THE ACCELERATION ANALYSIS STARTS BY TAKING THE DERIVATIVE OF (26)

$$r_2\cdot\ddot{\theta}_2\cdot\hat{e}_{\theta 2} - r_2\cdot\dot{\theta}_2^2\cdot\hat{e}_{r2} + \ddot{r}_3\cdot\hat{e}_{r3} + \dot{r}_3\cdot\dot{\theta}_3\cdot\hat{e}_{\theta 3} + \dot{r}_3\cdot\dot{\theta}_3\cdot\hat{e}_{\theta 3} + r_3\cdot\ddot{\theta}_3\cdot\hat{e}_{\theta 3} - r_3\cdot\dot{\theta}_3^2\cdot\hat{e}_{r3} = r_4\cdot\ddot{\theta}_4\cdot\hat{e}_{\theta 4} - r_4\cdot\dot{\theta}_4^2\cdot\hat{e}_{r4} \quad (33)$$

FROM TAKING THE DERIVATIVE OF (27)

$$\ddot{\theta}_4 = \ddot{\theta}_3 \quad (34)$$

SUBSTITUTING (27) AND (34) INTO (33)

$$r_2\cdot\ddot{\theta}_2\cdot\hat{e}_{\theta 2} - r_2\cdot\dot{\theta}_2^2\cdot\hat{e}_{r2} + \ddot{r}_3\cdot\hat{e}_{r3} + 2\cdot\dot{r}_3\cdot\dot{\theta}_3\cdot\hat{e}_{\theta 3} + r_3\cdot\ddot{\theta}_3\cdot\hat{e}_{\theta 3} - r_3\cdot\dot{\theta}_3^2\cdot\hat{e}_{r3} = r_4\cdot\ddot{\theta}_3\cdot\hat{e}_{\theta 4} - r_4\cdot\dot{\theta}_3^2\cdot\hat{e}_{r4} \quad (35)$$

IN (35) THE ONLY TWO UNKNOWNS ARE $\ddot{r}_3$ AND $\ddot{\theta}_3$. SINCE (35) IS A VECTOR EQUATION FOR A PLANER SYSTEM, IT REPRESENTS TWO EQUATIONS. THE SOLUTION FOR THE TWO UNKNOWNS STARTS BY COMBINING TERMS IN (35)

$$r_2\cdot\ddot{\theta}_2\cdot\hat{e}_{\theta 2} - r_2\cdot\dot{\theta}_2^2\cdot\hat{e}_{r2} + \underline{\underline{\ddot{r}_3}}\cdot\hat{e}_{r3} + 2\cdot\dot{r}_3\cdot\dot{\theta}_3\cdot\hat{e}_{\theta 3} + \underline{\underline{\ddot{\theta}_3}}\cdot(r_3\cdot\hat{e}_{\theta 3} - r_4\cdot\hat{e}_{\theta 4}) - r_3\cdot\dot{\theta}_3^2\cdot\hat{e}_{r3} + r_4\cdot\dot{\theta}_3^2\cdot\hat{e}_{r4} = 0 \quad (36)$$

DOTTING (36) WITH $\hat{\imath}$

$$-r_2\cdot\ddot{\theta}_2\cdot\sin\theta_2 - r_2\cdot\dot{\theta}_2^2\cdot\cos\theta_2 + \ddot{r}_3\cdot\cos\theta_3 - 2\cdot\dot{r}_3\cdot\dot{\theta}_3\cdot\sin\theta_3 - \ddot{\theta}_3\cdot(r_3\cdot\sin\theta_3 - r_4\cdot\sin\theta_4) - r_3\cdot\dot{\theta}_3^2\cdot\cos\theta_3 + r_4\dot{\theta}_3^2\cos\theta_4 = 0$$

SOLVING FOR $\ddot{r}_3$

$$\boxed{\ddot{r}_3 = \frac{r_2\cdot\ddot{\theta}_2\cdot\sin\theta_2 + r_2\cdot\dot{\theta}_2^2\cdot\cos\theta_2 + 2\cdot\dot{r}_3\cdot\dot{\theta}_3\cdot\sin\theta_3 + \ddot{\theta}_3\cdot(r_3\cdot\sin\theta_3 - r_4\cdot\sin\theta_4) + r_3\cdot\dot{\theta}_3^2\cdot\cos\theta_3 - r_4\cdot\dot{\theta}_3^2\cdot\cos\theta_4}{\cos\theta_3}} \quad (37)$$

DOTTING (36) WITH $\hat{\jmath}$

$$r_2\cdot\ddot{\theta}_2\cdot\cos\theta_2 - r_2\cdot\dot{\theta}_2^2\cdot\sin\theta_2 + \underline{\underline{\ddot{r}_3}}\cdot\sin\theta_3 + 2\cdot\dot{r}_3\cdot\dot{\theta}_3\cdot\cos\theta_3 + \ddot{\theta}_3\cdot(r_3\cdot\cos\theta_3 - r_4\cdot\cos\theta_4) - r_3\cdot\dot{\theta}_3^2\cdot\sin\theta_3 + r_4\cdot\dot{\theta}_3^2\cdot\sin\theta_4 = 0 \quad (38)$$

SUBSTITUTING (37) INTO (38)

$$r_2\cdot\ddot{\theta}_2\cdot\cos\theta_2\cdot\cos\theta_3 - r_2\cdot\dot{\theta}_2^2\cdot\sin\theta_2\cdot\cos\theta_3 + r_2\cdot\ddot{\theta}_2\cdot\sin\theta_2\cdot\sin\theta_3 + r_2\cdot\dot{\theta}_2^2\cdot\cos\theta_2\cdot\sin\theta_3 + 2\cdot\dot{r}_3\cdot\dot{\theta}_3\cdot\sin^2\theta_3$$
$$+ r_3\cdot\ddot{\theta}_3\cdot\sin^2\theta_3 - r_4\cdot\ddot{\theta}_3\cdot\sin\theta_3\cdot\sin\theta_4 + r_3\cdot\dot{\theta}_3^2\cdot\cos\theta_3\cdot\sin\theta_3 - r_4\cdot\dot{\theta}_3^2\cdot\cos\theta_4\cdot\sin\theta_3 + 2\cdot\dot{r}_3\cdot\dot{\theta}_3\cdot\cos^2\theta_3$$
$$+ r_3\cdot\ddot{\theta}_3\cos\theta_3\cos\theta_3 - r_4\cdot\ddot{\theta}_3\cos\theta_3\cdot\cos\theta_4 - r_3\cdot\dot{\theta}_3^2\cdot\sin\theta_3\cdot\cos\theta_3 + r_4\cdot\dot{\theta}_3^2\cdot\sin\theta_4\cdot\cos\theta_3 = 0$$

$$r_2\cdot\ddot{\theta}_2\left(\cos\theta_3\cdot\cos\theta_2 + \sin\theta_3\cdot\sin\theta_2\right) + r_2\cdot\dot{\theta}_2^2\left(\sin\theta_3\cdot\cos\theta_2 - \cos\theta_3\cdot\sin\theta_2\right) + 2\cdot\dot{r}_3\cdot\dot{\theta}_3\left(\sin^2\theta_3 + \cos^2\theta_3\right)$$
$$+ r_3\cdot\ddot{\theta}_3\cdot\left(\sin^2\theta_3 + \cos^2\theta_3\right) - r_4\cdot\ddot{\theta}_3\cdot\left(\cos\theta_3\cdot\cos\theta_4 + \sin\theta_3\cdot\sin\theta_4\right) + r_3\cdot\dot{\theta}_3^2\cdot\left(\sin\theta_3\cdot\cos\theta_3 - \cos\theta_3\cdot\sin\theta_3\right)$$
$$- r_4\cdot\dot{\theta}_3^2\left(\sin\theta_3\cdot\cos\theta_4 - \cos\theta_3\cdot\sin\theta_4\right) = 0$$

$$r_2\cdot\ddot{\theta}_2\cdot\cos(\theta_3-\theta_2) + r_2\cdot\dot{\theta}_2^2\cdot\sin(\theta_3-\theta_2) + 2\cdot\dot{r}_3\cdot\dot{\theta}_3 + r_3\cdot\ddot{\theta}_3 - r_4\cdot\ddot{\theta}_3\cos(\theta_3-\theta_4) + r_3\cdot\dot{\theta}_3^2(0) - r_4\cdot\dot{\theta}_3^2\cdot\sin(\theta_3-\theta_4) = 0$$

$$r_2\cdot\ddot{\theta}_2\cdot\cos(\theta_3-\theta_2) + r_2\cdot\dot{\theta}_2^2\cdot\sin(\theta_3-\theta_2) + 2\cdot\dot{r}_3\cdot\dot{\theta}_3 + [r_3 - r_4\cdot\cos(\theta_3-\theta_4)\cdot\ddot{\theta}_3 - r_4\cdot\dot{\theta}_3^2\cdot\sin(\theta_3-\theta_4) = 0$$

$$\boxed{\ddot{\theta}_3 = -\frac{r_2\cdot\ddot{\theta}_2\cdot\cos(\theta_3-\theta_2) + r_2\cdot\dot{\theta}_2^2\cdot\sin(\theta_3-\theta_2) + 2\cdot\dot{r}_3\cdot\dot{\theta}_3 - r_4\cdot\dot{\theta}_3^2\cdot\sin(\theta_3-\theta_4)}{r_3 - r_4\cdot\cos(\theta_3-\theta_4)}}$$