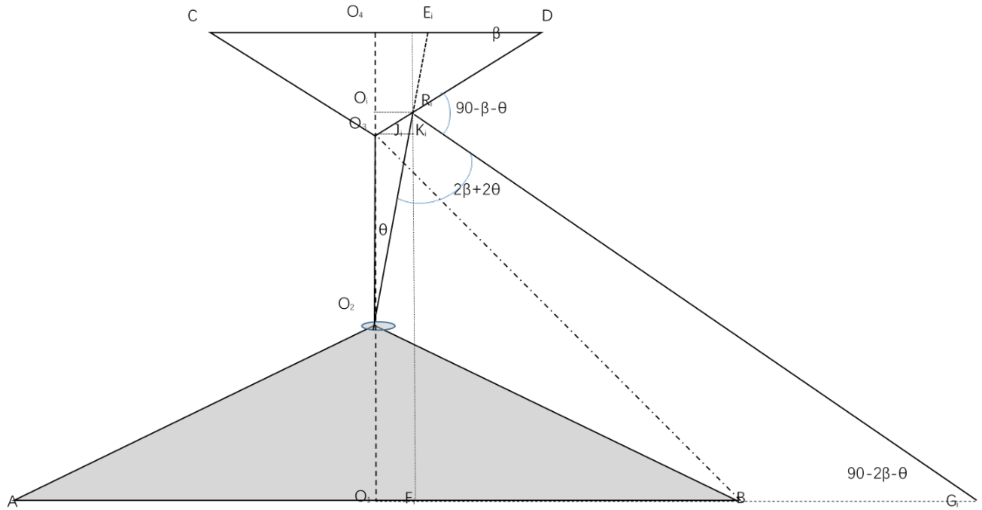


Any incident ray O_2R_1, strikingthe cone surface O_3D at point R_i, is reflected as R_iGi, reaching the ground at point G_i; Needs to calculate the length of O_1G_i:

$O_1G_i = \boldsymbol{O_1F_i + F_iG_i}$ (1)

$O_1F_i = O_iR_i = O_3J_i + J_iK_i = O_2O_3 \tan\theta + J_iK_i = \boldsymbol{O_2O_3 \tan\theta + R_iK_i \tan\theta}$ (2)

$R_iK_i = O_iO_3 = \boldsymbol{O_iR_i \tan\beta}$ (3)

(3) substituting into (2) gives: $O_iR_i = O_2O_3 \tan\theta + R_iK_i \tan\theta = \boldsymbol{O_2O_3 \tan\theta + O_iR_i \tan\beta \tan\theta}$ (4)

O_2O_3 is known, O_iR_i can be determined from equation (4): $O_iR_i = \boldsymbol{{O_2O_3 \tan\theta}/{1 - \tan\beta\tan\theta}}$ (5)

From (3) and (5), $R_iK_i = O_iR_i \tan\beta = \left({O_2O_3 \tan\theta}/{1 - \tan\beta\tan\theta}\right)\tan\beta = \boldsymbol{{O_2O_3 \tan\theta\tan\beta}/{1 - \tan\beta\tan\theta}}$ (6)

From $\Delta R_iF_iG_i$ we have $F_iG_i = R_iF_i \tan(90 - 2\beta - \theta) = (R_iK_i + K_iF_i)\tan(90 - 2\beta - \theta) = \boldsymbol{\left({O_2O_3 \tan\theta\tan\beta}/{1 - \tan\beta\tan\theta} + O_2O_3 + O_2O_1\right)\cot(2\beta + \theta)}$

(7)

$\boldsymbol{O_1G_i} = O_1F_i + F_iG_i = O_iR_i + F_iG_i = \left({O_2O_3 \tan\theta}/{1 - \tan\beta\tan\theta}\right) + \left({O_2O_3 \tan\theta\tan\beta}/{1 - \tan\beta\tan\theta} + O_2O_3 + O_2O_1\right)\cot(2\beta + \theta) =$

$O_2O_3\frac{\tan\theta(1+\tan\beta\cot(2\beta+\theta))}{1-\tan\beta\tan\theta} + (O_2O_3 + O_2O_1)\cot(2\beta + \theta) = \boldsymbol{O_2O_3\frac{\tan\theta(1+\tan\beta\cot(2\beta+\theta))}{1-\tan\beta\tan\theta} + (O_3O_1)\cot(2\beta + \theta)}$ **(8)**

From equation (8), it can be seen that O_1O_2 represents the height of the robot, O_2O_3 represents the height of the vertex of the panoramic conical mirror relative to the installation point, O_1O_3 represents the height of the vertex of the conical mirror, and β is the complementary angle of the cone angle of the conical mirror, all of which are known quantities. θ is the variable.

Along the horizontal y-direction (perpendicular to the optical axis), an obstacle located at G_i with the width G_iG_i' forms a circular image; the circle size corresponds to the radius O_iR_i associated with the incident angle θ in the previous figure. The image of the obstacle of width G_iG_i' is O_iO_i', whose magnitude is computed as follows:
The radial incident angle for the obstacle of width G_iG_i' is ϕ_i, which is computed as follows:

$$\varphi_i = \sin^{-1}\left({G_iG_i'}/{O_iR_i}\right) = \sin^{-1}\left(\boldsymbol{G_iG_i'}\Big/\left(\boldsymbol{O_2O_3\tan\theta}\big/\boldsymbol{1-\tan\beta\tan\theta}\right)\right) \quad (9)$$

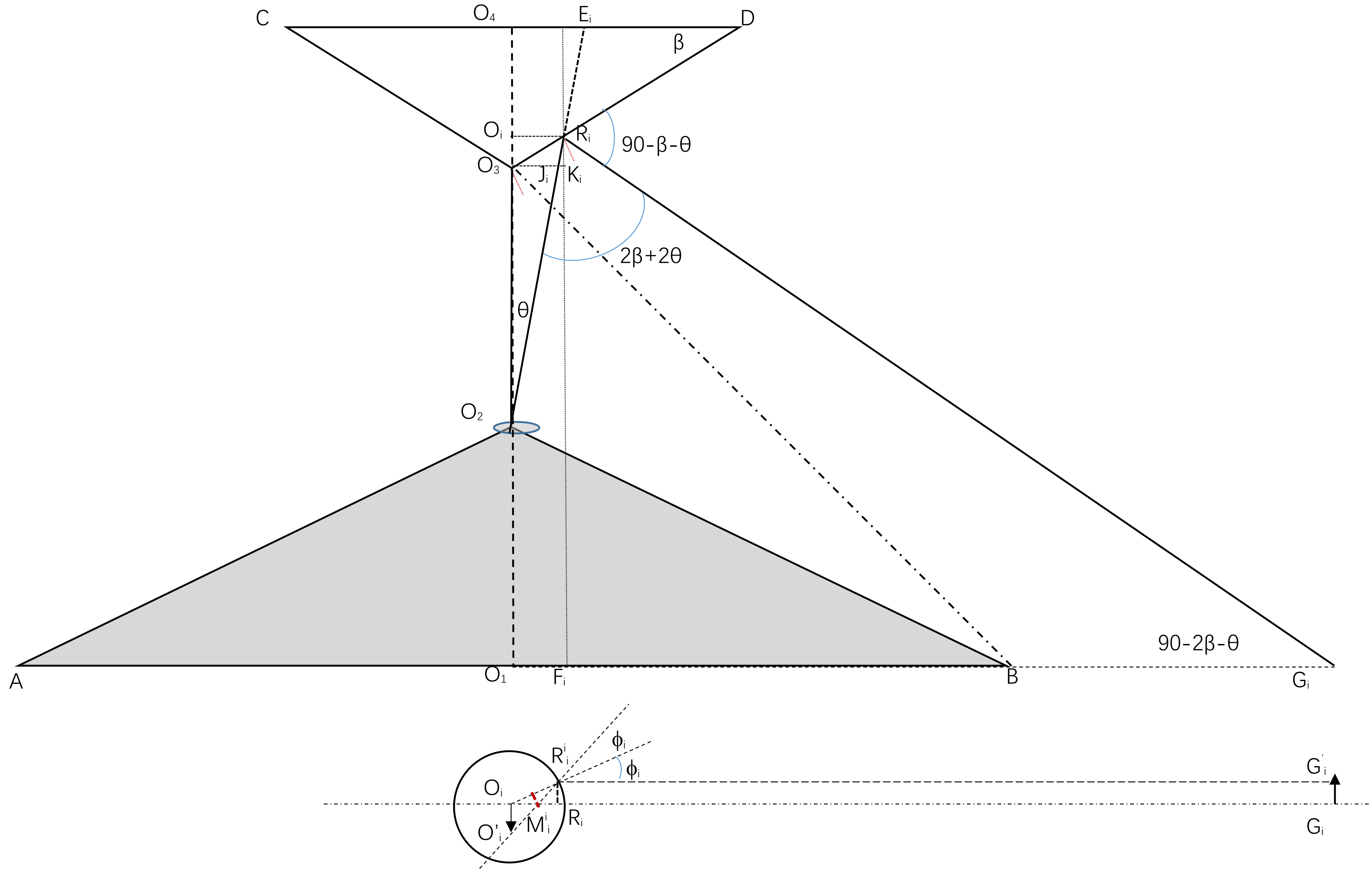
$$O_iO_i' = O_iM_i'\tan\Delta O_iM_i'O_i' = O_iM_i'\tan 2\varphi_i = \left(\frac{O_iR_i}{2}\Big/\cos\varphi_i\right)\tan 2\varphi_i = \left(\left(O_2O_3\tan\theta\big/1-\tan\beta\tan\theta\right)\Big/2\cos\varphi_i\right)\tan 2\varphi_i = \frac{\left(\boldsymbol{O_2O_3\tan\theta}/\boldsymbol{1-\tan\beta\tan\theta}\right)\boldsymbol{\tan 2\varphi_i}}{\boldsymbol{2\cos\varphi_i}} \quad (10)$$

$$O_iO_i' = \frac{\left(O_2O_3\tan\theta/1-\tan\beta\tan\theta\right)\tan 2\varphi_i}{2\cos\varphi_i} = \frac{\left(O_2O_3\tan\theta/1-\tan\beta\tan\theta\right)\sin 2\varphi_i}{2\cos\varphi_i\cos 2\varphi_i} = \frac{\left(O_2O_3\tan\theta/1-\tan\beta\tan\theta\right)2\sin\varphi_i\cos\varphi_i}{2\cos\varphi_i(1-2(\sin\varphi_i)^2)} = \frac{\left(\boldsymbol{O_2O_3\tan\theta}/\boldsymbol{1-\tan\beta\tan\theta}\right)\boldsymbol{\sin\varphi_i}}{\boldsymbol{(1-2(\sin\varphi_i)^2)}} \quad (11)$$

Substitute (9) into (11) gives

$$\boldsymbol{O_iO_i'} = \frac{\left(O_2O_3\tan\theta/1-\tan\beta\tan\theta\right)\sin\varphi_i}{(1-2(\sin\varphi_i)^2)} = \frac{\left(O_2O_3\tan\theta/1-\tan\beta\tan\theta\right)\left[G_iG_i'\Big/\left(O_2O_3\tan\theta/1-\tan\beta\tan\theta\right)\right]}{\left(1-2\left(G_iG_i'\Big/\left(O_2O_3\tan\theta/1-\tan\beta\tan\theta\right)\right)^2\right)} = \frac{\boldsymbol{G_iG_i'}}{\boldsymbol{1-2\left(\frac{G_iG_i'}{O_2O_3}\right)^2\left(\frac{1-\tan\beta\tan\theta}{\tan\theta}\right)^2}} \quad \textbf{(12)}$$

From equation (12), O_2O_3 represents the height of the vertex of the panoramic conical mirror relateive to its installation point, G_iG_i' represents the horizontal width of the obstacle, β is the complementary angle of the cone angle of the conical mirror; all of these are known quantities. θ is the variable. Thus for any direction θ, the conical image width of the obstacle with hirizontal width G_iG_i' is O_iO_i'.



C
O4
Ei
D
β
Oi
Ri
90-β-θ
O3
Ji
Ki
2β+2θ
θ
O2
90-2β-θ
A
O1
Fi
B
Gi
ϕi
Rii
ϕi
G'i
Oi
Ri
O'i
Mii
Gi