Supplementary document

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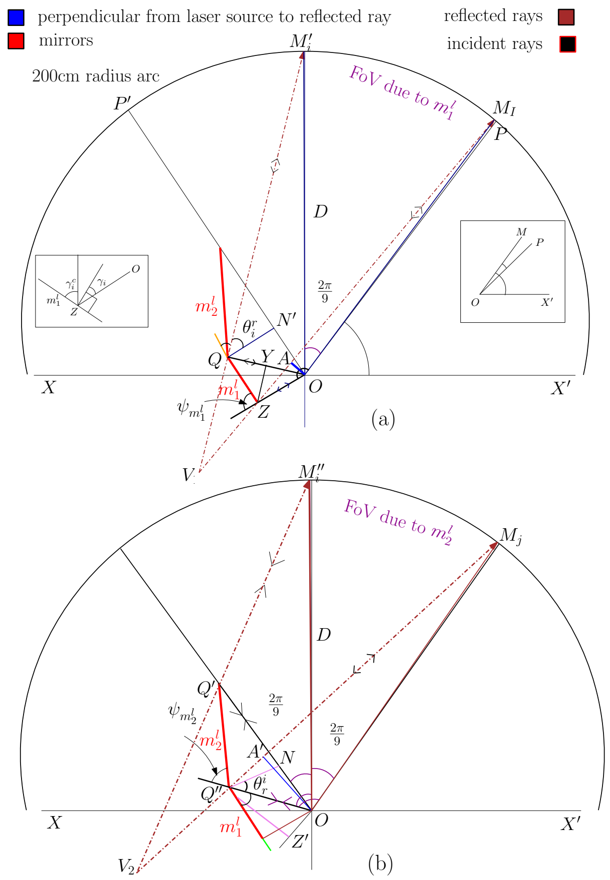

Figure 1: Geometry of the mirror configuration not to scale; for (a) $l1$ and. Zoomed-in views of the portions near the center O are provided for the betterment of understanding the geometry.

In $\triangle ZOM_I$, $\angle OM_IZ = \sin^{-1}(\frac{OA}{OM_I})$. Therefore, $\angle OZM_I = \pi - (\angle M_IOZ + \angle OM_IZ)$. Also, $OA = OZ \sin(\angle OZM_I)$. Again, for the I-th incident beam the angle of incidence $\gamma_I = \angle OZM_I/2$. To calculate α, we use the I-th beam. Then, $\alpha = \theta_I + \gamma_I$. Also, $\angle OQZ = \frac{\pi}{2} - \gamma_I - \angle QOZ)$. Now, based on the LIDAR's scan direction, the first beam to hit on $l1$ is OQ and due to the known bearings of the transmitted laser pulses, we can calculate $\angle QOZ = (\angle X'OZ - \angle X'OQ)$. At this point, a perpendicular YZ is drawn on OQ from Z. Then, from $\triangle OYZ$, $YZ = OZ \sin(\angle YOZ)$, $OY = \frac{YZ}{\tan(\angle YOZ)}$, and $YQ = \frac{YZ}{\tan(\angle OQZ)}$. Therefore, $L(l1) = |QZ| = \frac{YZ}{\sin(\angle YQZ)}$. The derivations shown above follows for the mirrors $l2$, and $r1$ and $r2$ and have been shown in the supplementary document. Then, we refer to Fig. 1b, for deriving the parameters relevant to $l2$. The last beam to hit mirror $l2$ is OQ'', which is the immediate previous one to the beam OQ hitting on $l1$. The first beam hitting on $l2$ is OQ'. A similar approach can be adapted to calculate the length $L(l2)$ and orientation ϕ_{l2} of $l2$. The derivations shown above follows for the mirrors $r1$ and $r2$ in the same manner. As the sensor provides range and bearing information, given a reflected range measurement corresponding to a bearing angle, we can calculate the actual orientation of the measured point.