$$\begin{aligned}
(x-a_1)^2+(y-a_2)^2+(z-a_3)^2 &= a_4^2\\
(x-b_1)^2+(y-b_2)^2+(z-b_3)^2 &= b_4^2\\
(x-c_1)^2+(y-c_2)^2+(z-c_3)^2 &= c_4^2\\
(x-d_1)^2+(y-d_2)^2+(z-d_3)^2 &= d_4^2
\end{aligned} \tag{1}$$

$$\begin{aligned}
x^2-2a_1x+y^2-2a_2y+z^2-2a_3z+a_1^2+a_2^2+a_3^2-a_4^2 &= 0\\
x^2-2b_1x+y^2-2b_2y+z^2-2b_3z+b_1^2+b_2^2+b_3^2-b_4^2 &= 0\\
x^2-2c_1x+y^2-2c_2y+z^2-2c_3z+c_1^2+c_2^2+c_3^2-c_4^2 &= 0\\
x^2-2d_1x+y^2-2d_2y+z^2-2d_3z+d_1^2+d_2^2+d_3^2-d_4^2 &= 0
\end{aligned} \tag{2}$$

$$\begin{aligned}
(2b_1-2a_1)x+(2b_2-2a_2)y+(2b_3-2a_3)z+(a_1^2+a_2^2+a_3^2-a_4^2)-(b_1^2+b_2^2+b_3^2-b_4^2) &= 0\\
(2c_1-2b_1)x+(2c_2-2b_2)y+(2c_3-2b_3)z+(b_1^2+b_2^2+b_3^2-b_4^2)-(c_1^2+c_2^2+c_3^2-c_4^2) &= 0\\
(2d_1-2c_1)x+(2d_2-2c_2)y+(2d_3-2c_3)z+(c_1^2+c_2^2+c_3^2-c_4^2)-(d_1^2+d_2^2+d_3^2-d_4^2) &= 0
\end{aligned} \tag{3}$$

Let
$p=(a_1^2+a_2^2+a_3^2-a_4^2)-(b_1^2+b_2^2+b_3^2-b_4^2)$,
$q=(b_1^2+b_2^2+b_3^2-b_4^2)-(c_1^2+c_2^2+c_3^2-c_4^2)$,
$r=(c_1^2+c_2^2+c_3^2-c_4^2)-(d_1^2+d_2^2+d_3^2-d_4^2)$,

$$\begin{bmatrix}(2b_1-2a_1) & (2b_2-2a_2) & (2b_3-2a_3)\\ (2c_1-2b_1) & (2c_2-2b_2) & (2c_3-2b_3)\\ (2d_1-2c_1) & (2d_2-2c_2) & (2d_3-2c_3)\end{bmatrix}\cdot\begin{bmatrix}x\\y\\z\end{bmatrix}=\begin{bmatrix}-p\\-q\\-r\end{bmatrix} \tag{4}$$

Let
$A=\begin{bmatrix}(2b_1-2a_1) & (2b_2-2a_2) & (2b_3-2a_3)\\ (2c_1-2b_1) & (2c_2-2b_2) & (2c_3-2b_3)\\ (2d_1-2c_1) & (2d_2-2c_2) & (2d_3-2c_3)\end{bmatrix}$
Least square estimate of

$$\begin{bmatrix}x\\y\\z\end{bmatrix}=(A'\cdot A)^{-1}\cdot A\begin{bmatrix}-p\\-q\\-r\end{bmatrix} \tag{5}$$