**Drawbacks:**
- Ill-posed problem (infinite number of minima)
- Dependence in $p$: hard to optimize
- Non-robust approach

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**Goal and General Principle**

Direct image registration: find the deformation that aligns the pixels of two images by using the colour information [2,3].

**Source image ($S$)**  
**Target image ($T$)**  
**Mosaic** (warped source + target)

Parametric formulation + least-squares:

$$\min_{p} \sum_{q \in \mathcal{R}} ||S(q) - T(W(q;p))||^2$$

Robust formulation using an M-estimator (for handling erroneous data caused by, for instance, occlusions):

$$\min_{p} \sum_{q \in \mathcal{R}} \rho(||S(q) - T(W(q;p))||)$$

**Problem: the Region of Interest (RoI)**

Which pixels must be included in the region of interest?

**Rectangular Region of Interest**

- A large RoI may contain pixels that do not belong to the true overlap of the images.
- Using a small RoI leads to a loss of information that could have been useful. Besides, it results in a cost function hard to optimize.

**Adaptive Region of Interest [1]**

**Principle:** consider all the pixels of the source image and, during each iteration of the optimization process, discard the ones that once warped fall outside of the target image.

$$\min_{p} \sum_{q \in \mathcal{R} \setminus \mathcal{R}^s(p)} ||S(q) - T(W(q;p))||^2$$

**Drawbacks:**
- Ill-posed problem (infinite number of minima)
- Dependence in $p$ of $\mathcal{R}^s$ hard to optimize
- Non-robust approach

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**Compatible Pixels**

The standard approach may be seen as the relaxation of another problem that estimates the geometric deformation by maximizing the number of compatible pixels.

$$\mathcal{C}(p;\mathcal{R}) = \{ q \in \Omega_S \mid \exists q' \in \Omega_T, (S(q) = T(q')) \}$$

Taking noise into account (normally-distributed):

$$\mu_{\mathcal{C}^n(p)}(q) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{||S(q) - T(q')||^2}{2\sigma^2}\right)$$

$$\max_{p} \prod_{q \in \mathcal{R}} \mu_{\mathcal{C}^n(p)}(q)$$

$$\min_{p} \sum_{q \in \mathcal{R}} ||S(q) - T(W(q;p))||^2$$

**Our Approach**

Our approach is a different relaxation that allows one to drop the need of a region of interest.

The pixels $q$ and $q'$ are compatible if the values $S(q)$ and $T(q')$ are similar when $q' \in \Omega_T$ and not compatible otherwise.

$$\mathcal{C}(p) = \{ q \in \Omega_S \mid (q' \in \Omega_T) \land (S(q) = T(q')) \}$$

A pixel $q$ such that $q' \notin \Omega_T$ has the same influence on the cost function as a pixel that corresponds to an outlier.

$$\min_{p} \sum_{q \in \mathcal{R} \setminus \mathcal{R}^s(p)} \rho(||S(q) - T(q')||)$$

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**Experimental Results**

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**Some References**


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