$\sum_{i=1}^{m} \| x^{(i)} - z \|^2$

$\nabla \sum_{i=1}^{m} \| x^{(i)} - z \|^2 = 2 \sum_{i=1}^{m} (x^{(i)} - z)$

By equating $2 \sum_{i=1}^{m} (x^{(i)} - z) = 0$,

we get $0 = \sum_{i=1}^{m} (x^{(i)} - z)$

$0 = -mz + \sum_{i=1}^{m} x^{(i)}$

$mz = \sum_{i=1}^{m} x^{(i)}$

$z = \frac{1}{m} \sum_{i=1}^{m} x^{(i)}$ (proven)