페이지	현재	수정
55	벡터 p-norm	p-norm
90	그림 2.27	그림 2.27에서 a와 n을 서로 교체
106	모든 조인트에서 대해	모든 조인트에 대해
136	그림 3.11	그림 3.11에서 a와 s를 서로 교체
154	그림 3.23에서	그림 3.24에서
160	오리엔테이션 정보가 있어야 역기구학을 풀 수 있음을 알 수 있다.	오리엔테이션 정보를 통해 역기구학을 풀었다.
200	식 (4.7)로 부터	식 (4.14)로 부터
250	U는 포텐셜 에너지	P는 포텐셜 에너지
267	벡터 r_i^i $P_i = -m\overline{g^T}\overline{\boldsymbol{r_i^i}}$ $= -m\overline{g^T}A_0^i\overline{\boldsymbol{r_i^i}}$ $P_i = -\sum_{i=1}^n m_i\overline{g^T}A_0^i\overline{\boldsymbol{r_i^i}}$ $L = K - P$ $= \sum_{i=1}^n K_i = \frac{1}{2}\sum_{i=1}^n Trace[\sum_{j=1}^i\sum_{k=1}^i \frac{\partial A_0^i}{\partial q_j} I_i \frac{\partial A_0^{i^T}}{\partial q_k}\dot{q}_j\dot{q}_k] + \sum_{i=1}^n m_i g^T A_0^i\overline{\boldsymbol{r_i^i}}$ $= \frac{1}{2}\sum_{i=1}^n\sum_{j=1}^i\sum_{k=1}^i [Trace(\frac{\partial A_0^i}{\partial q_j} I_i \frac{\partial A_0^{i^T}}{\partial q_k})\dot{q}_j\dot{q}_k] + \sum_{i=1}^n m_i g^T A_0^i\overline{\boldsymbol{r_i^i}}$	무게 중심 거리 벡터 $\overline{\boldsymbol{r_i^i}}$ $P_i = -m\overline{\boldsymbol{g}^T}\overline{\boldsymbol{r_i^i}}$ $= -m\overline{\boldsymbol{g}^T}A_0^i\overline{\boldsymbol{r_i^i}}$ $P_i = -\sum_{i=1}^n m_i\overline{\boldsymbol{g}^T}A_0^i\overline{\boldsymbol{r_i^i}}$ $L = K - P$ $= \sum_{i=1}^n K_i = \frac{1}{2}\sum_{i=1}^n Trace[\sum_{j=1}^i\sum_{k=1}^i \frac{\partial A_0^i}{\partial q_j} I_i \frac{\partial A_0^{i^T}}{\partial q_k}\dot{q}_j\dot{q}_k] + \sum_{i=1}^n m_i\overline{\boldsymbol{g}^T}A_0^i\overline{\boldsymbol{r_i^i}}$ $= \frac{1}{2}\sum_{i=1}^n\sum_{j=1}^i\sum_{k=1}^i [Trace(\frac{\partial A_0^i}{\partial q_j} I_i \frac{\partial A_0^{i^T}}{\partial q_k})\dot{q}_j\dot{q}_k] + \sum_{i=1}^n m_i\overline{\boldsymbol{g}^T}A_0^i\overline{\boldsymbol{r_i^i}}$
269	$\frac{\partial L}{\partial q_p} = \frac{1}{2}\sum_{i=p}^n\sum_{j=1}^i\sum_{k=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_j\partial q_p} I_i \frac{\partial A_0^{i^T}}{\partial q_k}]\dot{q}_j\dot{q}_k$ $+\sum_{i=p}^n\sum_{j=1}^i\sum_{k=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_k\partial q_p} I_i \frac{\partial A_0^{i^T}}{\partial q_j}]\dot{q}_j\dot{q}_k$ $+\sum_{i=p}^n m_i g^T \frac{\partial A_0^i}{\partial q_p}\bar{r}_i^i$ $\frac{\partial L}{\partial q_p} = \sum_{i=p}^n\sum_{j=1}^i\sum_{k=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_j\partial q_p} I_i \frac{\partial A_0^{i^T}}{\partial q_k}]\dot{q}_j\dot{q}_k + \sum_{i=p}^n m_i g^T \frac{\partial A_0^i}{\partial q_p}\overline{\boldsymbol{r_i^i}}$ $\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_p} - \frac{\partial L}{\partial q_p} = \sum_{i=p}^n\sum_{k=1}^i Trace[\frac{\partial A_0^i}{\partial q_k} I_i \frac{\partial A_0^{i^T}}{\partial q_p}]\ddot{q}_k$ $+\sum_{i=p}^n\sum_{k=1}^i\sum_{m=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_k\partial q_m} I_i \frac{\partial A_0^{i^T}}{\partial q_p}]\dot{q}_k\dot{q}_m$ $+\sum_{i=p}^n\sum_{k=1}^i\sum_{m=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_p\partial q_m} I_i \frac{\partial A_0^{i^T}}{\partial q_k}]\dot{q}_k\dot{q}_m$ $-\sum_{i=p}^n\sum_{j=1}^i\sum_{k=1}^i Trace[\frac{\partial^2 A_i}{\partial q_p\partial q_j} I_i \frac{\partial A_0^{i^T}}{\partial q_k}]\dot{q}_j\dot{q}_k$ $-\sum_{i=p}^n m_i g^T \frac{\partial A_0^i}{\partial q_p}\overline{\boldsymbol{r_i^i}}$ $\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_p} - \frac{\partial L}{\partial q_p} = \sum_{i=p}^n\sum_{k=1}^i Trace[\frac{\partial A_0^i}{\partial q_k} I_i \frac{\partial A_0^{i^T}}{\partial q_p}]\ddot{q}_k$ $+\sum_{i=p}^n\sum_{k=1}^i\sum_{m=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_k\partial q_m} I_i \frac{\partial A_0^{i^T}}{\partial q_p}]\dot{q}_k\dot{q}_m - \sum_{i=p}^n m_i g^T \frac{\partial A_0^i}{\partial q_p}\overline{\boldsymbol{r_i^i}}$	$\frac{\partial L}{\partial q_p} = \frac{1}{2}\sum_{i=p}^n\sum_{j=1}^i\sum_{k=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_j\partial q_p} I_i \frac{\partial A_0^{i^T}}{\partial q_k}]\dot{q}_j\dot{q}_k$ $+\sum_{i=p}^n\sum_{j=1}^i\sum_{k=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_k\partial q_p} I_i \frac{\partial A_0^{i^T}}{\partial q_j}]\dot{q}_j\dot{q}_k$ $+\sum_{i=p}^n m_i\overline{\boldsymbol{g}^T}\frac{\partial A_0^i}{\partial q_p}\bar{r}_i^i$ $\frac{\partial L}{\partial q_p} = \sum_{i=p}^n\sum_{j=1}^i\sum_{k=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_j\partial q_p} I_i \frac{\partial A_0^{i^T}}{\partial q_k}]\dot{q}_j\dot{q}_k + \sum_{i=p}^n m_i\overline{\boldsymbol{g}^T}\frac{\partial A_0^i}{\partial q_p}\overline{\boldsymbol{r_i^i}}$ $\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_p} - \frac{\partial L}{\partial q_p} = \sum_{i=p}^n\sum_{k=1}^i Trace[\frac{\partial A_0^i}{\partial q_k} I_i \frac{\partial A_0^{i^T}}{\partial q_p}]\ddot{q}_k$ $+\sum_{i=p}^n\sum_{k=1}^i\sum_{m=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_k\partial q_m} I_i \frac{\partial A_0^{i^T}}{\partial q_p}]\dot{q}_k\dot{q}_m$ $+\sum_{i=p}^n\sum_{k=1}^i\sum_{m=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_p\partial q_m} I_i \frac{\partial A_0^{i^T}}{\partial q_k}]\dot{q}_k\dot{q}_m$ $-\sum_{i=p}^n\sum_{j=1}^i\sum_{k=1}^i Trace[\frac{\partial^2 A_i}{\partial q_p\partial q_j} I_i \frac{\partial A_0^{i^T}}{\partial q_k}]\dot{q}_j\dot{q}_k$ $-\sum_{i=p}^n m_i\overline{\boldsymbol{g}^T}\frac{\partial A_0^i}{\partial q_p}\overline{\boldsymbol{r_i^i}}$ $\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_p} - \frac{\partial L}{\partial q_p} = \sum_{i=p}^n\sum_{k=1}^i Trace[\frac{\partial A_0^i}{\partial q_k} I_i \frac{\partial A_0^{i^T}}{\partial q_p}]\ddot{q}_k$ $+\sum_{i=p}^n\sum_{k=1}^i\sum_{m=1}^i Trace[\frac{\partial^2 A_0^i}{\partial q_k\partial q_m} I_i \frac{\partial A_0^{i^T}}{\partial q_p}]\dot{q}_k\dot{q}_m - \sum_{i=p}^n m_i\overline{\boldsymbol{g}^T}\frac{\partial A_0^i}{\partial q_p}\overline{\boldsymbol{r_i^i}}$

페이지	현재	수정
270	$\tau_i=\sum_{j=i}^{n}\sum_{k=1}^{j}Trace[\frac{\partial A_0^j}{\partial q_k}I_i\frac{\partial A_0^{j^T}}{\partial q_i}]\ddot{q}_k+\sum_{j=i}^{n}\sum_{k=1}^{j}\sum_{m=1}^{j}Trace[\frac{\partial^2 A_0^j}{\partial q_k\partial q_m}I_i\frac{\partial A_0^{j^T}}{\partial q_i}]\dot{q}_k\dot{q}_m$ $-\sum_{j=i}^{n}m_j g^T\frac{\partial A_0^j}{\partial q_i}\overline{r}_j^j$	$\tau_i=\sum_{j=i}^{n}\sum_{k=1}^{j}Trace[\frac{\partial A_0^j}{\partial q_k}I_i\frac{\partial A_0^{j^T}}{\partial q_i}]\ddot{q}_k+\sum_{j=i}^{n}\sum_{k=1}^{j}\sum_{m=1}^{j}Trace[\frac{\partial^2 A_0^j}{\partial q_k\partial q_m}I_i\frac{\partial A_0^{j^T}}{\partial q_i}]\dot{q}_k\dot{q}_m$ $-\sum_{j=i}^{n}m_j\overline{g}^T\frac{\partial A_0^j}{\partial q_i}\overline{r}_j^j$
284	$G_i=\sum_{j=1}^{n}(-m_j\overline{g^T}U_{ji}r_j^j)$ $G_1=\sum_{j=1}^{2}(-m_j\overline{g}^TU_{j1}r_j^j)$ $=-(m_1\overline{g}^TU_{11}r_1^1+m_2\overline{g}^TU_{21}r_2^2)$	$G_i=\sum_{j=1}^{n}(-m_j\overline{g}^TU_{ji}\overline{r_j^j})$ $G_1=\sum_{j=1}^{2}(-m_j\overline{g}^TU_{j1}\overline{r_j^j})$ $=-(m_1\overline{g}^TU_{11}\overline{r_1^1}+m_2\overline{g}^TU_{21}\overline{r_2^2})$
285	$G_2=\sum_{j=2}^{2}(-m_j\overline{g}^TU_{j2}\overline{r_j^j})$ $=-m_2\overline{g}^TU_{22}\overline{r_2^2}$	$G_2=\sum_{j=2}^{2}(-m_j\overline{g}^TU_{j2}\overline{r_j^j})$ $=-m_2\overline{g}^TU_{22}\overline{r_2^2}$
296	$G_i=\sum_{j=1}^{n}(-m_j\overline{g^T}U_{ji}r_j^j)$ $G_1=\sum_{j=1}^{2}(-m_j\overline{g}^TU_{j1}r_j^j)$ $=-(m_1\overline{g}^TU_{11}r_1^1+m_2\overline{g}^TU_{21}r_2^2)$	$G_i=\sum_{j=1}^{n}(-m_j\overline{g}^TU_{ji}\overline{r_j^j})$ $G_1=\sum_{j=1}^{2}(-m_j\overline{g}^TU_{j1}\overline{r_j^j})$ $=-(m_1\overline{g}^TU_{11}\overline{r_1^1}+m_2\overline{g}^TU_{21}\overline{r_2^2})$
358	$\theta(t_f)=\theta_f$ $\dot{\theta}(t_f)=0$	$\theta_2(t_f)=\theta_f$ $\dot{\theta}_2(t_f)=0$
359	$\dot{\theta}_1=2a_{12}+6a_{13}t_v$ $\dot{\theta}_2=2a_{22}+6a_{23}t_v$	$\ddot{\theta}_1=2a_{12}+6a_{13}t_v$ $\ddot{\theta}_2=2a_{22}+6a_{23}t_v$
414	그림 7.51 교체	그림 7.51 LSPB 경로 계획

```
% LSPB 경로 계획
function qd = lspb_qd_acc(u)
q01 = u(1); q02 = u(2);
qf1 = u(3); qf2 = u(4);
tf = u(5);
a1 = u(6);
a2 = u(7);
t = u(8);

    if qf1 > q01
       tb1 = tf/2-(sqrt(a1^2*tf^2 - 4*a1*(qf1-q01)))/(2*a1);
    else
       ac =-a1;
       tb1 = tf/2+(sqrt(ac^2*tf^2 - 4*ac*(qf1-q01)))/(2*ac);
    end

    if qf1 > q01
       V1 = a1*tb1;
    else
       a1 =-a1;
       V1 = a1*tb1;
    end

     if qf2 > q02
       tb2 = tf/2-(sqrt(a2^2*tf^2 - 4*a2*(qf2-q02)))/(2*a2);
    else
       ac =-a2;
       tb2 = tf/2+(sqrt(ac^2*tf^2 - 4*ac*(qf1-q01)))/(2*ac);
    end

    if qf2 > q02
       V2 = a2*tb2;
    else
       a2 =-a2;
       V2 = a2*tb2;
    end

% 1구간의 경로
if t <= 0
   qd1 = q01;
   qdd1 = 0;
   qddd1 = 0;
   qd2 = q02;
   qdd2 = 0;
   qddd2 = 0;
elseif (t>0 & t <= tb1)
   qd1 = q01 +a1*tb1/(2*tb1)*t^2;
   qdd1 = a1*t;
   qddd1 = a1;
   qd2 = q02 +a2*tb2/(2*tb2)*t^2;
   qdd2 = a2*t;
   qddd2 = a2;
% 2 구간의 경로
elseif (t > tb1 & t<= tf-tb1)
   qd1 = (qf1+q01-V1*tf)/2 + a1*tb1*t ;
   qdd1 = V1;
   qddd1 = 0;
   qd2 = (qf2+q02-V2*tf)/2 + a2*tb2*t ;
   qdd2 = V2;
   qddd2 = 0;
% 3 구간의 경로
elseif (t> tf-tb1 &  t<= tf)
    qd1 = qf1 - a1/2*tf^2 +a1*tf*t - a1/2*t^2;
    qdd1 = a1*tf -a1*t;
    qddd1 = -a1;
    qd2 = qf2 - a2/2*tf^2 +a2*tf*t - a2/2*t^2;
    qdd2 = a2*tf -a2*t;
    qddd2 = -a2;
else
   qd1 = qf1;
   qdd1 =0;
   qddd1 =0;
   qd2 = qf2;
   qdd2 =0;
   qddd2 =0;
end

qd =[qd1 qdd1 qddd1 qd2 qdd2 qddd2];
```

페이지	현재	수정
415		그림 7.52 조인트 1 그림 7.53 조인트 2
490	`>> r11 = [-L1/2; ; 0; 0; 1];` `>> r22 = [-L2/2; ; 0; 0; 1];`	`>> r11 = [-L1/2;  0; 0; 1];` `>> r22 = [-L2/2;  0; 0; 1];`