Locations L_k

Control points C_{ij} | These are 3-vectors, components subbed by m

u, v estimates U_k

Heightfunc z

$$d = \sum_k \| L_k - z(U_k) \|^2$$

$$d = \sum_k \Big\| L_k - \sum_i \sum_j C_{ij} \binom{n}{i}\binom{n}{j} u^i (1-u)^{n-i} v^j (1-v)^{n-j} \Big\|^2$$

$$\cancel{\frac{\partial d}{\partial C_{ijm}} = \sum_k \| L_k - z(U_k) \|}$$

$$d = \sum_k \sum_m \Big(L_{km} - \sum_i \sum_j C_{ijm} \binom{n}{i}\binom{n}{j} u_k^i (1-u_k)^{n-i} v_k^j (1-v_k)^{n-j} \Big)^2$$

$$\frac{\partial d}{\partial C_{ijm}} = -2 \sum_k \Big[\Big(L_{km} - \underbrace{\sum_{i'} \sum_{j'} C_{i'j'm} \binom{n}{i'}\binom{n}{j'} u_k^{i'} (1-u_k)^{n-i'} v_k^{j'} (1-v_k)^{n-j'}}_{\text{call this } S_{km}\text{, doesn't depend on } i,j} \Big) \Big] \cdot \Big[\binom{n}{i}\binom{n}{j} u_k^i (1-u_k)^{n-i} v_k^j (1-v_k)^{n-j} \Big]$$

$$\frac{\partial d}{\partial u_k} = -2 \sum_m (L_{km} - S_{km}) \Big[\sum_i \sum_j \binom{n}{i}\binom{n}{j} v_k^j (1-v_k)^{n-j} \cdot \Big((1-u_k)^{n-i} \, i \, u_k^{i-1} - u_k^i (n-i)(1-u_k)^{n-i-1} \Big) \Big]$$

v_k is similar