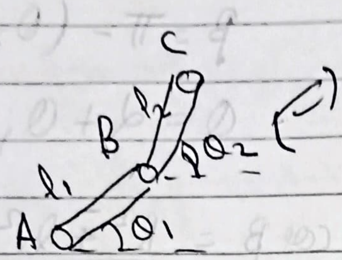


$B = (l_1 \cos\theta_1, l_1 \sin\theta_1)$

$C = (l_1 \cos\theta_1 + l_2 \cos\theta_2,$

$l_1 \sin\theta_1 + l_2 \sin\theta_2)$

Now, we have information θ_1, and θ_2 can only move by 1°

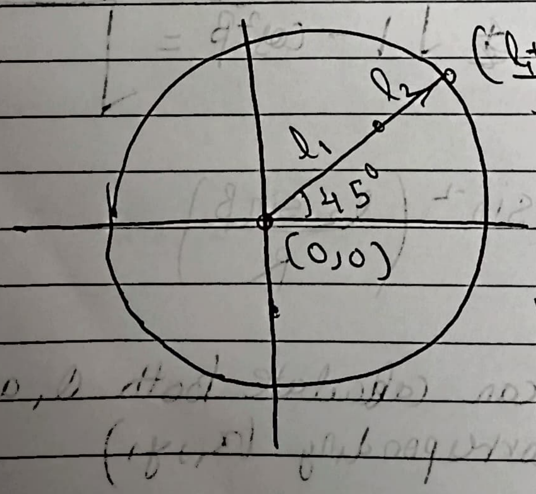
Moves = $[(0,1), (1,0), (1,1), (-1,0), (0,-1),$

$(-1,-1), (1,-1), (-1,1)]$

$\Rightarrow$ 8 possible moves

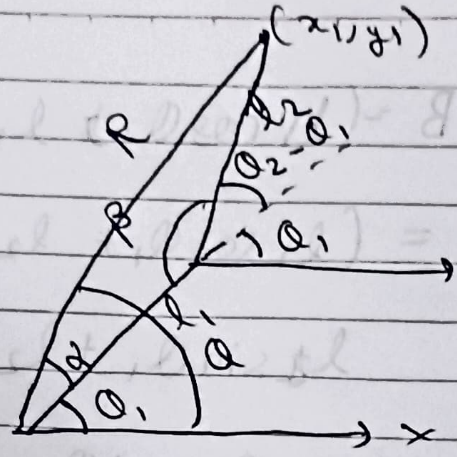
$\theta_1, \theta_2 \in [0, 2\pi]$

1) Some constraint is (x,y) cannot be greater than $\left(\frac{l_1+l_2}{\sqrt{2}}, \frac{l_1+l_2}{\sqrt{2}}\right)$ and if $l_1 > l_2$ then a circle $\left(\frac{l_1-l_2}{\sqrt{2}}, \frac{l_1-l_2}{\sqrt{2}}\right)$



$\left(\frac{l_1+l_2}{\sqrt{2}}, \frac{l_1+l_2}{\sqrt{2}}\right)$

gives a boundary point



$\beta = \pi - (\theta_2 - \theta_1)$

$\theta = \alpha + \theta_1$

$\cos\beta = \dfrac{R^2 \mp l_1^2 \mp l_2^2}{-2l_1l_2}$

$\cos(\theta_2 - \theta_1) = \dfrac{R^2 - l_1^2 - l_2^2}{2l_1l_2}$

$\theta_2 = \theta_1 + \cos^{-1}\left(\dfrac{R^2 - l_1^2 - l_2^2}{2l_1l_2}\right)$

By sine Rule,

$\dfrac{R}{\sin\beta} = \dfrac{l_2}{\sin\alpha} \Rightarrow \alpha = \sin^{-1}\left(\dfrac{l_2\sin\beta}{R}\right)$

$\therefore \theta_1 = \tan^{-1}\left(\dfrac{y_1}{x_1}\right) - \sin^{-1}\left(\dfrac{l_2\sin\beta}{R}\right)$

Now,

$R^2 = x_1^2 + y_1^2$

$\sin\beta = \pm\sqrt{1 - \cos^2\beta} = \sqrt{\quad}$

Put in $\sin^{-1}\left(\dfrac{l_2\sin\beta}{R}\right)$

Hence we can calculate both θ_1 and θ_2 for the corresponding (x_1, y_1)

Now for (x_2, y_2) we can do the same

We get θ_{1f} and θ_{2f}

Hence we have to just move from θ_1 to θ_{1f} and θ_2 to θ_{2f}

This makes the problem a simple problem of going from θ_1 to θ_{1f} and θ_2 to θ_{2f}

We have to move

θ_1 at $1°$ angle alone and θ_2 at $1°$ angle alone independent of each other till θ_{1f} and θ_{2f}

Possible moves are $\rightarrow$ successors

$(\theta_1 - 1°, \theta_2)$, $(\theta_1 + 1°, \theta_2)$, $(\theta_1 + 1°, \theta_2 + 1°)$
$(\theta_1 - 1°, \theta_2 + 1°)$, $(\theta_1 + 1°, \theta_2 - 1°)$ $(\theta_1 - 1°, \theta_2 - 1°)$
$(\theta_1, \theta_2 + 1°)$, $(\theta_1, \theta_2 - 1°)$

and constraint of $\theta_1 \rightarrow [0, 2\pi]$ and $\theta_2 \rightarrow [0, 2\pi]$

till the goal state of θ_{1f} and θ_{2f}

Part A: (θ_1, ϕ_1) to (x_2, y_2) anyhow

Algo:-

Find θ_1, θ_2 from x_1 and y_1 with help of R, α, β and l_1, l_2

$R^2 = x^2 + y^2$ and also θ_{1f} and θ_{2f} from x_2, y_2

$$\theta_2 = \theta_1 + \cos^{-1}\left(\frac{R^2 - l_1^2 - l_2^2}{2l_1l_2}\right)$$

$$\theta_1 = \tan^{-1}\left(\frac{y_1}{x_1}\right) - \sin^{-1}\left(\frac{l_2 \sin\beta}{R}\right)$$

$$\cos\beta = \frac{R^2 - l_1^2 - l_2^2}{-2l_1l_2} \Rightarrow \sin\beta = \sqrt{1-\cos^2\beta}$$

Now,
Perform dfs for finding successor with the possible move and go closer to goal state with the error of ~~going~~ abs $|\theta_{1new} - \theta_{1f}| + |\theta_{2new} - \theta_{2f}|$
$\Rightarrow$ This way we can find a optimal path by changing to θ_1 and θ_2 till it reach θ_{1f} and θ_{2f}

Part B: (x_1, y_1) to (x_2, y_2) in a straight line

Similar algorithm
Find θ_1, θ_2 and θ_{1f} and θ_{2f}

Now, perform dfs for finding successor with the possible move and go closer to goal state

DOMS Page No.
Date / /

but the constraint for lowest $|\theta_{1new} - \theta_{1f}| + |\theta_{2new} - \theta_{2f}|$ and add a constraint to ensure that it lies on the line of (x_1, y_1) and (x_2, y_2)

As we can make new x_{new}, y_{new}

$$\Rightarrow x_{new} = l_1 \cos\theta_{1new} + l_2 \cos\theta_{2new}$$
$$y_{new} = l_1 \sin\theta_{1new} + l_2 \sin\theta_{2new}$$

Make sure

$$\frac{x_{new} - x_1}{y_{new} - y_1} = \frac{x_2 - x_1}{y_2 - y_1}$$

if true then add to the optimal path

This way we will achieve optimal path at the end of the iteration