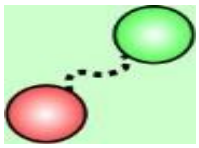

Introducing GoAvoid

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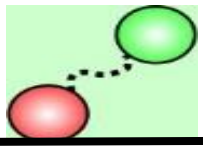

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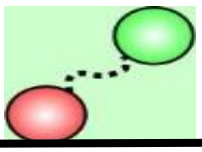

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Introduction

GoAvoid Software

GoAvoid® software is a path planner application for mobile robots that take advantage of GDI+ graphical user interface, which is a class-based API for C/C++ programmers in Microsoft Windows®. Using GDI+, users can draw rectangle shaped obstacles, set their speeds and directions. The workspace consists of the robot, start-goal points and obstacles. The user can change the position of the start-goal points by using mouse movements on the workspace. The obstacles can be drawn, moved and resized with mouse movements. The direction and speed of the obstacles may be set individually at any time using a simple tool appearing near the obstacle with a mouse click on the obstacle. The reference speed of the robot can also be set.

The software first calculates the path from the start point to goal point using the artificial potential field. Then calculates critical speeds of the mobile robot along the path, which is defined as the robot position in coincidence with each moving obstacle. Then safe robot speeds are determined based on these critical speeds. Finally, an animation is performed moving the robot along the path while avoding obstacles.

GoAvoid Fundamentals discuss the basic terminology and useful functions of the software. It guides the user how the software works via illustrations.

GoAvoid Fundamentals

GoAvoid Fundamentals introduce you to the following areas:

- **Terminology:** Lists the common GoAvoid terms used in the software.
- **User interface:** Describes the graphical user interface.
- **Workspace design:** Sets the dimensions of the workspace.
- **Environment creation:** Creates a motion scenario consisting of the start-goal and obstacles.
- **View tools:** Changes the workspace view.
- **Parameters setting:** Sets the parameters such as mobile robot reference speed and path filtering coefficient etc.
- **Animation:** Animates the mobile robot movement by taking into account the motion scenario.

Note: Balloon Tips are included in the interface to get informaton about all of the controllers by hovering the mouse on them. A balloon tip for the control is shown as in Figure 1.1. The user may disable Help->Show Balloon Tips option when he or she gets used to the software interface.

Figure 1.1: Balloon tip for a control

1. Terminology

The following terms appear throughout GoAvoid software and the documentation (Figure 1.2):

- **Workspace**: The area where the mobile robot can move.
- **Origin:** The (0, 0) coordinate of the workspace. Marked with a letter “O” and two green arrows showing “x” and “y” directions.
- **Start:** The start position of the mobile robot on the workspace.
- **Goal:** The final position that mobile robot reaches.
- **Stationary obstacle:** The obstacle whose speed value is set to zero.
- **Fixed size moving obstacle:** The fixed size obstacle whose speed is different from zero.

Note: The algorithm that is available in the software does not take into account the obstacle size of the moving obstacle. However, the user is free to change the algorithm in any way he or she wishes.

Path: The way that the mobile robot has to follow to avoid the obstacles and reach the goal. The path consists of points determined by means of the potential field and following each other almost uniformly spaced.

- **Intersected path point**: The path point intersected with the obstacle’s geometric center point.
- **Obstacle distance**: The distance from the moving obstacle to the path in the direction of the moving obstacle.
- **MajorTick**: The perpendicular line to the line made by the two respective path points, which is used to help the user see how the algorithm works.

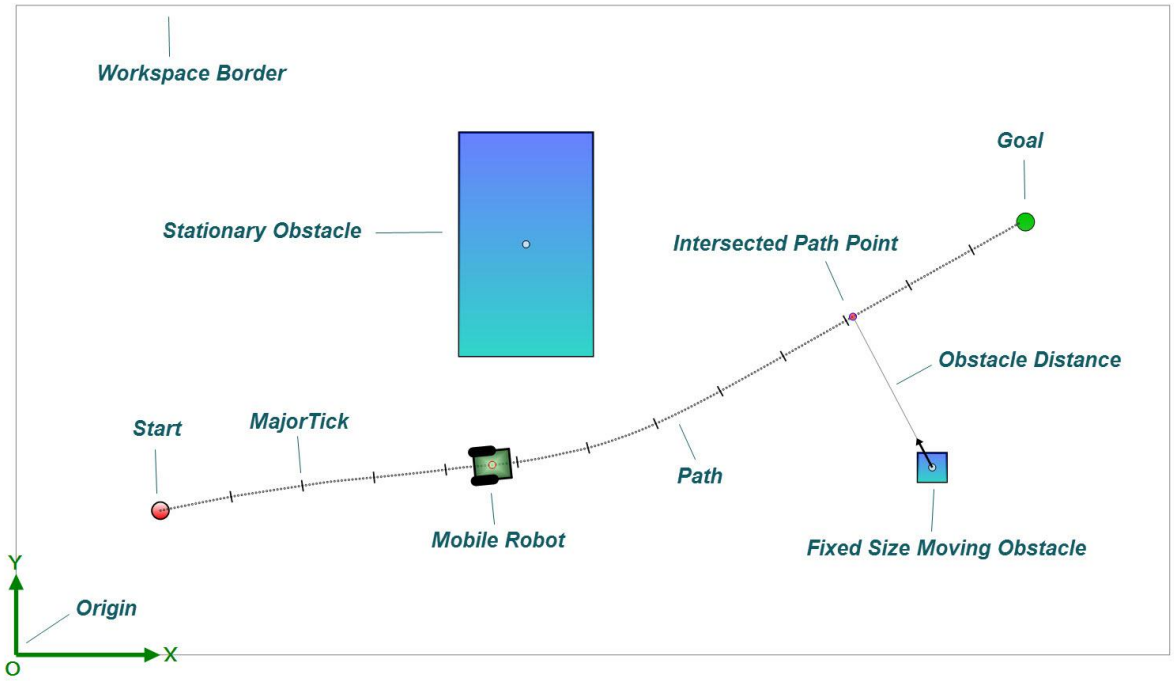

Figure 1.2: Terms appear throughout the software and documentation

2. User Interface

GoAvoid software includes a variety of user interface tools and capabilities to help you create and edit a workspace efficiently. These tools and capabilities include the following:

- Windows functions
- GoAvoid document window
- Function selection and feedback

2.1 Windows Functions

GoAvoid includes familiar Windows functions such as resizing, open and save windows.

Some common Windows-related functions include:

- **Create new document:** Creates new blank document
- **Open new document:** Opens saved document
- **Save document as a different name:** Saves the document with a different name with GoAvoid file extension "*.goav".
- **Save document:** Overwrites the saved document.
- **Tile the opened documents:** Tiles all of the opened documents vertically, horizontally. The user can also cascade the documents.
- **Close the document:** Closes the selected document.

The user can reach these functions via File and Windows menus (Figure 2.1).

Figure 2.1: File and Windows menu

2.2 GoAvoid Document Windows

GoAvoid document Windows have various panels as shown in Figure 2.2. These panels are listed below;

- Set panel
- Workspace panel
- Modes panel
- Delay panel
- Go panel
- Information panel
- Graphics panel

The right panel is the graphics area where you create and manipulate the items on the workspace.

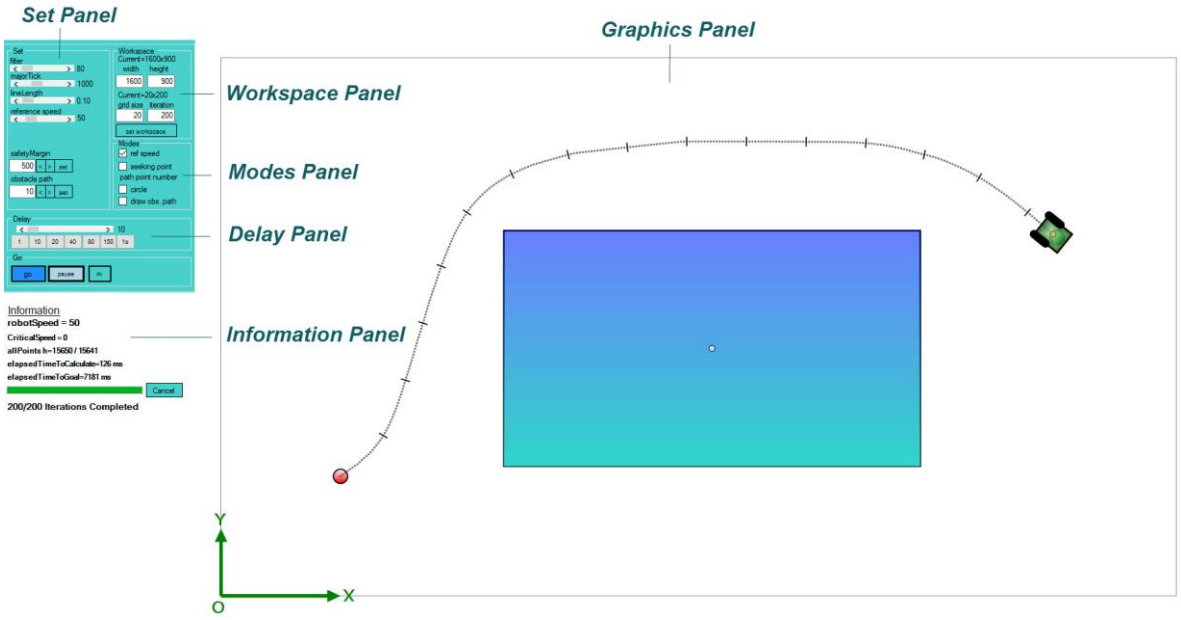

Figure 2.2: Panels in the software

In addition, the user can see current mouse coordinates with respect to the origin at the right bottom of the screen (Figure 2.3).

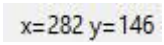

Figure 2.3: Current mouse coordinates

2.3 Function Selection and Feedback

GoAvoid allows the user to perform tasks in different ways. It also provides feedback as the user performs a task such as setting safety margin parameter of the mobile robot or activating pan. Feedback includes hand and arrow pointers and selected buttons highlighted.

2.4 Menus

You can access all GoAvoid commands using menus. GoAvoid menus use Windows conventions, including sub-menus and check marks to indicate if an item is active and so on. You can also use the context shortcut menu to perform common tasks. Main menu is shown in Figure 2.4.

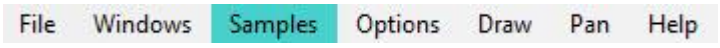

Figure 2.4: Main menu

2.5 Toolbar

You can access GoAvoid functions using its toolbar as well. Toolbar is consisted of individual icons that represent functions (Figure 2.5).

Figure 2.5: Toolbar menu

2.6 Mouse Buttons

Mouse buttons operate in the following ways;

- **Left:** Selects menu items and entities in the graphics area and objects on the left panel.
- **Right:** Displays the context shortcut menu.
- **Middle:** Activates/deactivates the panning function on the graphic area.
- **Middle Double Click:** Sets the default view.

Note: Any view can be set as the default view by using “Set as Default View” function on the context shortcut menu. This issue will be explained in detail in the Section 5.

3. Workspace Design

GoAvoid software makes it possible to resize the workspace. The user can set the dimensions of the workspace by using the workspace panel. Workspace panel components are shown in Figure 3.1.

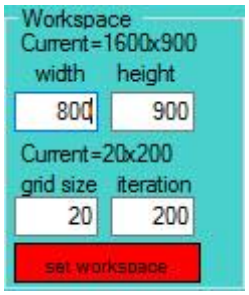

Figure 3.1: Workspace panel

When the current dimension values on the panel change, the set button becomes red to warn the user that there is an attempt to change the workspace dimensions. After the set button is clicked, the software checks whether all of the items in the current workspace are in the user-defined workspace. If there is an item out of the user-defined workspace, a messagebox appears on the screen to inform the user that all of the items on the current workspace must be moved into the user-defined workspace (Figure 3.2).

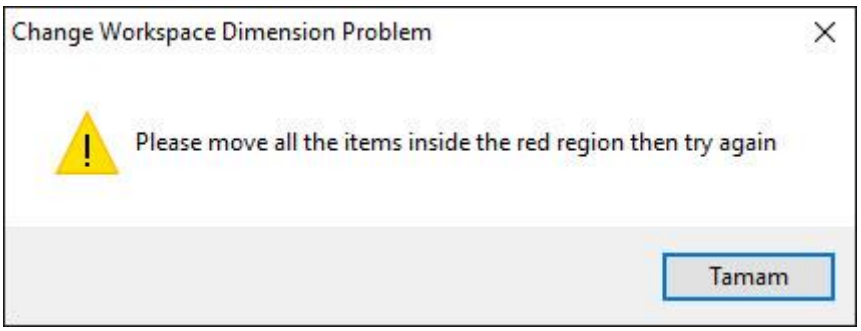

Figure 3.2: Changing workspace dimension problem

A temporary red user-defined workspace is drawn on the workspace to point out the user-defined workspace location after closing the messagebox as follows (Figure 3.3).

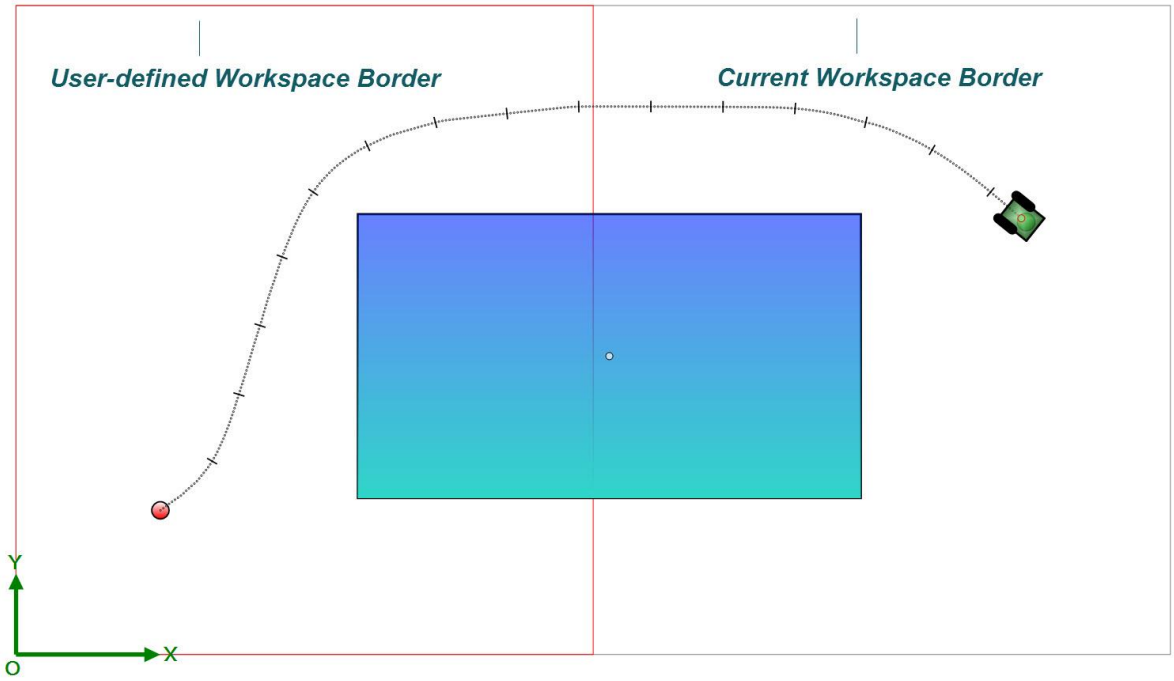

Figure 3.3: Workspace borders

If this button's color becomes white, the dimensions of the workspace are changed. In addition, the current dimension information will be updated as seen in Figure 3.4.

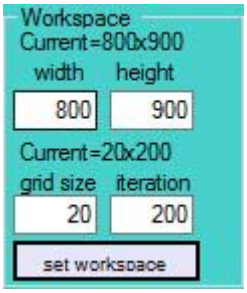

Figure 3.4: Current dimensions information

Once the dimensions of the workspace are changed, the software clears the temporary red workspace from the screen.

4. Environment Creation

The user can easily create a motion scenario consisting of the start-goal points and obstacles using the software. “Start” represents the start point of the motion and “Goal” represents the point where mobile robot aims to reach.

4.1 Setting Start-Goal Point Position

The user can invoke the setting process of the start or goal positions by means of the menus as shown in Figure 4.1, Figure 4.2 and Figure 4.3:

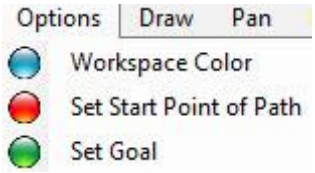

Figure 4.1: Setting start-goal point

Figure 4.2: Setting start-goal via toolbar menu

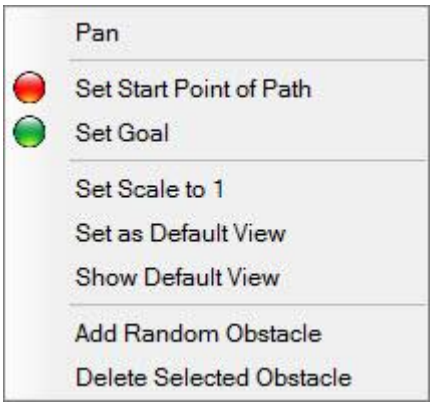

Figure 4.3: Setting start-goal via the context shortcut menu

After invoking the process, the user can change the start or goal position by pressing the left button while moving the mouse on the workspace.

Note: The software checks whether the start or goal point is inside an obstacle when the go button is clicked. If one of them is left inside the obstacle, a messagebox appears on the screen to inform the user as shown in Figure 4.4.

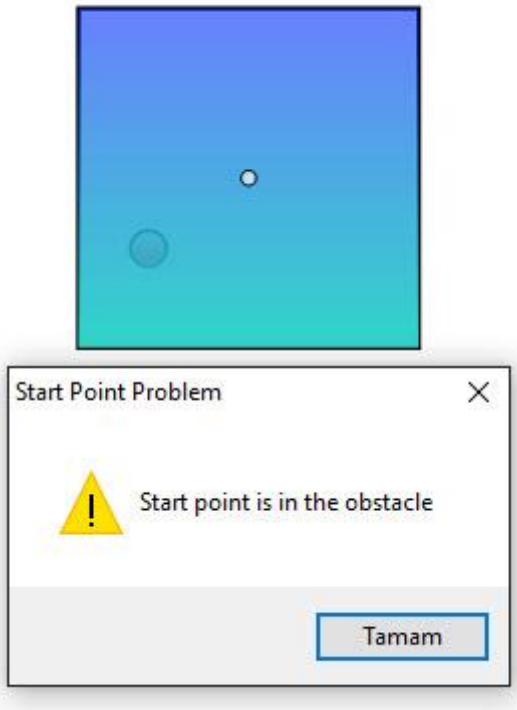

Figure 4.4: Start point position problem

GoAvoid allows the user to draw rectangle shaped obstacles in the workspace and set their speeds and directions.

4.2 Toolbar Menu Functions

The user can rapidly reach frequently used functions using this menu. All of the functions on this menu are shown in Figure 4.5.

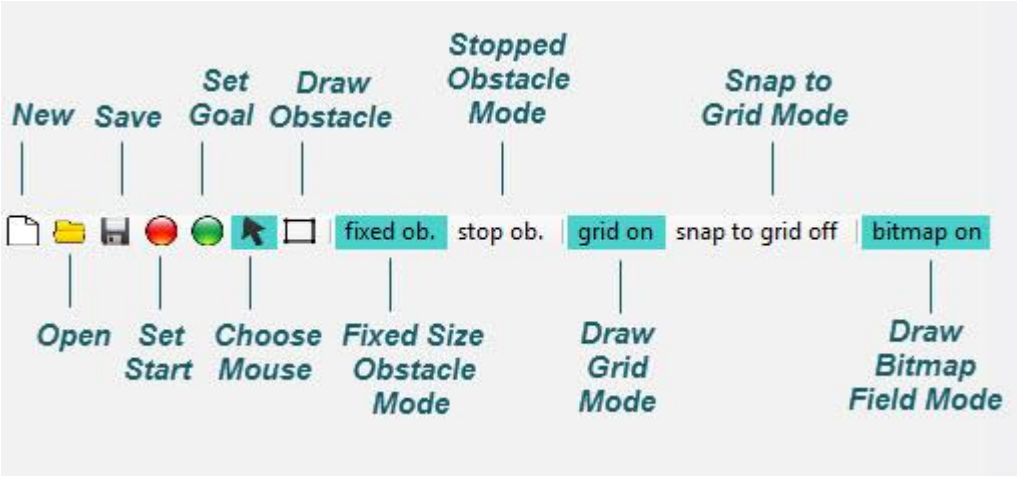

Figure 4.5: Toolbar menu functions

4.3 Draw Menu Functions

The draw menu functions are described below in Figure 4.6.

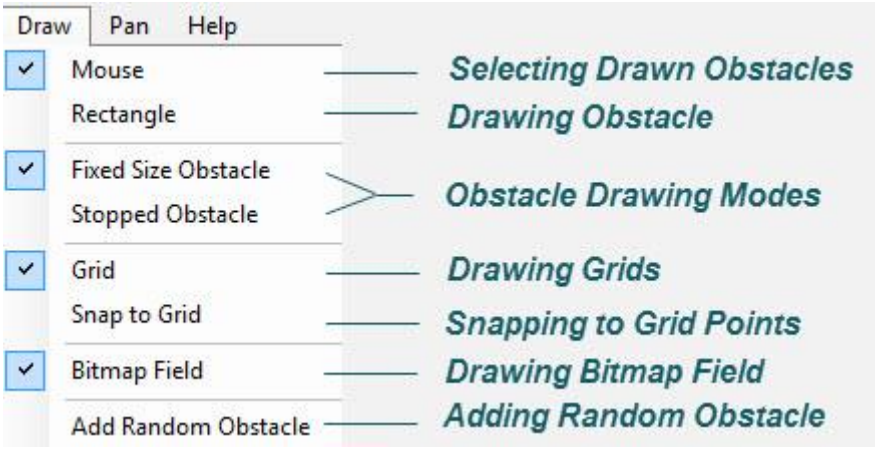

Figure 4.6: Draw menu functions

4.4 Drawing Obstacle

The user can initiate the drawing mode via followings:

- Associated toolbar icon

  Rectangle shaped toolbar icon can be used (Figure 4.5).

- Draw menu

  Rectangle option can be used in the Draw menu (Figure 4.6).

After initiating the drawing mode, the user can draw a rectangle shaped obstacle on the workspace with the mouse. The edge of the obstacle is specified by pressing the left button. Then, the mouse is dragged and the rectangle is completed by releasing the left button.

Note: The drawn obstacles must be in the region of the workspace. If the user attempts to draw an obstacle outside of the workspace, the software does not allow it and switches to selecting mode automatically.

4.5 Obstacle Draw Modes

The user can sets two obstacle draw modes.

- Fixed size obstacle

  This mode allows user that they can draw a fixed size obstacle by only clicking the left button.

- Stop Obstacle

  This mode determines whether the drawn obstacles must be stopped when it reaches the border of the workspace.

The user can start the obstacle drawing modes via followings:

- Associated toolbar icon

  Toolbar icons can be used captioned as “fixed ob. “and “stop ob.” (Figure 4.5).

- Draw menu

  Fixed size and stopped obstacle options can be used in the Draw menu (Figure 4.6).

4.6 Selecting Obstacles

The user can activate the selecting mode via followings:

- Associated toolbar icon

  Arrow shaped tolbar icon can be used (Figure 4.5).

- Draw menu

  Mouse option can be used in the Draw menu (Figure 4.6).

After activating the selecting mode, the user can easily select an obstacle by clicking on them. Once the obstacle is selected, the placeholders and obstacle information panel appear on the screen as seen in Figure 4.7. The user can resize the selected obstacle by dragging the placeholders and set the motion direction and speed of the obstacle via controllers on the panel.

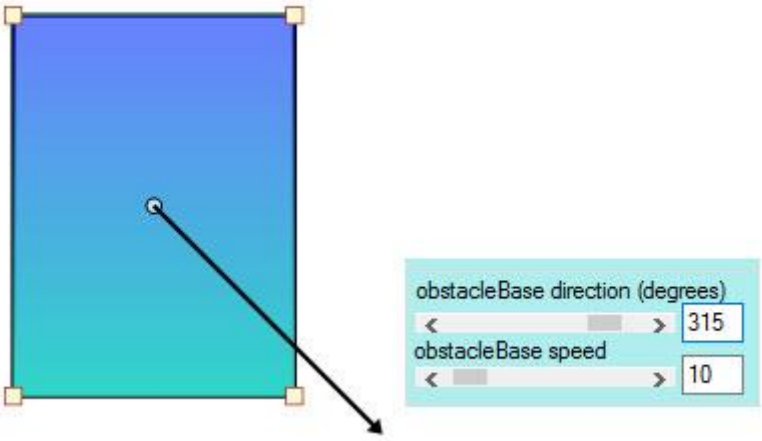

Figure 4.7: Placeholders and obstacle information panel

5. View Tools

5.1 Changing Workspace Color

The user can easily change the workspace color by using options menu as in Figure 5.1.

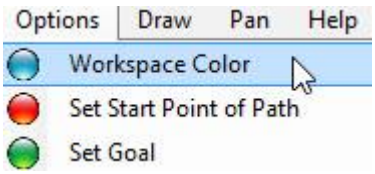

Figure 5.1: Changing workspace color

5.2 Panning on the Workspace

Panning mode can be enabled by means of the followings:

- Main menu (Figure 5.2)

Figure 5.2: Panning via main menu

- Context shortcut menu (Figure 5.3)

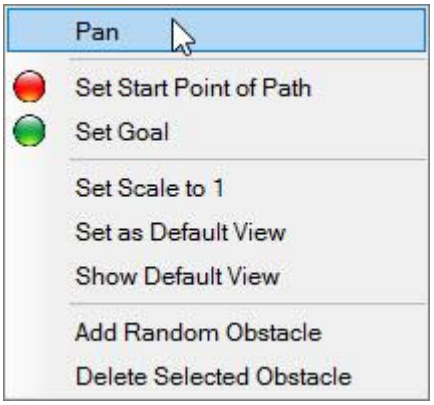

Figure 5.3: Panning via the context shortcut menu

- Mouse middle button clicking

The user can enable/disable pan mode by clicking the middle button of the mouse. The pan menu becomes turquoise when the panning mode is on as shown below in Figure 5.4.

Figure 5.4: Enabled panning mode

5.3 Zooming on the Workspace

The user can zoom in or zoom out in the workspace via mouse wheel.

5.4 Showing Original View

After zooming in or out, the user can go back to the original view using the context shortcut menu as below in Figure 5.5.

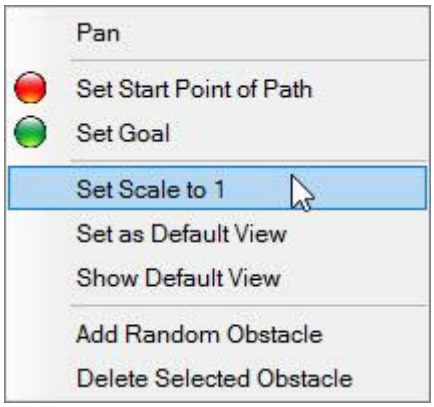

Figure 5.5: Going back to the original view

5.5 Setting Default View

For each document, different views can be set as a default view. This view is saved with the document files. The default menu can be set via context shortcut menu as in Figure 5.6.

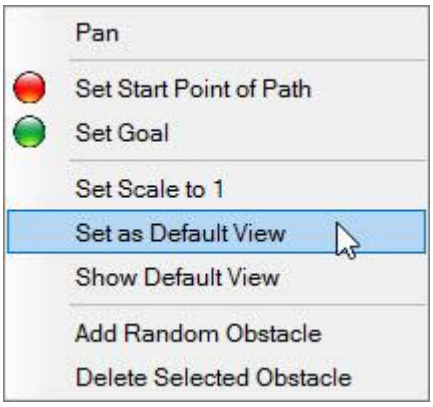

Figure 5.6: Setting default view

5.6 Showing Default View

The user can view the default view by using the context shortcut menu as below in Figure 5.7. If the default view is saved with the document, this view will be shown. Otherwise, the original view will be shown on the screen.

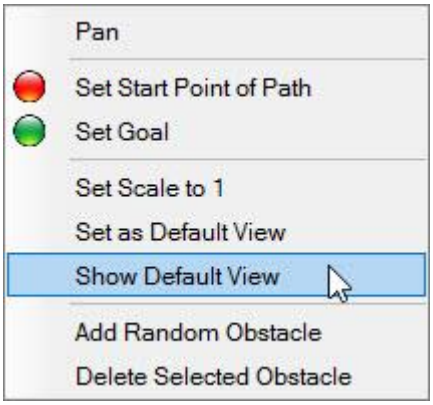

Figure 5.7: Showing default view

5.7 Showing the Grid in the Workspace

The grid is not shown when a new document is created since it slows down the processes in the workspace. It can be enabled by using draw menu in Figure 5.8.

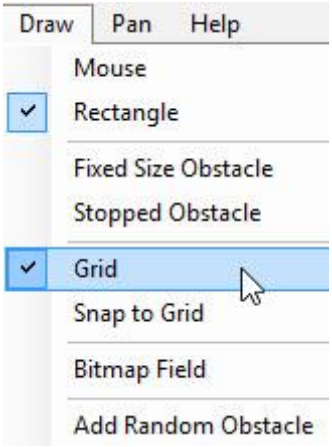

Figure 5.8: Showing grids in the workspace

5.8 Snapping to the Grid

When you draw, resize or move an obstacle, this property will align the nearest intersection of lines in the grid even if the grid is not visible. The user can enable this property by using draw menu as shown in Figure 5.9.

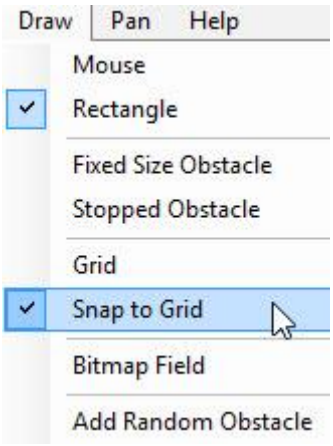

Figure 5.9: Snapping to the grid in the workspace

5.9 Drawing Bitmap Field

Similar to the grid, not only drawing the bitmap field slows down the animation but also it increases the software response time. It can be enabled via Main menu-> Draw menu as in Figure 5.10.

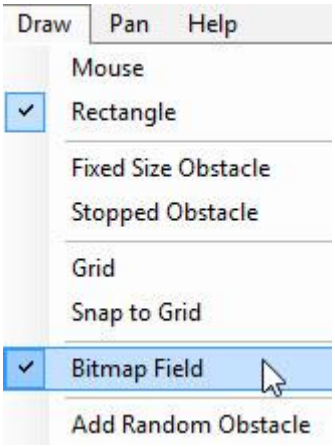

Figure 5.10: Drawing bitmap field on the workspace

This command draws the workspace calculated by the potential field as bitmap. Using this option the user can observe the slope from the start point to the goal. A workspace is shown below in Figure 5.11.

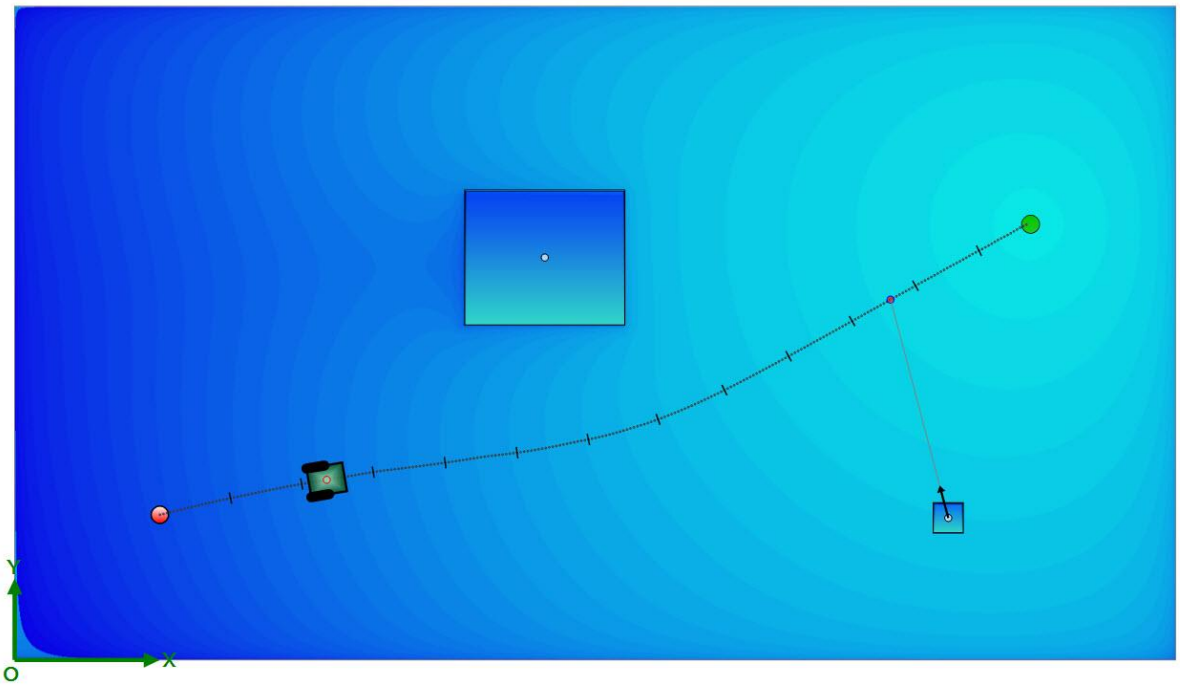

Figure 5.11: Drawing bitmap field on the workspace

5.10 Adding Random Obstacles

The user can add random obstacles when the animation does not run via followings:

- Draw menu (Figure 5.12)

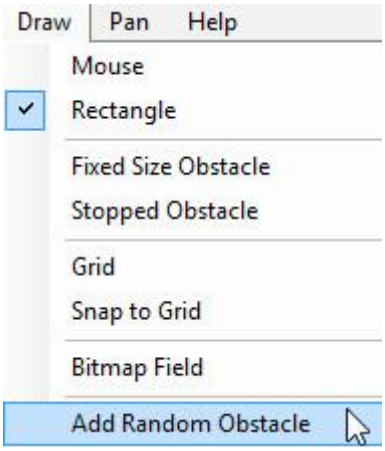

Figure 5.12: Adding random obstacle via draw menu

- Context shortcut menu (Figure 5.13)

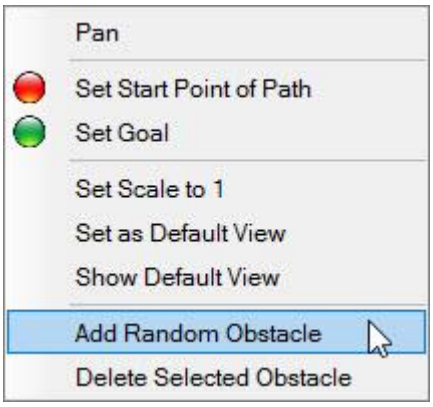

Figure 5.13: Adding random obstacle via the context shortcut menu

Note: This function adds non-fixed size random obstacles and sets its motion direction and speed automatically. The user can move, resize and set its paramaters.

5.11 Deleting Selected Obstacle

The user can delete the selected obstacle via the context shortcut menu as below in Figure 5.14.

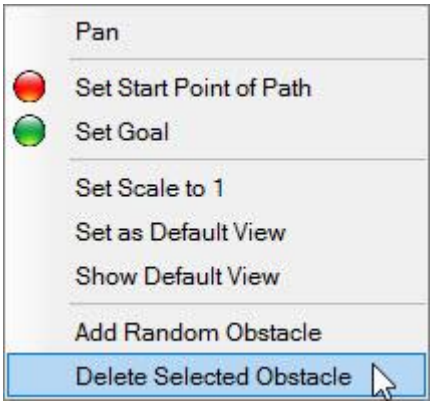

Figure 5.14: Deleting selected obstacle

Note: Selected obstacle can be deleted by using the “delete” button on the keyboard as well.

6. Parameters Settings

The user can use the set panel to assign values to the parameters in GoAvoid software (Figure 6.1). There are seven parameters on the set panel shown as follows.

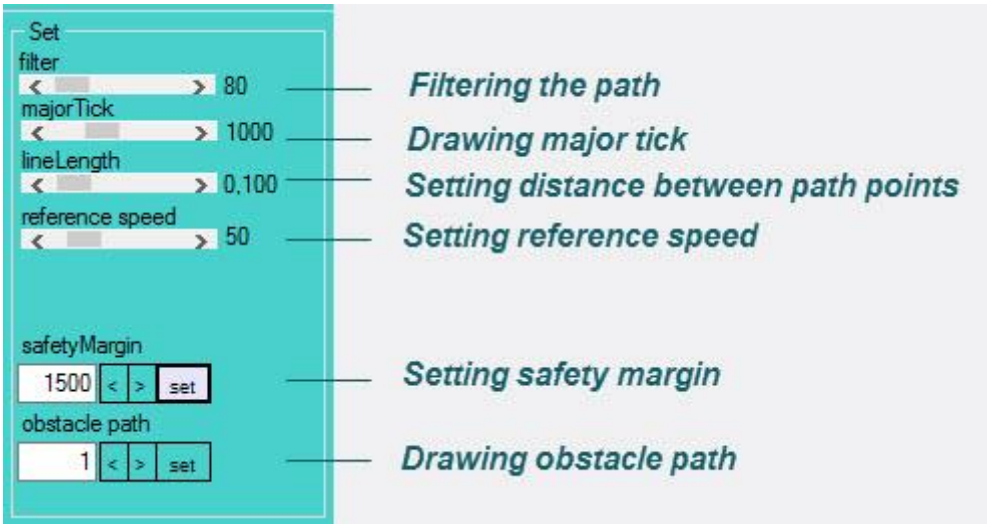

Figure 6.1: Set panel parameters

All of the parameters are described below respectively.

6.1 Filtering path

This parameter sets the number of points including in the windows averaging calculations that smooth the path calculated. It cannot be used while the animation is running. If its value is set too high, the path is diverted from its original location and it is no more represent the way through obstacles. It is recommended to set this parameter before the animation. The default value of this parameter is 80.

6.2 Drawing Major Tick

As mentioned in the section of terminology, the major tick is a mark drawn at a certain frequency to make it easy for the user to follow the robot and the path. The frequency of the majorTick can be set by the user. The default value of this parameter is 1000.

6.3 Setting Distance between Path Points

As mentioned before, the path generated by the potential field consists of successive points. This parameter sets the distance between two path points. It cannot be used while the animation is running. The default value of this parameter 0.1 (Figure 6.2).

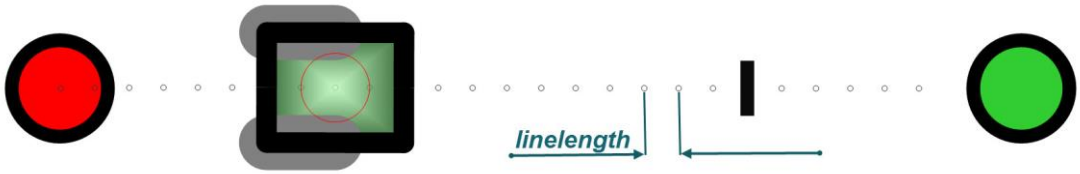

Figure 6.2: Overview of the path points

6.4 Setting Reference Speed

Reference speed of the mobile robot represents the desired speed value. This mode uses the reference speed value instead of the calculated speed considering the safety margin parameter value. The default value of this parameter is 50.

6.5 Setting Safety Margin

The safety margin parameter represents the difference between the robot distance on the path and the current obstacle position when the geometric center of the current obstacle intersects with the path points. It is clear that the path point representing the robot's position must be different from the obstacles intersection path point. Otherwise, the robot collides with the obstacle. The safety margin ensures that the robots's position is far away from the current obstacle position.

It cannot be used while the animation is running as mentioned above. If the safety margin value is equal to zero, the robot and obstacles' centers are coincided.

The aim of the algoritm included in the software is to show that how the software works. It is not intended to be a perfect obstacle-avoiding algorithm. The main limitations of the algorithm is listed below:

- The direction angle of an obstacle to the path must be windin the range +-45 degrees.
- The safety margin cannot be higher than the distance between two obstacles' intersection points.

Considering this limitations, the robot can avoid all of the obstacles. On the information panel the critical speed is the speed that safety margin value equals to zero, the "robotspeed" is the speed value according to the safety margin value set by the user. The default value of this parameter is zero.

6.6 Drawing Obstacle Path

The obstacle path parameter represents the frequency of drawing the obstacle path points while obstacles are moving if draw obstacle path mode is activated on the modes panel. If this parameter value is set to 5, it means that the software draws one point after 5 points. Using this property the user can calculate the distance that obstacle is gone via obstacle speed value. The default value of this parameter is 10.

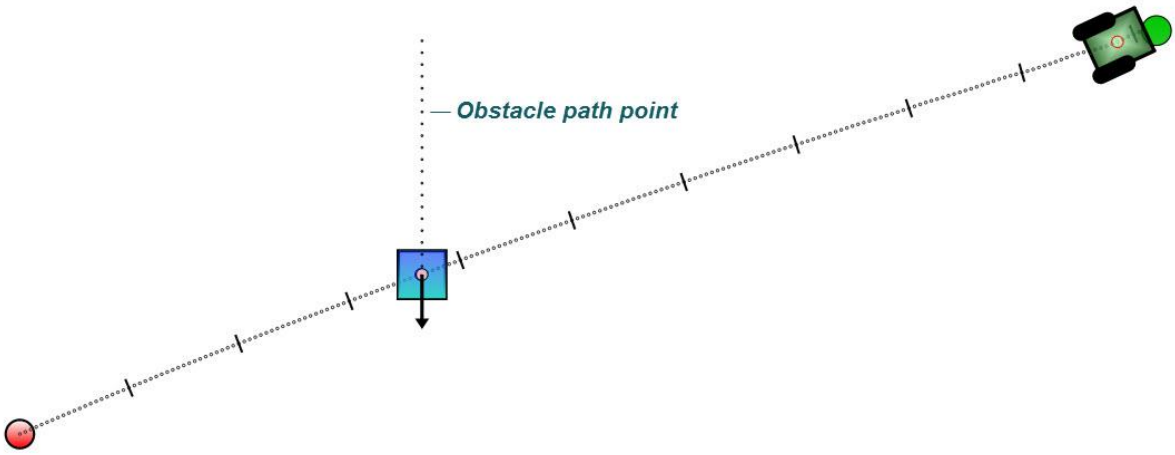

Figure 6.3: Drawing obstacle path points

7. Animation

7.1 Modes panel

There are four modes that the user can enable or disable as shown in Figure 7.1. These modes are described respectively below.

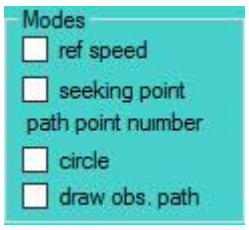

Figure 7.1: Modes panel

- **Reference speed mode:** This mode uses the reference speed value instead of the calculated speed considering the safety margin parameter value.
- **Seeking path point mode:** This mode allows the user to seek for the path point number by moving the left button pressed mouse on the path when it is on. The path point number will appear on the label below this mode's checkbox per mouse movement.
- **Draw enclosing circle mode:** This mode draws red enclosing circles to all moving obstacles when it is on.
- **Draw obstacle path mode:** This mode draws moving obstacles path on the screen considering the obstacle path parameter as mentioned in the section 6.7 when it is on.

7.2 Delay panel

The user can slow down the animation to observe the robot motion details to check whether the algorithm proposed works as intended. The user can set the delay value not only by using hscrollbar controller but also by using the buttons as shown below (Figure 7.2). If the user clicks the button with the caption 150, it means the software will delay the animation 150 milliseconds.

Figure 7.2: Delay panel

7.3 Go panel

There are three animation buttons including “go”, “pause” and “ini” on this panel (Figure 7.3). These buttons are described respectively as follows.

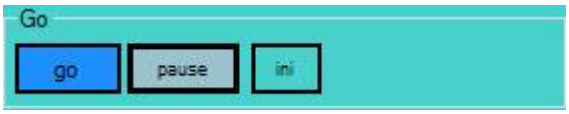

Figure 7.3: Go panel

- **Go button:** It runs the main method. In other words, it performs all of the calculations and starts the animation.
- **Pause button:** It pauses the animation. When paused, the caption of the button changes from “pause” to “continue”. The user can restart the animation by clicking this button again.
- **Ini button:** It sets the mobile robot and obstacle values to their initial positions.

7.4 Information panel

There is information about the robot on this panel as shown in the Figure 7.4. The information is described respectively below.

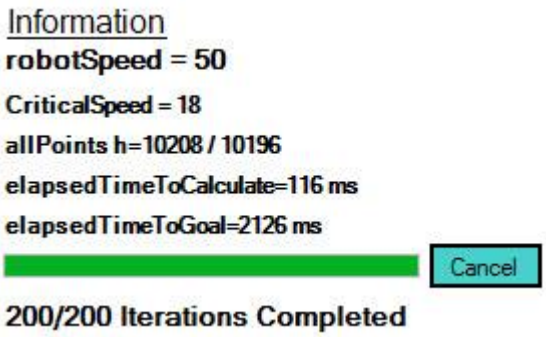

Figure 7.4: Information panel

- **Robot speed:** The current speed value of the mobile robot when it moves on the calculated path.
- **Critical speed:** Mobile robot speed value that coincides with the obstacles. If overall value is set to zero, the critical speed equals to the robot speed.
- **Path points:** It informs the user about progress of the movement.
- **Calculation time:** It is the artificial potential field calculation time for the created environment in milliseconds.

- **Elapsed time:** It is the time the robot takes from the start to the goal point in milliseconds.
- **Progressbar:** It informs the user about progress of the artificial potential field calculation.

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