b) LIQUIDS – PARTICLE MODELS

TOTAL FORCE: $g_i(t) = \sum_{j \neq i} g_{ij}(t)$

$$g_{ij}(t) = m_i m_j (x_i - x_j)\left[-\frac{\alpha}{(r_{ij}+\delta^*)^a} + \frac{\beta}{(r_{ij})^b}\right] \qquad a=2,\ b=4$$

α & β DETERMINE STRENGTH OF ATTRACTION & REPULSION FORCES

δ – SEPARATION $r_{ij} = \|x_j - x_i\|$

c) CLOTH – VISCOELASTICITY – MASS-SPRINGS MODEL

$$m_i \ddot{x}_i + \gamma_i \dot{x}_i + c_{ij} r_{ij} = f_i$$
$$m_j \ddot{x}_j + \gamma_j \dot{x}_j - c_{ij} r_{ij} = f_j$$
$$c_{ij}(x_i, x_j) = \frac{k_{ij} e_{ij} + \gamma_{ij} \dot{e}_{ij}}{\|r_{ij}\|}$$

$$\begin{bmatrix} m_i & 0 \\ 0 & m_j \end{bmatrix}\begin{bmatrix} \ddot{x}_i \\ \ddot{x}_j \end{bmatrix} + \begin{bmatrix} \gamma_i & 0 \\ 0 & \gamma_j \end{bmatrix}\begin{bmatrix} \dot{x}_i \\ \dot{x}_j \end{bmatrix} + \begin{bmatrix} -c_{ij} & c_{ij} \\ c_{ij} & -c_{ij} \end{bmatrix}\begin{bmatrix} x_i \\ x_j \end{bmatrix}$$

$$M\ddot{x} + G\dot{x} + K(x)x = f$$

4. EYE POSITION: $(2,10,3)^T$, LOOK AT PT $(-2,2,0)^T$, UP VECTOR $(-1,-1,0)^T$

$$k = \frac{P_{eye} - P_{ref}}{|P_{eye} - P_{ref}|} = \frac{(2,10,3)^T - (-2,2,0)^T}{|(2,10,3)^T - (-2,2,0)^T|} = \frac{(4,8,3)^T}{|(4,8,3)^T|}$$

$$\boxed{k = \frac{1}{\sqrt{89}}(4,8,3)^T}$$

$$i = \frac{v_{up} \times k}{|v_{up} \times k|} \qquad v_{up} \times k = \begin{vmatrix} i & j & k \\ -1 & -1 & 0 \\ \frac{1}{\sqrt{89}}\cdot 4 & 8 & 3 \end{vmatrix} = (-3-0)i - (-3-0)j + (-8+4)k$$

$$v_{up} \times k = \frac{1}{\sqrt{89}}(-3, +3, -4)^T$$

$$|v_{up} \times k| = \frac{9}{89} + \frac{9}{89} + \frac{16}{89} = \sqrt{\frac{34}{89}}$$

$$\boxed{i = \frac{(-3,+3,-4)^T}{\sqrt{34}}}$$

$$j = k \times i = \begin{vmatrix} i & j & k \\ 4 & 8 & 3 \\ -3 & +3 & -4 \end{vmatrix} \cdot \frac{1}{\sqrt{89}}\frac{1}{\sqrt{34}} = \frac{1}{\sqrt{89}\sqrt{34}}\left[(-32-9)i - (-16+9)j + (+12+24)k\right]$$

$$\boxed{j = \frac{(-41, 7, 36)^T}{\sqrt{89}\cdot\sqrt{34}}}$$

$$M_{cam}^{-1} = \begin{bmatrix} i_x & i_y & i_z & 0 \\ j_x & j_y & j_z & 0 \\ k_x & k_y & k_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 & -P_{eye_x} \\ 0 & 1 & 0 & -P_{eye_y} \\ 0 & 0 & 1 & -P_{eye_z} \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} \frac{-3}{\sqrt{34}} & \frac{3}{\sqrt{34}} & \frac{-4}{\sqrt{34}} & 0 \\ \frac{-41}{\sqrt{3026}} & \frac{7}{\sqrt{3026}} & \frac{36}{\sqrt{3026}} & 0 \\ 4/\sqrt{89} & 8/\sqrt{89} & 3/\sqrt{89} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\times \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 10 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} -0.51 & 0.51 & -0.69 & -2.1 \\ -0.75 & 0.13 & 0.65 & -1.75 \\ 0.42 & 0.85 & 0.32 & -10.28 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$