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# Validation of Alternate Paths for Motion of Multiple Robots

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***Abstract:*** **Every experiment need to be validated. Without validation, to accept the hypothesis is difficult. In my work, in which 10 robots are taken and its path is destined from original to target position. While the robots starts moving from initial to final position on a particular path, It comes across various obstacles, by which it as to deviate its path in order to avoid collision. Therefore for every such obstacle, alternate paths are generated and the simulated values are compared with experimental (Decision Tree) values and thus the Chi Square test gives the validation.**

***Index Terms:*** **Validation, Chi Square Test, Obstacle, Collision.**

## I. INTRODUCTION

Any Model requires validation and its truthfulness. Therefore, the validation can be through the comparison of the present research work results with that of the experimental results or published results in the literature and or by mathematical techniques resembling similar situations. As such, a mathematical model based on the Decision Tree Analysis is carried-out considering the Robot motion distances between each obstacle.

## II. CHI SQUARE TEST

The Chi-square test is often used to test whether sets of frequencies or proportions follow certain patterns. The two most common instances are tests of goodness of fit using multinomial tables and tests of independence in contingency tables. The Chi-square goodness of fit test is used to test whether the distribution of a set of data follows a particular pattern. For example, the goodness-of-fit Chi-square may be used to test whether a set of values follow the normal distribution or whether the proportions of Democrats, Republicans, and other parties are equal to a certain set of values, say 0.4, 0.4, and 0.2. The Chi-square test for independence in a contingency table is the most common Chi-square test. Here individuals (people, animals, or things) are classified by two (nominal or ordinal) classification variables into a two-way, contingency table. This table contains the counts of the number of individuals in each combination of the row categories and column categories. The Chi-square test determines if there is dependence (association) between the two classification variables. Hence, many surveys are analyzed with Chi-square tests. In this paper an attempt is made to validate the results with this test between the observed and expected values. How far the observed values fit with the expected values gives the confidence levels.

## III. DATA ACQUISITION

The data is acquired from an experimental setup, where the time, the initial position and final positions are evaluated. When a robot is moving from original position to target position, it might come across many obstacles. So for every located obstacle in the robot's path, always there are two alternative paths available. Since the set up is involving 10 robots, every robot's path is dynamically changing as and when it is about to collide with an obstacle. Similarly to obstacle, for any robot, the other robot also acts as a hurdle, but this hurdle is liable to move. So in the present layout, there are robots, located(fixed obstacles) and other robots(moving obstacles). At one instant, if the path is analysed, it might come across two obstacles and one

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moving robot in its path from origin to destination. So every such obstacle leads to two alternative paths, whose distance and time can be measured. The deviated(alternate path) again may come across another obstacle(fixed or moving), leading to further two more alternate paths. So all such paths are calculated and the least distance is preferred and accordingly the time is taken. Thus the database is created in which the simulated values are observed values and decision tree values are expected values.

## IV. GRAPHIC REPRESENTATION

A decision tree is a graphic representation of the decision processing indicating decision alternatives, states or nature, probabilities attached to the status of nature and conditional advantages and disadvantages. It consists of network nodes and branches, two types of nodes are used, Decision node represented by a circle, Decision node represented by a square and state of the nature. Alternative causes of action originate from the decision node as main branches, as shown in Figure -1. At the end of each decision branch, there is a state of nature node from which emanates chance events (either one or two) in the sub-branches. The respective probabilities associated with alternate causes and the events are shown along these branches. At the terminal of the chance, branches are shown the expected values of the outcome. As an example, 3 robots are considered with its alternate paths as shown in Figure 2.

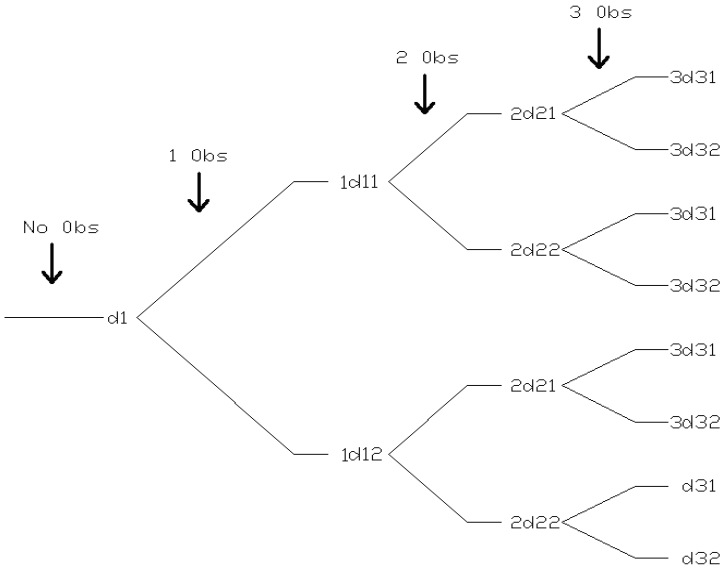


**Figure 1: Decision Tree Analysis for APs.**

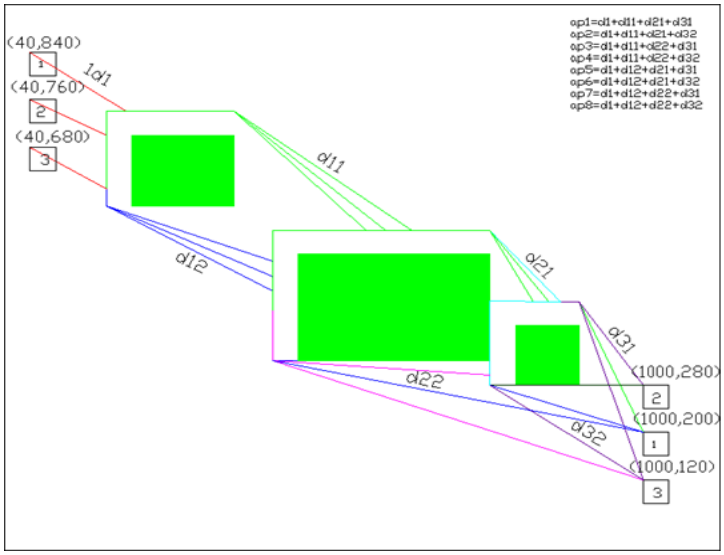


**Figure 2: Alternate paths of 3 robots with 3 obstacles.**

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## V. RELEVANCE TO THE PRESENT WORK

The decision tree has two alternatives from its origin to opt for 1 or 2. In the present work the Z - Function indicates from the 3 x 2 array whether to go in Alternative - 1 or Alternative -2 at an obstacle. The three obstacles in the present work are taken as three nodes with possible two paths. The short path among the two alternatives is considered. The Decision Tree relating to the present work based on the Decision Tree for Analysis is shown in Figure -1. Based on the results obtained for all the robots with three obstacles, the statistical analysis is carried-out considering the maximum efficiencies obtained from the research work and maximum efficiencies obtained from Decision Tree analysis. The Chi-square $(\chi^2)$ - Test is carried-out [1],[2],[3]. as shown in the Table.

| Robot No. | Maximum efficiency obtained with one obstacle | | | | |
|---|---|---|---|---|---|
| | Simulated Value (O) | Decision tree values (E) | (O-E) | (O-E)2 | (c2) = $\frac{(O-E)^2}{E}$ |
| | | | | | |
| 1 | 97.21 | 99.81 | -2.6 | 6.76 | 0.068 |
| 2 | 93.45 | 99.17 | -5.72 | 32.71 | 0.329 |
| 3 | 98.58 | 99.73 | -1.15 | 1.32 | 0.013 |
| 4 | 88.86 | 99.7 | -10.64 | 113.2 | 1.135 |
| 5 | 98.58 | 98.27 | 0.31 | 0.09 | 0.0001 |
| 6 | 91.55 | 96.3 | -4.75 | 22.56 | 0.234 |
| 7 | 87.02 | 92.07 | -5.05 | 25.5 | 0.293 |
| 8 | 94.58 | 88.97 | 5.61 | 31.47 | 0.353 |
| 9 | 95.72 | 90.26 | 5.36 | 28.73 | 0.318 |
| 10 | 93.25 | 88.17 | 5.08 | 25.08 | 0.292 |
| | | | | (c2) =Total = 3.0351 | |

**$\chi^2$ Test for Validation**

The Table value at 95% confidence level is 3.325. Therefore, the table value is greater than the calculated value of $(\chi^2)$. Hence, the null Hypothesis is accepted, ie., there is no change in the two results. Hence, the validation.

## VI. RESULTS AND CONCLUSION

The Chi Square test was conducted for 10 robots for its alternate paths. The Average Chi Square Value is 3.0351, which is less than the table value of 95% confidence levels of 3.325 which is a null hypothesis accepted value. In this date and experiment, the original and alternate paths taken were straight lines. It may be concluded that further improvement in value will be enhanced if the distances can be reduced by taking the curved path wherever required.

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