

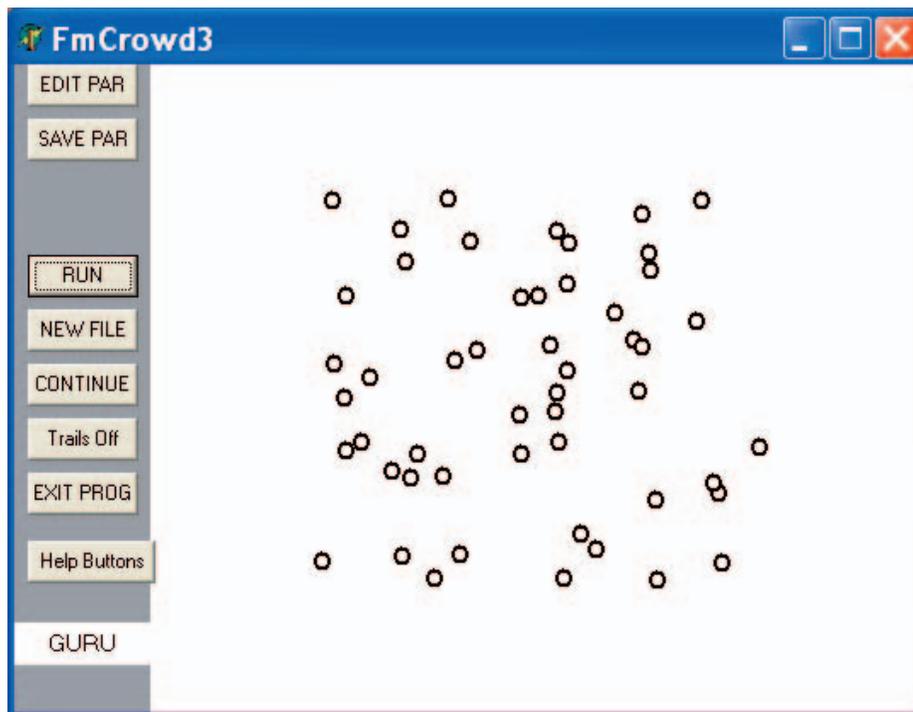
# *CROWD for Windows*

## *A simulation of crowd behavior*

### UPDATED WINDOWS PROGRAM

This program simulates up to 255 individuals moving around on a field, moving toward a destination, following another individual at a specific distance and maintaining a specific direction, and avoiding collisions with each other and with stationary obstacles. Each person contains up to six simple control systems. There are preconfigured setups showing, among other things, a “guru” being followed by several “disciples,” a “man” and a “dog” at heel, a rabble converging on the same destination and competing to occupy the center, a “mother goose” followed by a train of “goslings”, and other examples of people moving in relation to other people and things. The user can create new setups and save them in named files.

When the program starts, you are asked to select a setup file from a list in a window. If there are no setup files, or you do not want to use any existing ones, click on “Cancel” and a default setup will be loaded. The default setup consists of a single active “person” that travels across the screen to a destination. The initial screen is shown in Fig. 1 after a setup (Guru) has been chosen.



*Figure 1: Screen after initial choice of setup file*

## RUNNING THE PROGRAM

Clicking on the "Run" button starts the program. Watch the action. Run the program repeatedly. Each time, the selected number of stationary persons are placed randomly on the field. Turn trails on and off. Pause and continue. Note that the Pause function remains as set from one session to the next. Thus if nothing happens when you click on Run, watch to see if the program is set to Pause or Continue.

## OVERVIEW OF PARAMETERS FOR EDITING

Clicking on the "Edit Par" button brings up a list of the parameters, with a name at the left and a box on the right in each line where values can be entered. Figure 2 shows the editing panel that appears.

The first three items set the initial X position, Y position, and Initial Direction of movement for the object with the number shown by the "Person" label at the top. To change an entry, click on the up and down arrows to the right of the entry box, or click inside the box and enter a new number from the keyboard. Screen dimensions are about 800 x 600 units.

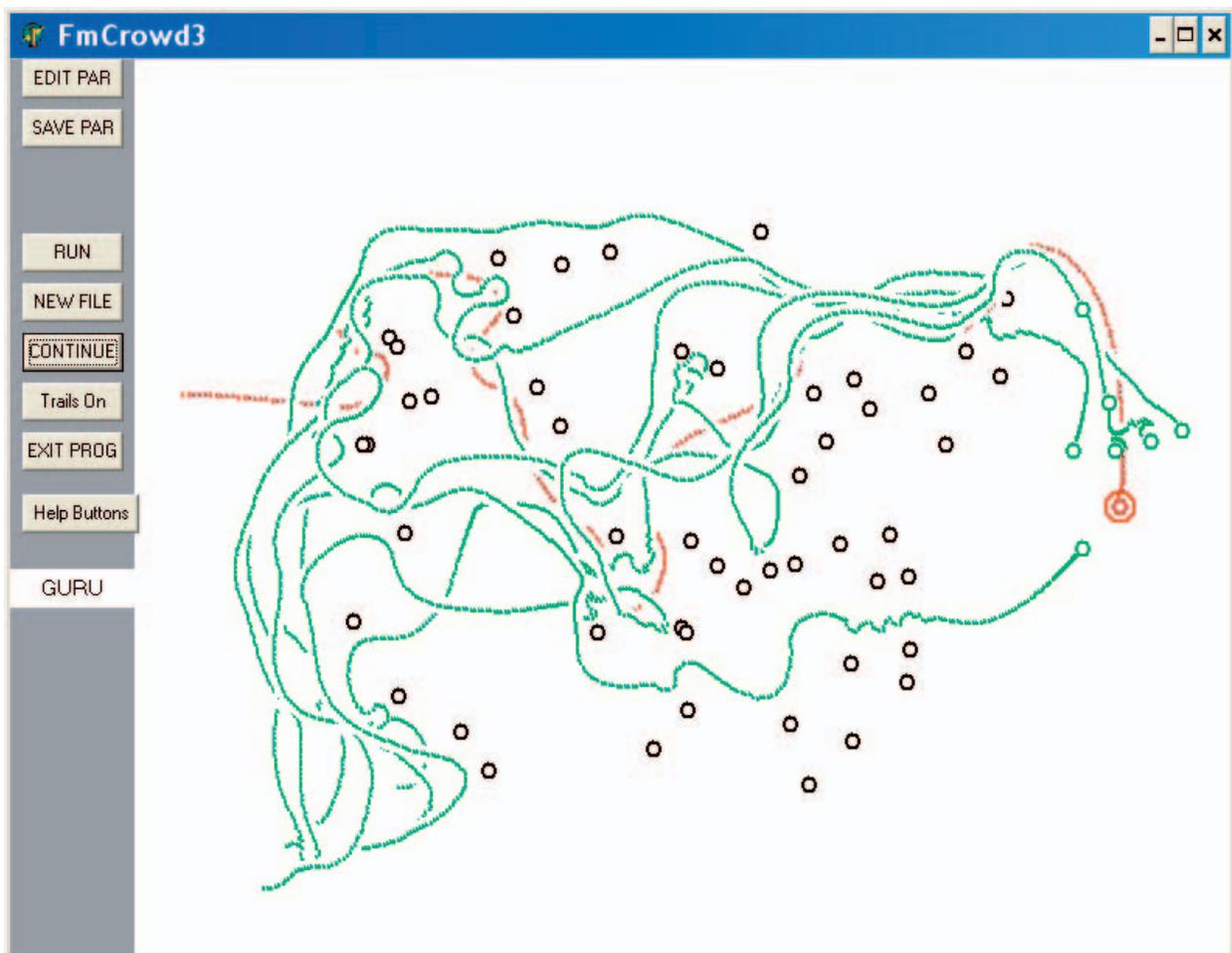


Figure 2: Screen after clicking on RUN. Trails on.

Following this are three groups of four parameters each, pertaining to control systems inside this person. The first group of four entries sets up the control systems for avoiding collisions. The second sets up the system for seeking the destination position. The third sets up the system for seeking the position of another active person. These will be discussed in a later section.

The final five entries are as follows:

Seek Pers/Dest – Designates whether this person seeks another person, a destination, or “none”. Click the arrows to change. Does not apply if person is inactive or unused ( see below).

SeekPerNum – Number of the person this person is to follow. Applies only if seeking another person’s position. Change with arrows or enter from keyboard.

Active/Inactive – Designates whether the object is an active person, an inactive person, or an unused entry. Click the arrows to change. “Inactive” means this object is a stationary obstacle randomly located on the screen. “Active” means the person seeks another person or a destination (see entry above). “Unused” means that this entry is completely ignored.

Dest X, Dest Y – Fill in these entries if the person is active and seeking a destination. Click the arrows or enter from keyboard. Dimensions of the screen are about 800 x 600 units. A large red circle is placed at the coordinates [DestX,. DestY]..

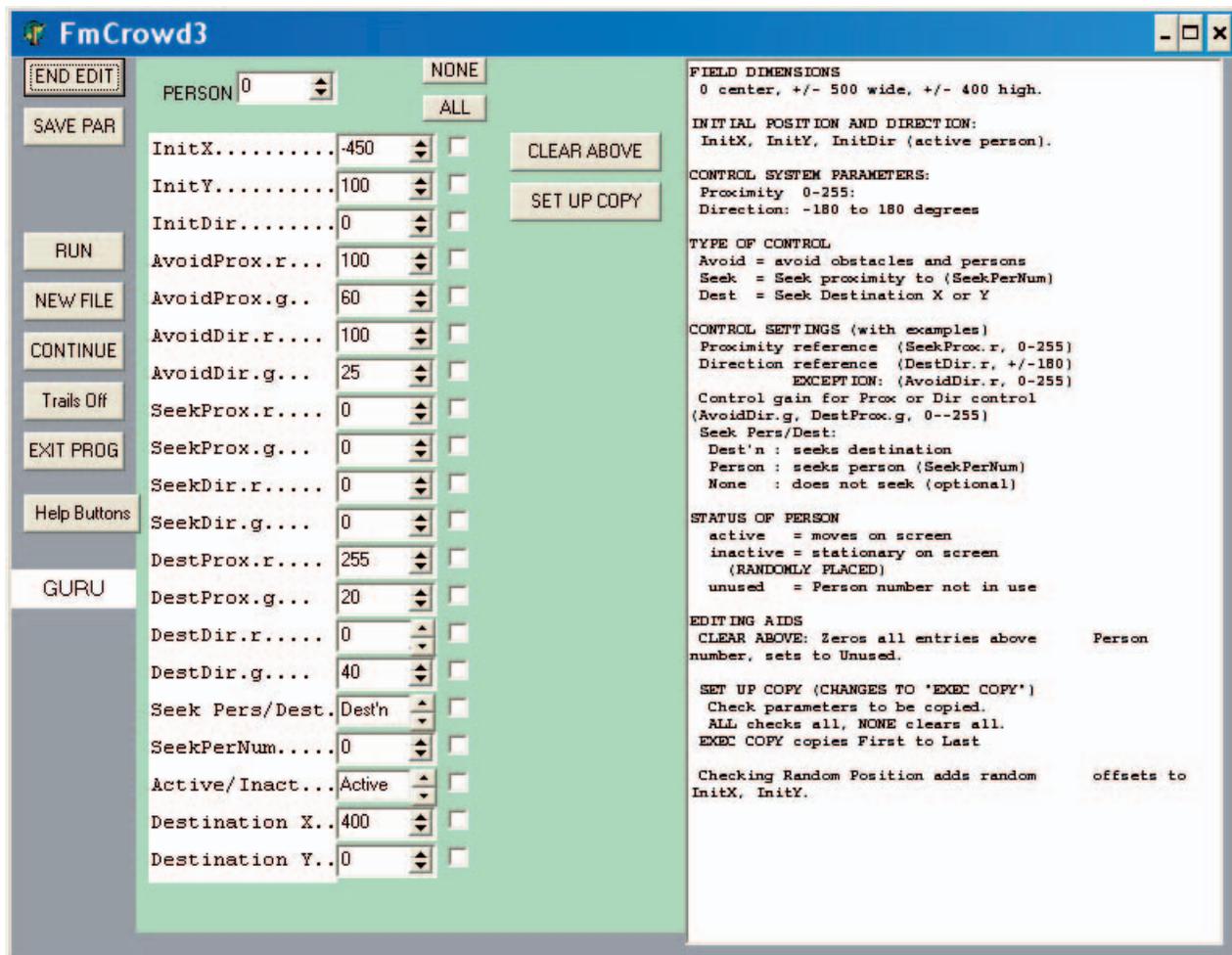


Figure 3: Screen after clicking on “Edit Par” button.

## SETTING UP THE CONTROL SYSTEMS

Each active person has three possible control systems (avoidance, person-seeking, and destination-seeking), and each control system is two-dimensional, needing reference and gain parameters to be set for both proximity and direction control. Inactive or unused objects ignore these parameters.

Proximity control:

“Proximity” is a perception based on the distance from the active person to any object. It is computed from the inverse square of the distance, with a minimum value of zero (large distance) and a maximum value of 255 (zero distance). The reference level that is set for proximity determines “how much proximity” the system will try to maintain. The gain setting determines how rapidly the output of the control system will change as the proximity departs from its reference level.

The outputs of the proximity controllers in each of the three control systems are added together to determine the speed of motion of the person in the direction of travel (speed is prevented from dropping below zero).

For the destination-seeking control systems, the reference level for proximity control should be set high, to about 250, so the error will not drop to zero until the person has moved inside the destination circle. For person-seeking systems, it should be set somewhat lower, say to 150, so the controller will try to maintain a polite distance from the person being followed. For the avoidance control system, the proximity reference level is set to about 50. The program sums the proximities of all objects to the right of the direction of travel as Right Proximity, and of all objects to the left as Left Proximity. It then steers itself to left or right according to whether it is going to pass to the left or right of the “virtual” obstacle – a single virtual obstacle placed so as to give the same left and right proximity readings. If the reference level is lowered, the person will pass farther to the left or right from the real or virtual obstacle.

## Direction control

For seeking a person or a destination, direction is computed relative to the person’s direction of travel. If the direction to an object is to the left of the reference direction, the direction error is positive; if to the right, the error is negative. The error is amplified by the “gain” setting to produce the direction-control output signal, and the output signals from all direction control systems are summed to determine the net rate of turn to the left or right. The actual direction of travel is the time-integral of the rate of turn – a running summation.

In the avoidance systems, the directional control is somewhat unusual. The directional error signal is computed by subtracting the sum of left and right proximities (rather than a difference in desired and actual directions) from the reference setting, and this proximity error, instead of being used to vary the speed, changes the direction of travel. In addition, the difference between right and left proximities is used to switch the sign of the action of the control system so it will tend to seek (rather than avoid) the reference proximity whether the obstacle is to the left or the right.

The speed control for the avoidance system operates on the normal proximity error signal. If proximity is above the reference level, the speed is reduced. If the proximity is less than the reference level, the output remains zero. Speed, in other words, is never increased when the proximity is too low. The gain determines how much it will be reduced for a given excess-proximity error.

## EDITING AIDS

The “Set Copy” and “Clear Above” buttons, which show up while editing, will help create complex setups. The “Set Copy” button reveals places to enter the starting person number (“first”) and the ending person number (“Last”). The parameters for the person currently being shown in the table of parameters to the left are simply copied into the parameters of each person from the first to the last in the indicated range. There are no restrictions on the copying range other than the restriction to the range 0 to 255. Thus you can copy into the record for the person number from which you are copying, which might produce some odd effects.

In addition, if the box labeled “Random Position” is checked, the initial X and Y positions in the list will have a random number added to them in the range of about plus or minus 50 screen units, so that all the persons in this group will have somewhat different starting positions (based on the InitX and InitY positions in the list being copied from).

The “Clear Above” button applies to all person numbers higher than the one indicated over the table of parameters. All those entries are set to “Unused” and “None”, with all other parameters set to zero. CAUTION. If you have just copied the parameters into a series of person numbers, and then click on “Clear Above”, entries for all persons with numbers higher than the current person number on the left will be set to “Unused” – including the ones just created by the copy operation if entries higher than the current person number are included. To clear entries above the last good entry, set the person number to the last good entry and then click on “Clear Above.” All entries from the next one to the 255th will be set to “Unused.”

Because it is often desirable to vary the number of obstacles on the screen, it’s a good idea to assign the highest person numbers to be obstacles (setting them to “inactive” is all that is required). To reduce the number of obstacles, set the person number to the last one to be retained, and click on “Clear Above.” To increase the number, set the person number to the first obstacle, and do a copy with the appropriate range. When inactive persons are assigned, their screen locations are selected randomly.

## LOADING AND SAVING SETUPS

When the program first starts you are invited to select a previously-created setup file (with an extension of .per). If you select one, a complete set of parameters will be loaded, and the parameters for person 0 will be displayed when you click on Edit Par. If you want to create a new setup you can modify the one just loaded, and then some time before exiting the program, save it by clicking on the Save Par button (which operates like “save as ...”). You can save the new setup under a new name, or select any existing name, replacing its former contents.

When opening a setup file, you can also click on cancel or just close the selection window, in which case a default set of parameters will be loaded for Person 0, and the others will be set to “Unused.”

Remember that you must consciously choose to save a setup before you exit the program (clicking the Exit Prog button will actually give you a last chance to save). If you don’t, or if you click cancel when the saving window appears or use the close (X) button, the setup will not be saved and will be gone forever.