

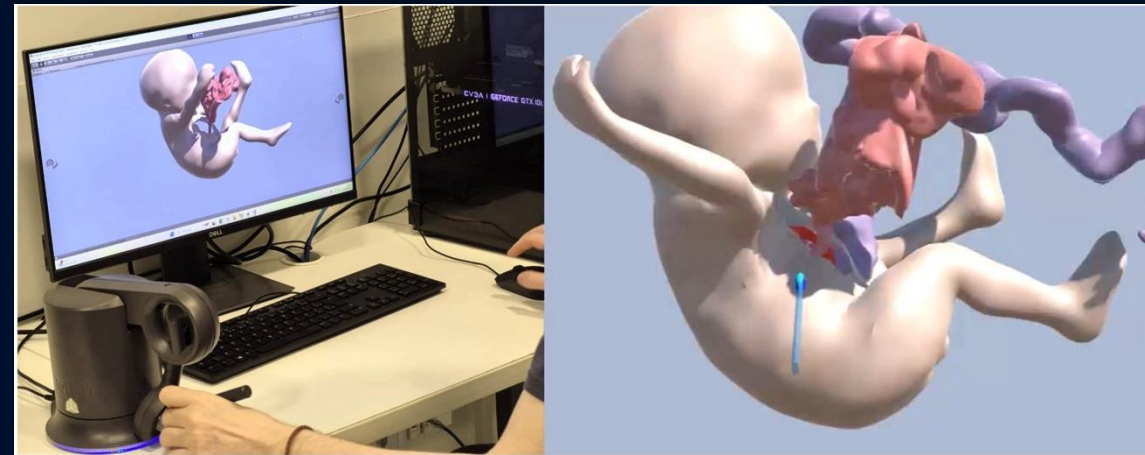
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Objective: The term “haptics” emerged to designate the science of touch, dedicated to studying and simulating pressure, texture, vibration and other related biological sensations. The aim here was to use haptic technology to demonstrate the reintegration of intestinal loops in a 28-week gastroschisis case.

Methods: The initial stage involved segmenting fetal magnetic resonance imaging data from a gastroschisis case. This process enabled the creation of detailed three-dimensional (3D) models, ensuring the fidelity of simulated tissues and organs. To achieve this, segmentation and 3D reconstruction software were used to convert 2D images into models compatible with Unity. To enable realistic movement of tissues and organs, rigging was applied to the 3D models. This process involved creating articulation and deformation structures using bones (to define articulation points and internal movements of the model) and influence weights (to control the degree of deformation in response to articulations). The simulation was integrated with the Touch device from 3D Systems using the “OpenHaptics” library, allowing users to experience tactile feedback.

Results: Several technical challenges arose during the development of the haptic simulation, including the lack of torque feedback from the haptic device, which required adaptations to prevent excessive deformations and ensure stability during interactions. Additionally, real-time dynamic registration of tactile surfaces was a complex process, as it was essential to ensure that surfaces were accurately generated and synchronized with visual objects during the simulation. Another critical challenge was fine-tuning movement parameters to respect anatomical constraints without compromising overall system functionality. The rigging and joint configuration enabled natural and consistent movements, allowing fluid interactions such as repositioning tissues or manipulating the umbilical cord.



Conclusions: The technical results demonstrate the effectiveness of the chosen approach. The haptic simulation accurately replicates sensations of weight and resistance to touch, which are fundamental aspects of realistic medical training. The system proved to be flexible, supporting the real-time creation and manipulation of tactile surfaces. We believe in the potential of these devices for medical training.