General form of the social force model equations:

$$\frac{d\vec{v}_\alpha(t)}{dt} = \vec{f}_\alpha(t) + \underbrace{\vec{\xi}_\alpha(t)}_{\text{Noise term}}$$

Where:

$$\vec{f}_\alpha(t) = \frac{1}{\underbrace{\tau_\alpha}_{\text{Acceleration time}}}\left(\underbrace{v_\alpha^0 \vec{e}_\alpha}_{\text{Desired velocity}} - \underbrace{\vec{v}_\alpha}_{\text{Actual velocity}}\right) + \overbrace{\sum_{\beta(\neq\alpha)} \vec{f}_{\alpha\beta}(t)}^{\text{Forces from all other pedestrians } \beta} + \underbrace{\sum_i \vec{f}_{\alpha i}(t)}_{\text{Forces from all boundaries } i}$$

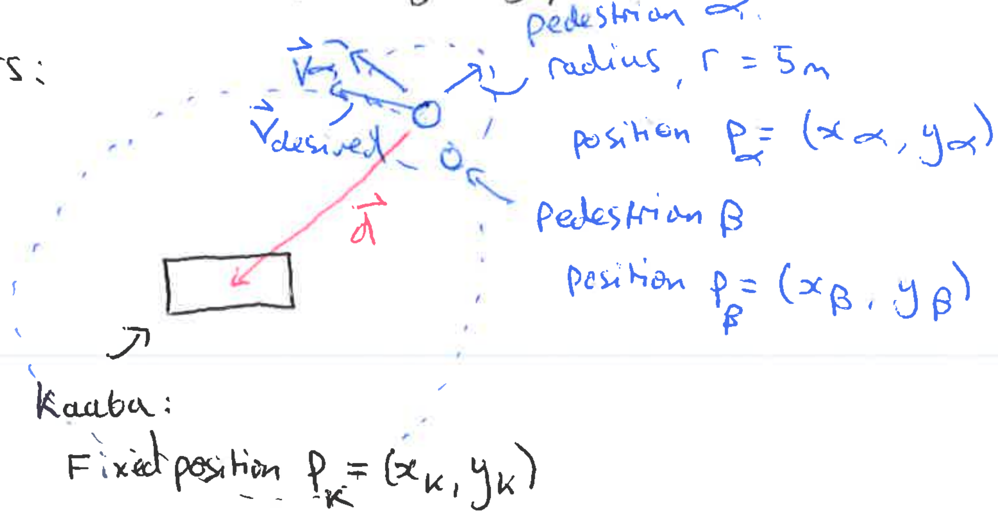
Following behaviours need to be added:

① The walking ~~speed~~ direction of each person should be circular around a central point, in a counter clockwise direction.

② If the local density around a pedestrian exceeds $6m^{-2}$ (measured with a 5-meter radius around that person), an additional social force will act upon that pedestrian away from the central point, in order to seek out a lower density environment

③ When a pedestrian has completed the seven laps, the person will change their walking direction to be tangentially away from the centre.

Diagram of behaviours:



For behaviours ① and ③ the desired velocity needs to be modified :

$$\vec{v}_{desired} = v^{o}_{\alpha} \, \vec{e}_{\alpha}$$

v^{o}_{α} is a constant and so isn't changed. Therefore $\vec{e}_{\alpha}$ must be changed. This is known as the pedestrian α's desired direction and is defined as follows to simulate behaviours ① and ③ :

$$\vec{e}_{\alpha} = \begin{cases} \dfrac{(d_j , -d_i)}{\|\vec{d}\|} & D_{\alpha} < D_{\text{seven Laps}, \alpha} \\ \dfrac{\vec{v}_{\alpha}}{\|\vec{v}_{\alpha}\|} & \text{Otherwise} \end{cases}$$

Where :

$$\vec{d} = (d_i , d_j) = \frac{p_k - p_{\alpha}}{\|p_k - p_{\alpha}\|}$$

And :

$$D_{\alpha} = \underset{(\text{Total over Simulation})}{\text{Distance covered by pedestrian}} = \sum_{i=1}^{t} v^{i}_{\alpha}(t)\, dt$$

$$D_{\text{seven Laps}, \alpha} = \underset{\text{to be complete (for each pedestrian } \alpha)}{\text{Distance to be covered for seven laps}} = 7 \left(2\pi \, \|\vec{d}\| \right)$$

For behaviour ②, the noise term should be edited to be the following:

$$\vec{\xi}_{\alpha}(t) = \begin{cases} \dfrac{(-d_i, -d_j)}{\|\vec{d}\|} & \rho^{\alpha}_{5\text{-metre}} > 6 \\ 0 & \text{otherwise} \end{cases}$$

where $\rho^{\alpha}_{5\text{-metre}}$ is the local density in a 5-metre radius around pedestrian α. This is calculated using the following equation:

$$\rho^{\alpha}_{5\text{-metre}} = \sum_{(\beta \neq \alpha)} \rho_{\alpha\beta}$$

where:

$$\rho_{\alpha\beta} = \begin{cases} 1 & \sqrt{(x_{\alpha} - x_{\beta})^2 + (y_{\alpha} - y_{\beta})^2} < 5 \\ 0 & \text{otherwise} \end{cases}$$