**Purpose**

We present a new curve evolution model for registering step functions. The proposed model simulates the biological contraction and expansion behaviors of organs and is referred to as the connected rubber model (CRM). Our registration algorithm produces a guaranteed optimal solution in polynomial time.

**Method and Materials**

The new connected rubber model (CRM) we propose aims to simulate the contraction and expansion behaviors of organs. Given two step functions, the target and source functions of registration, to represent the changing boundary of an object, our main idea is to deform the source function (i.e., each of its horizontal segments can extend or shrink) such that a best matching with the target function is obtained, minimizing a given cost function. We adopt the dynamic programming paradigm to solve this step function registration problem. The derived algorithm is based on the analysis of the model behavior and properties of internal function and it can be theoretically proved to produce the optimal solution within the time complexity of $O(N^2)$.

**Results**

Our CRM algorithm has been applied to two scenarios to verify its effectiveness. The first one is the deformation field initialization for the image registration problem. The initial deformation field generated by CRM is able to reduce the computation time of Demon's image registration algorithm by 20%~40%. The second application is polygon registration, where our result demonstrate a fully recovery of deformation complying with our assumption.

**Conclusion**

We develop a new registration model for step functions. The guaranteed optimal solution and fast algorithm running time make it an useful tool with great potential for object registration problems. An extension will be made in the future to also allow changes along the vertical direction.