Computer-assisted spine surgery enables surgeons to view the position of their instruments against three-dimensional images of a patient’s spine, increasing the accuracy and safety of the procedure. The instrument tracking technology is similar to the way a GPS satellite tracks automobiles on the roads. The ability to see and track instruments in three-dimensional views allows for accurate targeting, improved measurements, and precision in surgical spine procedures that were not possible using the naked eye alone.
**Introduction**

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**Components (Part 1)**

A computer-assisted spine surgery system consists of four primary components: a digital camera array and computer, smart instrumentation, software, and monitors. The digital camera array uses infrared signals to work with the computer to track instruments against the position of the spine. The smart instrumentation consists of wireless devices such as a pedicle feeler used for probing, an awl used for creating or enlarging holes in bone, and a patient spine tracker that attaches to a vertebra to ensure the 3D imagery remains accurate, even if the patient is repositioned. Maintaining an update of the spinal detail with the spine tracker can eliminate or reduce the amount of imaging required during the operation.
Components (2)
The computer-assisted spine surgery system uses sophisticated, intuitive software to create three-dimensional images of the patient’s spine by correlating imagery taken before or during the procedure with instrument calibrations done at the start of surgery. The software also tracks and displays the positions and trajectories of the smart instrumentation. The monitors provide surgeons an alternate, real time, three-dimensional view of the spine that can be zoomed and rotated, greatly extending the viewing capabilities beyond what is seen in the exposed surgical field.

Preparation
Prior to spine surgery, imagery from a CT (computed tomography) scan or MRI (magnetic resonance imaging) scan may be loaded into the computer. The software interprets the imaging data and prepares three-dimensional, virtual images of the patient’s spine. The surgeon can then study the images to preplan details such as the proper size of instruments and hardware, or the best trajectories for inserting hardware into bone. The operating room is set up and the camera is positioned to track the instruments and spine position. To ensure a direct match between the virtual images and the actual patient anatomy, a series of points are selected using the software. These points are identified on the patient’s spine at the beginning of the procedure.
**Registration**
Matching the actual spine anatomy to the virtual images is called registration. The procedure starts with an incision, and a patient spine tracker is clamped to a vertebra. This step ensures that the camera will detect any spine movement. Next, the smart instruments are identified for tracking with a one step validation process. Once instruments are identified, the points previously selected in the software are touched in sequence. The camera tracks when an instrument contacts the registration points and the software performs calculations to ensure the virtual image is accurate.

**Procedure (1)**
The surgery can proceed once the short registration process is complete. The surgeon can see both the exposed spinal anatomy as well as three-dimensional images on the monitor. A variety of different angles and views are available, including a tools-eye view from the tip of an instrument. In addition to being able to track and pinpoint the smart instruments, a trajectory line is also displayed on the monitor, which helps accurately position instruments. In this example, screws will be inserted into the pedicle regions of vertebrae. This is done to add instrumentation that will stabilize the spine following a partial disc removal.
Procedure (2)
After using the software for measurements to determine the proper insertion point for pedicle screws, a tracked awl is used to create pilot holes. A universal tracker can be used with a drill to monitor the position and depth of the drill bit as pilot holes are drilled deep enough to accept the pedicle screws. This process is repeated for each screw before it is fastened into bone. Next, the smart instrumentation is removed before affixing the metal rods that will stabilize the spine. Finally, the incision is closed to complete the procedure.

Summary
Computer-assisted spine surgery allows surgeons to actively track instruments against a virtual 3D image of a patient’s spine during a procedure. This technology provides the ability to preplan procedures, perform precise measurements and targeting, and visualize instrument trajectories. Computer-assisted spine surgery results in improved efficiency and reduced operating room time with increased safety in technical spine surgery procedures.