A modification in a method of automated evolutionary synthesis of voltage-controlled multifunctional logic circuits makes it possible to synthesize more circuits in less time. Prior to the modification, the computations for synthesizing a four-function logic circuit by this method took about 10 hours. Using the method as modified, it is possible to synthesize a six-function circuit in less than half an hour.

The concepts of automated evolutionary synthesis and voltage-controlled multifunctional logic circuits were described in a number of prior NASA Tech Briefs articles. To recapitulate: A circuit is designed to perform one of several different logic functions, depending on the value of an applied control voltage. The circuit design is synthesized following an automated evolutionary approach that is so named because it is modeled partly after the repetitive trial-and-error process of biological evolution. In this process, random populations of integer strings that encode electronic circuits play a role analogous to that of chromosomes. An evolved circuit is tested by computational simulation (prior to testing in real hardware to verify a final design). Then, in a fitness-evaluation step, responses of the circuit are compared with specifications of target responses and circuits are ranked according to how close they come to satisfying specifications. The results of the evaluation provide guidance for refining designs through further iteration.

As described in more detail in the prior NASA Tech Briefs articles on multifunctional logic circuits, the multiple functionality of these circuits, the use of a single control voltage to select the function, and the automated evolutionary approach to synthesis, offer potential advantages for the further development of field-programmable gate arrays (FPGAs):

- Typical circuitry can be less complex and can occupy smaller areas; because only a single analog control line is needed to select different functions.
- If voltage-controlled multifunctional gates were used in the place of the configurable logic blocks of present commercial FPGAs, it would be possible to change the functions of the resulting digital systems in much shorter times;
- Relative to conventional circuits designed to perform single functions, multifunctional circuits can be synthesized to be more tolerant of radiation-induced faults.

In the unmodified method of automated evolutionary synthesis, the target responses of a multifunctional logic circuit are fixed: that is, the user specifies in advance which logic function the circuit is to perform at each of several discrete values of control voltage (for example, AND at 0 V, NOR at 0.9 V, and NAND at 1.8 V). In the modified method, the user no longer specifies which logic function occurs at which control voltage; Instead, the evolutionary algorithm is allowed to find the control-voltage levels at which various logic functions appear, and the fitness-evaluation function is modified to assign a higher fitness score to a circuit that exhibits a greater number of logic functions over the full range of the control voltage. Thus, evaluation is driven to find circuits that perform larger numbers of logic functions.

A Buffer Must Be Added to an evolving circuit to obtain a digital output because the direct output of a typical evolving circuit is an analog voltage.
Video-Camera-Based Position-Measuring System
Coordinates of nearby targeted objects are measured quickly, easily, and safely.

John F. Kennedy Space Center, Florida

A prototype optoelectronic system measures the three-dimensional relative coordinates of objects of interest or of targets affixed to objects of interest in a workspace. The system includes a charge-coupled-device video camera mounted in a known position and orientation in the workspace, a frame grabber, and a personal computer running image-data-processing software. Relative to conventional optical surveying equipment, this system can be built and operated at much lower cost; however, it is less accurate. It is also much easier to operate than conventional instrumentation systems. In addition, there is no need to establish a coordinate system through cooperative action by a team of surveyors.

The system operates in real time at around 30 frames per second (limited mostly by the frame rate of the camera). It continuously tracks targets as long as they remain in the field of the camera. In this respect, it emulates more expensive, elaborate laser tracking equipment that costs of the order of 100 times as much. Unlike laser tracking equipment, this system does not pose a hazard of laser exposure.

Images acquired by the camera are digitized and processed to extract all valid targets in the field of view. The three-dimensional coordinates \((x, y, \text{ and } z)\) of each target are computed from the pixel coordinates of the targets in the images to accuracy of the order of millimeters over distances of the orders of meters. The system was originally intended specifically for real-time position measurement of payload transfers from payload canisters into the payload bay of...