on equivalence deterministic finite automata. Performance verification of this algorithm uses the artificial set of data. The algorithm which generated based on hash table which gives the better performance than using the deterministic finite automata using the array. Hash table used here will be useful for only searching but not useful for pattern matching or path finding. Counting problem is solved which with set of string not as words.N.Murugesan, O.V.Shanmuga Sundaram [11] they proposed various problem based on binary strings multiple of three are taken into consideration. Systematic procedure is given to convert the non-deterministic finite automata thus the construction of deterministic finite automata can be made easily by following the step of procedure. They take set of binary number and its decimal equivalence for the construction using the mod 3 and set of string the deterministic finite automata state is generated. It take the multiples of 3 and decimal number. It does not guarantee the construction step for other than 3 input binary strings. Jelani Zhang1 et al. [10] has constructed five equivalent conversion algorithms of finite automata to left linear grammar. First, construction algorithm deal with finite automata to left linear and right linear grammar. Second algorithm used in construction of non-deterministic finite automata from left linear grammar. Third algorithm deal with construction of finite automata and right linear grammar, Fourth algorithm based on for any a belongs to epsilon and a, b belongs to s the finite automata and left linear grammar is constructed. Fifth algorithm uses 4^{th} algorithm to convert finite automata to left linear grammar. Correctness proof for equivalent conversion finite automata is given. Where, its proof is complicated for the simplified conversion algorithm. K.Senthil Kumar, D.Malathi [16] proposed the second degree of polynomial algorithm for converting the regular grammar to deterministic finite automata instead of converting the regular grammar to non-deterministic finite automata and then to deterministic finite automata can be constructed and they use this technique for goto and closure in order to find the states, Conversion of regular grammar of size n uses linear polynomial time this construction which involves only two terminal which can be extended up to k alphabet. Ambuj Tewari, et al [2] proposed that the parallel algorithm is used to minimize the state minimization algorithm. It uses n number of states, k number of input to minimize the deterministic finite automata. The time complexity of this algorithm is O(knlogn) with CRCW PRAM (n/log n) processors. New parallel algorithm used in deterministic minimization overcomes the sequential algorithm by using the hash. This algorithm used here does not guarantee as reasonable cost. Himanshu Pandey V. K Singh Amit [9] combines the kameda weiner algorithm and local search heuristics i.e. stochastic hill climbing and simulated annealing in order to reduce the state minimization of non-deterministic finite automata. Time consuming part of the algorithm is replaced by the fast heuristic procedure but it is not exact method obtained to minimize the time. In state minimization of non-deterministic finite automata the solution obtained is not unique it used PSPACE complete and worst case complexity is same as deterministic finite automata problem. Chao Yin [5] constructs the BM algorithm based on deterministic finite automata theory. The algorithm checks the matching of pattern string with text string. The experimental result shows the effectiveness of pattern matching through the BM algorithm. Boyer and Moore proposed BM algorithm which compare the text suffix and prefix for pattern matching, here improved BM algorithm matches the character higher than BM algorithm. But both algorithm is not compare in same network speed and does not run in absolute time. Nazir Ahmad et al [13] focus on the functional and behavioural model of the system. The deterministic finite automata and non-deterministic finite automata have different complexity and time. Z notation is used to find the behaviour of system. Conversion is based on z notation use Z/EVES toolset for validation. Both non-

deterministic finite automata and deterministic finite automata notation is used for functional and behavioural integration. The proposed work has taken some assumption for integration and uses the conceptual integrations. P. Ezhilarasu et al [6] proposed method of finding the palindrome which is accepted by the finite automata is proposed in this work. $3^0 +31+3^{2}+\ldots. 3^n$ is a formula used where 3 is the input, n is maximum length. Here to find the palindrome of string using finite automata construction and systematic procedure is given to find the palindrome. Turning machine is used in order to overcome the disadvantage of abstract which can read input from left to right not from right to left. This paper construct only string length up to 5.It accept only the 27 palindrome out of 273.

B. FINITE AUTOMATA CONSTRUCTION BASED ON PROGRAMMING

Abdulmajid Mukhtar Afat et al [1] in finite automata theory convert the non-deterministic finite automata to deterministic finite automata using the subset construction algorithm. They use the c++ programming language which reads 5 tuples from text file. Non deterministic finite automata transition table is constructed and then converted to deterministic finite automata if new quintuples is given with alphabet of 0, 1 the transition table is generated .The string w whether present in regular language or not is decided by accepted or rejected and tracks the path. Non deterministic construction is needed in order to track the path of deterministic finite automata. Amit Kishore Shukla et al [3] proposed algorithm in order to remove the state of deterministic finite automata and became optimized deterministic finite automata by removing the unreachable state or dead state. JFLAP simulation is used to optimise the state. The set of state which accepts or reject is found using multiple run in JFLAP and then eliminate the unreachable state. Thus useful state will be removed from the useless state. This approach is based on the string that accepts and reject not based on the construction of deterministic finite automata only one outgoing symbol has taken into consideration. Neha, Abhishek Sharma [12] uses the graph grammar rule in order to convert the regular expression to minimal deterministic finite automata. The algorithm proposed removes the lengthy chain dependency in converting the regular expression to non-deterministic finite automata with and without epsilon transition then to deterministic finite automata final to minimal deterministic finite automata. If the regular expression is of size n the time of minimal deterministic finite automata is O(n log2n) if n greater than or equal to 75 then complexity is further reduced to O(n logen).Conversion of regular expression to deterministic finite automata is implemented using java thus time consuming part is coding the parser of regular expression because it described in context free grammar not as regular.

C. FINITE AUTOMATA APPLICATION IN VARIOUS FIELDS

Yanni Li, [20] Multiple longest common subsequence search used in many application in bioinformatics, data mining and so on thus to reduce the complexity of biologic data. Multiple longest common subsequence algorithms are constructed. Existing algorithm uses map reduces whereas proposed work uses the novel finite automata based cloud computing. Proposed algorithm has better performance than FAST-LCS only for large alphabet. The algorithm proposed for better performance and cost effectiveness thus it is used in simulating the DNA and amino acid sequences. Result is better than FAST-LCS. A common sequence uses the construction of finite automata. Proposed algorithm has better performance than FAST-LCS only for large alphabet not for small. Rajib Saha [14] deals with human face recognition using the finite automata when face recognition matches the database image this is done using the image Euclidean distance and freechet distance and tested in the database. Variance of image in gray scale is determined face recognition matching is done. Using the finite state automata two algorithm for recognition with noise and without noise is generated. It uses the general pattern identification technique. This approach gives better result of noisy image but not for noiseless image than existing method. Qura-Tul-Ein et al [18] DNA deals with genetic science which holds information about genes of the living organism. Changes in gene information lead to many problem. DNA

pattern based solution can be obtained from the finite automata thus pattern will be converted to non-deterministic finite automata to deterministic finite automata any changes in genetic can be found using the finite automata. This method used to convert the non-deterministic finite automata to deterministic finite automata to accept all the state rather making the non-deterministic finite automata accepting the set of states. Thus, decreased time complexity and DNA pattern leads to convert the non-deterministic finite automata to deterministic finite automata efficiently. Adam Roman [4] the test case is generated to find several faults, missing and incorrect transition. It uses the model based testing approach. Different software under test uses different modelling language based on software testing to generate the test case. To optimize the test suite based on its size uses automata synchronization. An algorithm is designed for generating test case using the model based testing with input as finite automata and procedure output in detecting all possible incorrect transition, missing transition, faults synchronization approach minimize the number of test cases. More number of faults at the same time cannot be handled easily.

D. APPROACHES BASED ON PERFORMANCE

Hsiang-jen Tsai et al [7] Simultaneously pattern matching used to find the wildcard pattern in two search engine whereas previous methodology only single active states is possible to track and its unable to handle pattern in search engine. So wildcard pattern used in two search engine rise the performance and diminishes the energy intake to 39%. Here the proposed architecture used SRAM ternary content addressable memory (TCAM) for tracking two active state. TCAM based search engine used here cannot recognize the wildcard pattern however the proposed system just support it. Yanbing Liu et al [19] Deterministic finite automata which recognize the regular expression to find the network traffic byte by byte. Generally constructing the deterministic finite automata using the regular expression signature is time consuming thus to overcome deterministic finite automata is merged with hierarchical merging with single regular expression O (|Q||Σ| ln n) time is constructed which is higher than existing time of O(|Q||Σ|($\sum^{n}{}_{i=1}$ |Qi |) 2) of subset construction algorithm. The performance of proposed work is 45 times faster than subset construction algorithm. K reduction method used instead of subset construction algorithm with minimum time and cost. In k reduction with k=3 and k=n^2 fairly improve the performance than other reduction method used. . B. Ravikumara, G. Eismanb [15] they address minimization of deterministic finite automata constructed based on the notation. The two deterministic finite automata which accept same set of string is called as weak equivalences for which the deterministic finite automata notation are constructed. The counting problems are solved using the algorithm of computational linear algebra. The time complexity is order of K^3 for weakly constructed deterministic finite automata and for tilting problem the algorithm which was proposed minimizes the factor to ½ for strong minimal deterministic automata. This paper leads to certain practical and theoretical problem of finding the automata class to find deterministic finite automata and to construct software design framework and counting function will be same for non-regular and regular grammar.

III. ANALYSIS OF VARIOUS FINITE AUTOMATA METHODOLOGIES

The table 1 shown below shows the various algorithm used and different approaches of deterministic finite automata non deterministic finite automata and techniques used in solving size, performance and time complexity are analysed.

TABLE I. COMPARISON OF VARIOUS FINITE AUTOMATA TECHNIQUES AND ALGORITHM

Author's name	Algorithm used	Proposed system	Existing system
Hemant Pandey et al [8]	LR rotation rule	Complexity of kameda weiner algorithm is reduced	Used complex kameda weiner algorithm
Jelani Zhang [10]	Simplified 5 Equivalent Conversion Algorithm	Finite automata to left and right linear grammar	Complicated Equivalent Conversion Algorithm

Yanbing Liu et al[19]	Parallel algorithm	DFA is merged with hierarchical merging with single regular expression O (|Q||Σ| ln n) time	Existing time of O(|Q||Σ|($\sum^{n}_{i=1}$ |Qi |) 2) of subset construction algorithm
Hsiang-jen Tsai et al [7]	Uses SRAM (static random access memory) TCAM (ternary content addressable memory)	Reduced energy consumption to 39%	TCAM cannot recognize wildcard pattern
K.Senthil Kumar, et al [16]	Second degree of polynomial algorithm	Converting Regular grammar to DFA	Used linear polynomial algorithm for size n regular grammar
Neha, Abhishek Sharma [12]	1)Thompson's algorithm 2) McNaughton and Yamada Algorithm	n>=75 time complexity reduced to O(nlogen)	Minimal DFA of size n have time O(nlog2n)
Ravikumar et al[15]	Weak minimization algorithm	Proposed algorithm minimize the factor to ½ for strong minimal DFA	Time complexity is order of k^3 for weekly constructed

IV CONCLUSION

Finite automata which used in finding the state and transition among states in solving complex problem used in different field using various In this paper various finite automata are studied and their performances, algorithms and techniques is evaluated .From this survey we can able to know about several techniques and algorithms in existing system.

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