A simple prior free method for non-rigid structure-from-motion Factorization

About:

- This paper can recover both camera motion and non-rigid shape accurately without any ambiguity.
- The paper discusses about the factorisation problem of measurement matrix and techniques employed to accurately extract non-rigid shape and camera motion.
- The paper does not assume any constraints on non-rigid shape, scene , camera motion etc…..

Discussion:

- Tomasi and Kanade proposed a factorisation techniques from rigid bodies and orthographic projections.
- Bregler's paper on non-rigid shapes from Image streams discusses a technique on recovering 3-D models from 2-D sequences recorded with a single camera.
- The big success of this paper is that a 3-D non rigid shape can be recovered from single view without a-priori models.
- Next a paper by Jing Xiao on a closed from solution to Non-rigid shape and Motion recovery argues that enforcing only the rotation constraints leads to ambiguous and invalid solutions
- To explain the above statement , it means that when we also introduce basis constraints in addition to rotation constraints we can uniquely determine the basis shapes.
- The paper argues that non-linear optimization is what makes good 3-D constructions .This paper provides optimal solution to structure from motion factorization problem.
- Measurement matrix W = R S = π'B' = π'GG\`B' . where R is rotation matrix .S is non-rigid shape. S is assumed to be linear combination of base shapes and rank of w <= 3*k;

- The π and B found from SVD are determined upto 3k*3k linear transformation. The main problem is finding the gram matrix G such that π' is rectified to Euclidean form π = π'G and B=G\`B\`.
- According to xio et al theorem Gram matrix Qk = GG\` solutions are subspace of dimension $2k^2 - k$.
- The centralised theorem of the paper says that any correct solution of Q^k must be intersection of the $2k^2 - k$ null space of matrix A and rank 3 PSD matrix .
- The above finally reduces to min trace (Q*k*) *,* such that*,* Q*k* >_ 0*,* A vec(Q*k*) = **0***.* The author says that this is standard SDP problem of fixed size $2k^2 - k$ and can be solved easily.
- The next steps are finding rotation and non-rigid shape matrix S.
- R = blkdiag(R1,R2,…..Rk) where each Rj can be calculated from 2*I and 2*i-1 th rows of π\` found from svd multiplied with Gk.
- Solving s is the rank minimisation problem: find min-rank(s) such that W = RS . S = R\`W where R\` is the pseudo-inverse of R.