# 16-720 Computer Vision Spring 2016

# Azarakhsh Keipour (akeipour@andrew) Assignment 3

## Q 1.1 Lucas-Kanade Derivation

We have to find *u* and *v* that minimize the following cost function:



By linearizing  by first order Taylor expansion around the point  we have:



In which  and  are partial derivatives of  at point . Now by replacing  in the above cost function, we have:



Therefore, converting the equation to the matrix form, we need to compute:



To solve this system, we have:



Where:



and



The  is shown above with green color. It is not important if individual  matrices for the points have certain conditions or not; however, the  matrix should not be singular. Also if it is near to singular conditions (determinant is near to zero), then numerical error in our estimation of *u* and *v* will be high and the template offset cannot be calculated reliably.

## Q 1.2 Lucas-Kanade Algorithm

For each iteration we want to find ,  such that the following cost function is minimized:



To simplify the notation, I will use  instead of . By linearizing  by first order Taylor expansion around point  we have:



In which  and  are partial derivatives of  at point . By replacing it in the cost function above we have:



To simplify the notation, I will use *I* instead of  and  instead of  :



To find the minimum, differentiate w.r.t.  and:





Rewriting the above equations in matrix notation and eliminating the constant multiplier 2, we have:



The code that implements this formulation is provided as requested.