

PICOMOUSE COMPETITION

INTRODUCTION

Picomouse is an autonomous mobile vehicle, which is able to navigate its way through an unknown maze from the start to the destination. It is also required to search for the best path between the start and the destination for the picomouse to run along this path in the shortest time.

The main challenge for picomouse designers is to build a fast moving wheel-driven robot. They need to work out the maze solving intelligence for the robot that is able to handle different maze configurations and compute the optimum path for the shortest fast-run time, and to control the robot to run at very fast speed without hitting the wall.

1. MAZE SPECIFICATIONS

1.1 The maze is be configured by placing walls along the grid-points formed by multiples of 9cm square. The squares are arranged in a 16 x 16 row-column matrix. The walls constituting the maze are in 2.5cm high and 0.6cm thick. Passageways between the walls are in 8.4cm wide. The boundary of maze is enclosed with walls.

1.2 White plastics make the maze walls. The maze platform is made by plywood and finished with black color matted paint. The maze walls shall reflect infra red light. The maze floor shall absorb it.

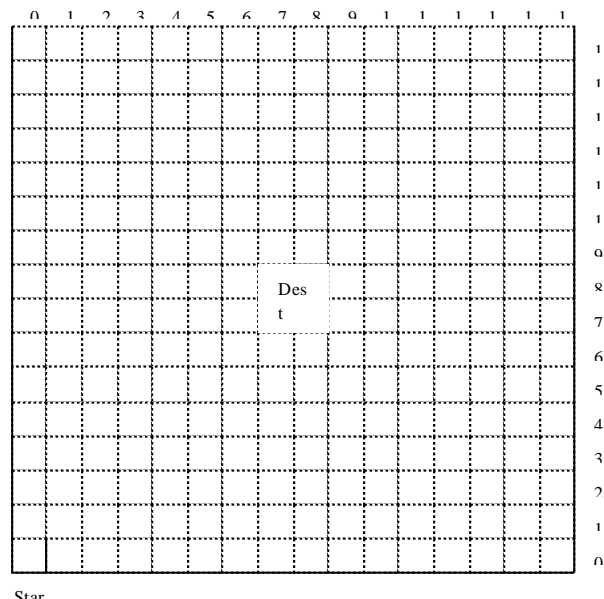


Figure 1: Start and Destination Points and Grid Lines for Maze

1.3 The starting position of the maze shall locate at one of the maze corner. There shall be three walls surrounding it. Its opening shall be towards destination that is the center of the maze, locating at the right of the starting square.

1.4 There are poles, in dimensions 0.6cm (length) x 0.6cm (width) x 2.5cm (height), locating at four Corners of each maze square. They are called lattice points. The maze shall be constituted such that there is at least one wall attached to each lattice point, except the lattice point that is locating at the center of the destination.

1.5 The accuracy of maze dimensions shall be within +/- 5% or 1cm; whichever is less. The assembly joints on the maze floor shall not involve steps of greater than +/- 0.25mm. The gaps between the walls of adjacent squares shall not greater than 0.5 mm.

2. PICOMOUSE SPECIFICATIONS

2.1 The length and width of any picomouse shall be within 12.5cm x 12.5cm. There is no limit on the height of the picomouse. The picomouse shall not change its dimensions while it is navigating along the maze.

2.2 The picomouse shall be fully autonomous and shall not receive any outside help throughout the contest.

- 2.3 The method of wall sensing is at the discretion of the designer, however; the picomouse shall not exert a force on any wall that is likely to cause damage. The method of propulsion is also at the discretion of the designer, provided that the energy source is non-polluted.
- 2.4 The picomouse shall not leave any parts on the passageway while navigating along the maze.
- 2.5 The picomouse shall not jump over, climb over, or damage the walls of the maze.

3. RULES FOR THE CONTEST

The crucial task of the picomouse is to navigate from the starting square to the destination square. This is called a run and the time taken is called the run time. Traveling from the destination back to the start is not considered as a run. The total time taken from the first time left the start square until the start of each run is also measured. This is called the search time. If the picomouse requires a manual assistance at any time during the contest, it is considered as a touch. A one-time penalty shall be added on those scores that are obtained after the touch. The run time, the search time and the touch penalty are to be used for the calculation of each score that the picomouse reaches the destination from the start successfully.

The picomouse competition is divided into three categories. They are the secondary schools (SSs) category, the junior colleges/institutes of technical education (JC/ITEs) category and the open (Open) category.

3.1 The Secondary Schools (SSs) Category

- 3.1.1 The SSs Category is opened for all full time students from secondary schools. Each school shall be limit to **Four** entries. Each entry shall not be more than **Six** students and must have its own picomouse. No picomouse shall be shared by any entries neither in this category nor the Open category.
- 3.1.2 Each entry shall be given time limit of 5 minutes or 6 crashes to contest on the maze. The picomouse may make as many runs as possible within time limit provided the picomouse does not crash more than 5 times.
- 3.1.3 The score of a picomouse shall be obtained by computing a handicapped time for each run as follows:

$$\text{Score of Current Run (reached the destination successfully)} = \text{Run Time} + \text{Search Penalty} + \text{Touch Penalty}$$

$$\text{Search Penalty} = 1/60^{\text{th}} \text{ of the Search Time, in seconds}$$

$$\text{Touch Penalty} = 2 \text{ seconds}$$

For example, if a picomouse, after being on the maze for 4 minutes without being touched, starts a run that takes 20 seconds to reach the destination; the run will have a handicapped time score of $20 + 1/60^{\text{th}}$ of $(4 \times 60 \text{ seconds}) = 24$ seconds. However, if the picomouse has been touched before the run, an additional touch penalty of 2 seconds is added on giving a new handicapped time score of 26 seconds. The run with the fastest handicapped time score for each picomouse shall be the official time score of that picomouse. The accuracy of time score is to the nearest $1/100^{\text{th}}$ seconds.

- 3.1.4 The run time shall be measured from the moment that the picomouse leaves the starting square until it enters the destination square. A run shall be complete only if the whole of the picomouse enters the destination square.

- 3.1.5 A computer timing system with electronic triggering devices shall be used for measuring scores of each picomouse. The electronic triggering devices are located at the exit and entry of the starting square and the destination square respectively. The triggering device is constructed from the infra red transceivers. They are placed about 1cm above the maze floor. Any failure on the electronic triggering devices shall be back up by a manual timing system.
- 3.1.6 The starting procedure of each entry shall be simple and must not offer a choice of strategies to the handler. Pressing a "Start" button/switch once shall activate the picomouse. Throughout the duration of the given time limit, the handler shall not enter any information into the picomouse (such as to change the search strategy, the speed and the maze data).
- 3.1.7 The handler shall be given a setup time of 1 minute to calibrate the sensors, if required. However the handler shall not select any strategies and enter the maze data into the picomouse. The search time shall be started upon the expiry of setup time if the handler still continues to calibrate the sensors. Only **One** handler shall be allowed to operate the picomouse throughout the contest.
- 3.1.8 When the picomouse reaches the destination square, it may stop on its own and remain at the destination or continue to navigate to other parts of the maze or make its own way back to the starting square. If the picomouse chooses to stop at the destination, it shall be manually lifted out and restarted by the handler. Manually lifting the picomouse out shall be considered as a touch to the picomouse. Therefore a touch penalty shall be added on the scores for all subsequent successful runs.
- 3.1.9 If a picomouse appears to be malfunctioning, the handler may ask the judges for the permission to abandon the run and restart the picomouse from the starting square. The handler shall not require restarting only if the picomouse makes a wrong turn; the judges' decision is final. All handlers have to manage the technical problems within the time limit of 5 minutes given. No re-scheduling of the entry due to technical problems shall be allowed.
- 3.1.10 Before the complete maze is configured, all handlers have to register and cage their entries to the contest officials. Once the entry is caged, no replacement of any parts of the picomouse shall be allowed. Once a picomouse starts its run, no replacement of batteries shall be allowed otherwise considered as a touch to the picomouse and the touch penalty shall be added on for the subsequent scores made by the picomouse.

3.2 The Junior Colleges/Institutes of Technical Education (JC/ITEs) Category

- 3.2.1 The JC/ITEs Category is opened for all full time students from colleges/institutes. Each college/institute shall be limited to **Four** entries. Each entry shall not be more than **Six** students and must have its own picomouse. No picomouse shall be shared by any entries neither in this category nor the Open category.
- 3.2.2 Each entry shall be given a time limit of 5 minutes or 6 crashes to contest on the maze. The picomouse may make as many runs as possible within the time limit provided the picomouse does not crash more than 5 times.
- 3.2.3 The score of a picomouse shall be obtained by computing a handicapped time for each run as follows:

$$\text{Score of Current Run (reached the destination successfully)} = \text{Run Time} + \text{Search Penalty} + \text{Touch Penalty}$$

Search Penalty = $1/60^{\text{th}}$ of the Search Time, in seconds

Touch Penalty = 2 seconds

For example, if a picomouse, after being on the maze for 4 minutes without being touched, starts a run that takes 20 seconds to reach the destination; the run will have a handicapped time score of $20 + 1/60^{\text{th}}$ of $(4 \times 60 \text{ seconds}) = 24$ seconds. However, if the picomouse has been touched before the run, an additional touch penalty of 2 seconds is added on giving a new handicapped time score of 26 seconds. The run with the fastest handicapped time score for each picomouse shall be the official time score of that picomouse. The accuracy of time score is to the nearest $1/100^{\text{th}}$ seconds.

- 3.2.4 The run time shall be measured from the moment that the picomouse leaves the starting square until it enters the destination square. A run shall be complete only if the whole of the picomouse enters the destination square.
- 3.2.5 A computer timing system with electronic triggering devices shall be used for measuring scores of each picomouse. The electronic triggering devices are located at the exit and entry of the starting square and the destination square respectively. The triggering device is constructed from the infra red transceivers. They are placed about 1cm above the maze floor. Any failure on the electronic triggering devices shall be back up by a manual timing system.
- 3.2.6 The starting procedure of each entry shall be simple and must not offer a choice of strategies to the handler. Pressing a "Start" button/switch once shall activate the picomouse. Throughout the duration of the given time limit, the handler shall not enter any information into the picomouse (such as to change the search strategy, the speed and the maze data).
- 3.2.7 The handler shall be given a setup time of 1 minute to calibrate the sensors, if required. However the handler shall not select any strategies and enter the maze data into the picomouse. The search time shall be started upon the expiry of setup time if the handler still continues to calibrate the sensors. Only **One** handler shall be allowed to operate the picomouse throughout the contest.
- 3.2.8 When the picomouse reaches the destination square, it may stop on its own and remains at the destination or continues to navigate to other parts of the maze or makes its own way back to the starting square. If the picomouse chooses to stop at the destination, it shall be manually lifted out and restarted by the handler. Manually lifted the picomouse out shall be considered as a touch to the picomouse. Therefore a touch penalty shall be added on the scores for all subsequent successful runs.
- 3.2.9 If a picomouse appears to be malfunctioning, the handler may ask the judges for the permission to abandon the run and restart the picomouse from the starting square. The handler shall not require restarting only if the picomouse makes a wrong turn; the judges' decision is final. All handlers have to manage the technical problems within the time limit of 5 minutes given. No re-scheduling of the entry due to technical problems shall be allowed.
- 3.2.10 Before the complete maze is configured, all handlers have to register and cage their entries to the contest officials. Once the entry is caged, no replacement of any parts of the picomouse shall be allowed. Once a picomouse starts its run, no replacement of batteries shall be allowed otherwise considered as a touch to the picomouse and the touch penalty shall be added on for the subsequent scores made by the picomouse.

3.3 The Open Category

3.3.1 The Open Category is opened for all individuals from the universities, the polytechnics, the industry, and the private. **Participants who qualify to take part in the Secondary Schools Category are strictly not allowed to take part in the Open Category. Participants from JC/ITEs may be allowed to take part in the Open Category if**

- **the entries are not kit sets purchased or/and subsequently modified, and**
- **the entries have participated and performed well in the JC/ITEs category in the same year, and**
- **the entries are recommended and accepted for Open Category.**

Each entry shall not be more than **Six** participants and must have its own picomouse. No picomouse shall be shared by any entries.

3.3.2 The destination zone, ie goal area, for the Open Category shall consist of 2x2 squares. The entry point, or entry square, refers to the one that has an opening into the destination/goal area. The entry point, or entry square, of the destination zone shall be determined individually for each competition and shall be announced on the Singapore Robotic Games website at least one month before each competition. The entry point of the destination zone shall be indicated by a set of x-y coordinates. Only the coordinates of entry square in the destination zone shall be announced. The direction of entry and the coordinates of the other 3 squares of the destination zone shall not be announced. (Refer to Figure 2 for an explanation on how to read the coordinates of the entry square.)

3.3.3 The maze shall have at least two different paths from the starting square to the destination.

3.3.4 Each entry shall be given a time limit of **5 minutes** to contest on the maze. Within this time limit, the picomouse may try up to a maximum of **5 runs**.

3.3.5 The score of a picomouse shall be obtained by computing a handicapped time for each run as follows:

$$\begin{aligned} \text{Score of Current Run (reached the destination successfully)} &= \text{Run Time} + \\ &\quad \text{Search Penalty} \\ \text{Search Penalty} &= 1/30^{\text{th}} \text{ of the Search Time, in seconds} \end{aligned}$$

For example, if a picomouse, after being on the maze for 4 minutes starts a run that takes 20 seconds to reach the destination; the run will have a handicapped time score of $20 + 1/30^{\text{th}}$ of (4 x 60 seconds) = 28 seconds. The run with the fastest handicapped time score for each picomouse shall be the official time score of that picomouse. The accuracy of time score is to the nearest $1/100^{\text{th}}$ seconds.

3.3.6 The run time shall be measured from the moment that the picomouse leaves the starting square until it enters the destination square. A run shall be complete only if the whole of the picomouse enters the destination square.

3.3.7 The search time shall be measured from the moment that the picomouse leaves the starting square for the first time.

3.3.8 A computer timing system with electronic triggering devices shall be used for measuring scores of each picomouse. The electronic triggering devices are locating at the exit and entry of the starting square and the destination square respectively. The triggering device is constructed from

the infra red transceivers. They are placed about 1cm above the maze floor. Any failure on the electronic triggering devices shall be back up by a manual timing system.

- 3.3.9 The starting procedure of each entry shall be simple and must not offer a choice of strategies to the handler. Pressing a “Start” button/switch once shall activate the picomouse. Throughout the duration of the given time limit, the handler shall not enter any information into the picomouse (such as to change the search strategy, the speed and the maze data).
- 3.3.10 The handler may calibrate the sensors, if required. However the handler shall not select any strategies and enter the maze data into the picomouse. The time spent in calibration is counted towards the total given competition time of 5 minutes. Calibration is only allowed within the starting square. The picomouse is considered to have started its run if it moves out of the starting square and triggers the electronic triggering devices. Only **One** handler shall be allowed to operate the picomouse throughout the contest.
- 3.3.11 When the picomouse reaches the destination square, it may continue to navigate to other parts of the maze or make its own way back to the starting square. No manual lifting of the picomouse at the destination is allowed.
- 3.3.12 The handler shall not touch the picomouse while the picomouse is running in the maze unless he is given permission by the judges to do so. If a picomouse appears to be malfunctioning, the handler may ask the judges for the permission to abandon the run and restart the picomouse from the starting square. The handler shall not require restarting only if the picomouse makes a wrong turn; the judges’ decision is final. All handlers have to manage the technical problems within the time limit of 5 minutes given. No re-scheduling of the entry due to technical problems shall be allowed.
- 3.3.13 Before the complete maze is configured, all handlers have to register and cage their entries to the contest officials. Once the entry is caged, no replacement of any parts of the picomouse shall be allowed. Once a picomouse starts its run, no replacement of batteries shall be allowed.

4. CLONING (APPLIES ONLY TO OPEN CATEGORY)

- 4.1 In accordance with the spirit of the competition, clones among the winning entries will only be awarded one prize. Clones will be identified during the "caging" procedure.
- 4.2 Clones are robots with substantially identical physical appearance and working principles.
- 4.3 When in doubt, the decision of the Judges will be final.

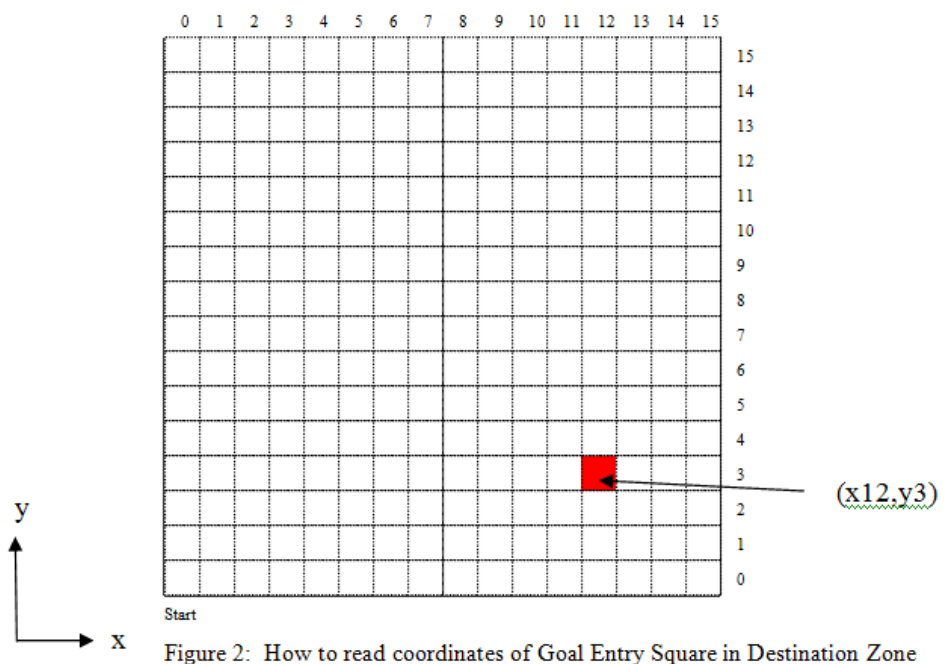


Figure 2: How to read coordinates of Goal Entry Square in Destination Zone