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On behaviour of automata in labyrinths*

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Abstract — This article reviews over 80 works on the behaviour of automata systems in labyrinths which have appeared in the last two decades. Main concepts, problems, results, methods for solving problems and problems to be solved are selected. In a number of cases the main statements are given in a stronger form compared to their original formulations. This article also contains some new results on the problem of searching labyrinths by automata.

1. INTRODUCTION

In recent years, the growing attention of researchers is attracted by the problems connected with automata analysis of images, graphs, formal languages and other discrete systems. In all, over a hundred papers on these subjects have already been published.

One of the first papers of this trend is the work by Shannon [55], where he actually touches upon the problem of searching a certain target in a labyrinth by a mouse-automaton. This work determined the range of problems of the trend in question for the years to follow. The study of computer systems with external memory in the form of a plane or Fischer's space [23], although they were rather quickly replaced by multitape computers, can also be considered as another source of the trend.

Shannon's ideas were not developed for quite a long time. This may be accounted for by some peculiarities of the basic model of research considered by automata theory at the time. First, the attention of the specialists on automata theory was concentrated upon the study of automata possibilities to process the words which have no interpretation. It was the typical approach while studying all the main types of automata behaviour, first of all, such as automata-transformers, automata-acceptors etc. (Various problems concerning those types of behaviour still remain the main problems in automata theory.) Second, with respect to the set of input words, i.e. 'the medium' affecting them, the automata in question were considered only as 'acceptors' in no way affecting the medium. The model 'automaton in the labyrinth' lacks those peculiarities that considerably restricts transferring the results of other types of automata behaviour to this model.

Active study of the behaviour of automata in labyrinths and graphs began after the papers by Dopp [19, 20] had appeared. In those papers Shannon's model was formalized. A connected configuration of squares on the plane similar to a chessboard or analogous cubes in space were considered as labyrinths (chess labyrinths), and finite automata which survey some neighbourhood of the occupied square and move to one of the neighbouring squares in the coordinate directions were considered as automata. In the paper some results for the problem of searching such labyrinths by automata were obtained, and an important question of the existence of an automaton searching all such labyrinths was also raised; some arguments in favour of the possibility of constructing a trap-labyrinth for an automaton in case of spatial labyrinth were given. For a given

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