AM-Align Supplemental Material

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$$
\boldsymbol{R}^{\mathrm{a}}_{\mathrm{m,true}} = \begin{pmatrix} 0.8698 & 0.2063 & 0.4483 \\ -0.2507 & 0.9672 & 0.04127 \\ -0.4251 & -0.1483 & 0.8929 \end{pmatrix}
$$

with $\cos\theta_{\mathrm{true}} = 0.861311153421915$, which denotes a position in the Northern hemisphere. The normalized accelerometer and magnetometer measurement pairs are simulated using model

$$
\boldsymbol{a}^{\mathrm{b}} = \boldsymbol{R}\boldsymbol{a}^{\mathrm{r}}, \quad \boldsymbol{m}^{\mathrm{b}} = \boldsymbol{R}\boldsymbol{m}^{\mathrm{r}} \tag{1}
$$

with the noise level of $\gamma = 10^{-3}$ for accelerometer with a unit of $\mathrm{m/sec^2}$ and for magnetometer with a unit of Gauss, as follows

$$
\begin{aligned}
\boldsymbol{a}^{\mathrm{b}}_1 &= (-0.32646898, 0.93167874, 0.15935094)^\top \\
\boldsymbol{a}^{\mathrm{b}}_2 &= (0.94024823, -0.24908176, 0.23214553)^\top \\
\boldsymbol{a}^{\mathrm{b}}_3 &= (-0.078698444, -0.040278934, -0.99608442)^\top \\
\boldsymbol{a}^{\mathrm{b}}_4 &= (-0.30214477, -0.55269862, -0.77668061)^\top \\
\boldsymbol{m}^{\mathrm{b}}_1 &= (-0.26457266, 0.88781747, -0.37653877)^\top \\
\boldsymbol{m}^{\mathrm{b}}_2 &= (0.56789277, 0.39065359, 0.72449125)^\top \\
\boldsymbol{m}^{\mathrm{b}}_3 &= (0.15855473, -0.39080406, -0.90671527)^\top \\
\boldsymbol{m}^{\mathrm{b}}_4 &= (0.12203279, 0.018472239, -0.99235416)^\top
\end{aligned}
$$

with which we construct the optimization kernel and is later solved using AM-Align.

The proposed algorithm returns 6 pairs of distinct real solutions:

$$
\boldsymbol{R}^{\mathrm{a}}_{\mathrm{m},1} = \begin{pmatrix} -0.4789 & 0.1937 & 0.8562 \\ 0.8354 & 0.4001 & 0.3768 \\ -0.2696 & 0.8958 & -0.3534 \end{pmatrix}, \cos\theta_1 = 0.1598
$$

$$
\boldsymbol{R}^{\mathrm{a}}_{\mathrm{m},2} = \begin{pmatrix} 0.8685 & 0.2078 & 0.4499 \\ -0.2523 & 0.9668 & 0.0405 \\ -0.4266 & -0.1486 & 0.8921 \end{pmatrix}, \cos\theta_2 = 0.8612
$$

$$
\boldsymbol{R}^{\mathrm{a}}_{\mathrm{m},3} = \begin{pmatrix} -0.9555 & -0.0186 & 0.2944 \\ -0.2707 & -0.3416 & -0.9000 \\ 0.1173 & -0.9397 & 0.3214 \end{pmatrix}, \cos\theta_3 = -0.0982
$$

$$
\boldsymbol{R}^{\mathrm{a}}_{\mathrm{m},4} = \begin{pmatrix} -0.0534 & 0.4665 & -0.8829 \\ 0.9372 & -0.2818 & -0.2056 \\ -0.3447 & -0.8384 & -0.4222 \end{pmatrix}, \cos\theta_4 = -0.7191
$$

$$
\boldsymbol{R}^{\mathrm{a}}_{\mathrm{m},5} = \begin{pmatrix} 0.5082 & -0.5002 & -0.7011 \\ -0.4606 & -0.8457 & 0.2694 \\ -0.7277 & 0.1860 & -0.6602 \end{pmatrix}, \cos\theta_5 = -0.4812
$$

$$
\boldsymbol{R}^{\mathrm{a}}_{\mathrm{m},6} = \begin{pmatrix} -0.8918 & -0.3134 & 0.3264 \\ -0.1718 & -0.4328 & -0.8850 \\ 0.4186 & -0.8453 & 0.3321 \end{pmatrix}, \cos\theta_6 = -0.1084
$$