VisSim Embedded
Model-Based Design of Embedded Systems

Introduction
VisSim Embedded is a graphical environment for model-based embedded development. The generated code is both highly-optimized and compact, which is essential for low-cost microprocessors and high-speed sampling rates.

By performing off-line simulation and prototyping, you can identify and correct problems in the control algorithms earlier in the design cycle, resulting in lower development costs and faster time to market.

VisSim Embedded has deep support for Texas Instruments C2000 and MSP430 control MCUs. It covers hundreds of part configurations, consisting of different peripheral mixes, Flash, and RAM, making it easy to choose the part best suited for your design.

Model-Based Design

Key Highlights

- Intuitive graphical interface for model-based design and simulation of embedded systems
- Rapid prototyping and code generation for Texas Instruments MCUs
- Automatic programming of on-chip peripherals
- Production-quality C code with automatic scaling of fixed-point operations
- Algorithm validation using off-line simulation
- Automatic compilation, linking, and download of algorithm to the target
- JTAG hotlink for target-in-the-loop verification
- Retain the VisSim GUI while the algorithm executes on the target

System Requirements

- Windows XP, Vista, or 7
- 1 GB RAM
- Texas Instruments CCS v3+
- Target hardware
- JTAG emulator (TI, Spect. Digital, Blackhawk, or compatible)
- Texas Instruments CCS v3+

Subsystem 1 of two sensorless PMSM motors using sliding mode observer estimation of rotor position. Sample rate is 10 kHz running both motors on a Piccolo F28036 with 50% utilization.

When I used C code to develop and debug my digital control algorithms, it was like I was fumbling around a twisty maze with high walls. When I switched to VisSim, I got a bird’s eye view of that maze and a clear view of the path to solution. I will never go back to C coding for my digital power and digital control applications.

Anthony Boon, Chief Engineer, ETA Electronic Design
Using VisSim Embedded, you can build a model of your entire system, including the control algorithm and the plant.

The controller system can be built in scaled, fixed-point arithmetic, while the plant is built in full-precision, floating point arithmetic.

For model construction, VisSim Embedded provides extensive block libraries, including:
- TI C2000 Motor Control block library
- TI InstaSPIN block library
- On-chip peripheral block library
- Fixed-point block library
- Motor block library (available separately)

**TI C2000 Motor Control Blocks**
The TI C2000 Digital Motor Control blocks are used to design motion control systems based on AC induction, brushless DC, PMSM, and stepper motors.

VisSim Embedded provides both 16- and 32-bit digital motor control blocks, including PID, 3-Phase PWM Drivers, Space Vector Waveform Generators, Park and Clarke Transforms, Volts-to-Hertz Profiles, sensorless flux and rotor speed estimation, and quadrature-encoder-based speed calculator.

Sample diagrams are included with VisSim Embedded for sensored and sensorless vector control of PMSM and AC induction motors.

**TI InstaSPIN Blocks**
The InstaSPIN block library allows sensorless rotor position estimation using algorithms burned into ROM on selected chips. The InstaSPIN blocks perform identification of key motor parameters, as well as field-oriented motor control. The blocks also provide a simple interface to the complex InstaSPIN API, thereby shortening your design time for InstaSPIN applications.

**Target-Specific Blocks**
The target-specific blocks let you easily program on-chip devices. Using built-in these blocks include analog ADC, ePWM, eCAP (event capture), SPI, SCI (RS232 serial), I2C, digital GPIO, QEP (quadrature encoder), and CAN 2.0.

**Scaled, Fixed-Point Algorithms**
The Fixed-Point blockset lets you perform simulation and efficient code generation of scaled, fixed-point operations.

**CAN Bus Support**
CAN bus blocks offer an extensive range of capabilities to support the development of systems with CAN communication. The CAN transmit and receive blocks support up to 32 CAN mailboxes on the TI C2000 series. Baud rates to 2 megabits are supported. Mailboxes are configurable from 0- to 8-byte data packet size. User-configurable addressing can be 11 or 23 bits. Remote frame requests and auto-answer are also supported.

**Serial LCD**
Serial LCD blocks support up to 4-line-by-20-column serial interfaced LCDs. You can compose text prompts, numeric formatting, field placement, and page address for each block. Additionally, runtime paging commands are supported. Serial baud rate, serial protocol, and LCD vendor format are user-configurable.
Overflow and precision loss effects are easily seen and corrected at simulation time. Auto-scaling speeds fixed-point development, while in-line code generation creates fast target code.

**Off-line Simulation**

During initial simulation of the controller and plant, you can verify, debug, and tune your control algorithms, and view the results interactively in graphical plots. This step lets you interact with and assess the simulated controller and the simulated plant.

**Automatic Code Generation**

Once the model is verified, you can automatically generate code for the controller and download the code to the target MCU. The code is optimized for speed and memory usage.

You can execute the generated code with your plant model within VisSim to verify successful translation of model to code.

**Efficient ANSI C Code**

VisSim Embedded generates efficient and compact ANSI C code for discrete, continuous, and hybrid systems. MCU target support includes a report to display the COFF section sizes of the generated execution file.

For example, code generated for closed-loop motor control - including, PI controller, digital output, PWM, and encoder peripherals - runs at 300KHz on a 150MHz F28335 MCU.

The memory footprint is:

- Code size: 2095 bytes
- Initialized data: 501 bytes
- Uninitialized data: 504 bytes

**MCU-in-the-Loop Simulation**

In MCU-in-the-loop simulation, the plant model runs on the host computer in VisSim while the control algorithm runs in real time on the target MCU. Real-time communication between the target MCU and VisSim is performed via a JTAG hotlink. The VisSim GUI is retained while you tune parameters and monitor real-time data.

**Synchronous MCU-in-the-Loop Simulation**

VisSim Embedded also supports a PIL-synchronous communication mode that runs the target in lock step with the simulation, allowing easy verification of embedded algorithms.

**Unsupported Platforms**

You can extend VisSim Embedded to target unsupported platforms using the VisSim Support Library Source Code (available separately). The generated fixed-point and floating-point code can be compiled on any platform with an ANSI C compiler.
VisSim Blocks
Summary of Standard

Animation
animate
animation3D
camera3D
light3D
lineDraw
mesh3D
world3D

Annotation
bezel
cmt
index
label
scalarToStruct
scalarToVec
StructToScalar
variable
vecToScalar
wirePositioner

Arithmetic
-X
*
/
abs
complexToReIm
convert
gain
magPhase
pow
sign
summingJunction
unitConversion

Audio
audioIn
audioOut

Boolean
>
<
>=
<=
!=
and
not
or
xor

DDE
DDE
DDEsend

Integration
integrate
limitedIntegrator
resetIntegrator

Linear Systems
stateSpace
transferFunction

MatLab Interface
MatLab Expression
MatLab Read Variable
MatLab Write Variable

Matrix Operations
buffer
diag
dotProduct
eigenvalues
fft
ifft
indexAssigned
invert
linearSolve
maxElement
minElement
matrixConst
matrixIn
matrixMerge
matrixOut
matrixSize
meanSmooth
medianSmooth
multiply
polyFit
polyRoots
psd
reshape
splineFit
transpose
vectorSort
vsum

Nonlinear
case
crossDetect
deadband
delayedSwitch
init
limit
map
max
merge

min
quantize
relay
sampleHold

Optimization
constraint
cost
globalConstraint
parameterUnknown
unknown

Random Generator
beta
cauchy
erlang
gamma
gaussian
pareto
PRBS
rayleigh
triangular
uniform
weibull

Real-Time
rt-DataIn
rt-DataOut
ActiveXread
ActiveXwrite

State Chart
statechart
trigger

State Transition
stateTransition

Signal Consumer
display
error
execOrder
eventDisplay
eventLog
export
histogram
light
meter
plot
polarPlot
plot3D
spectrumDisplay
stop
stripChart
video

Signal Producer
button
Const
dialogConstant
dialogTable
import
parabola
pulseTrain
ramp
realTime
sawtooth
sinusoid
slider
squareWave
step
timeStamp
triangleWave

Time Delay
timeDelay
unitDelay

Transcendental
acos
asin
atan2
bessel
cos
cosh
exp
In
log10
sin
sinh
sqrt
tan
tanh

Embedded Blocks

General
embed*
expression
OLEobject
userFunction*

Bold blocks indicate new version 9 blocks and new features to existing blocks

Blocks followed by an asterisk (*) are not included in the Personal or Student Edition of VisSim
Embedded Blocks

Summary of Blocks

**Fixed Point Blocks**

- abs
- and
- atan2
- const
- convert
- cos
- CRC 16
- div
- gain
- limit
- limitedIntegrator
- merge
- mu
- not
- or
- PI Regulator
- PID Regulator
- sampleHold
- shift
- sign
- sin
- sqrt
- sum
- transferFunction
- unitDelay
- xor
- -X
- >
- <
- <=
- >=
- ==
- !=

**Target-Specific Blocks**

- ADC10/12
- AI0 In
- AI0 Out
- Analog Comparator DAC
- Analog In
- Analog Input
- Analog Output
- CAN Receive
- CAN Transmit
- CAN Transmit Ready
- Comparator
- Comparator DAC
- DAC
- DAC12
- Digital/Analog Input
- Digital Input
- Digital Output
- DMA Enable
- Download
- eCAP
- eCAP PWM
- ePWM
- ePWM Action
- ePWM Action Write
- ePWM Chopper
- ePWM Force Action
- ePWM Force Action Write
- eQEP
- Event Capture
- External Definition
- External Function
- External Read
- External Write
- Full Compare Action
- Full Compare PWM
- Get CPU Usage
- Get Target Stack and Heap
- GPIO In
- GPIO Out
- I2C Read Buffer
- I2C Start Communication
- I2C Write Buffer
- I/O Memory Read
- I/O Memory Write
- LCD
- LCD Control
- Monitor Buffer Empty
- Monitor Buffer Read
- Monitor Buffer Write
- Op Amp
- PWM
- Quadrature Encoder
- Read Target Memory
- Reset Target
- SD16
- SD16A
- Segment LCD
- Serial UART Read
- Serial UART Write
- SPI Read
- SPI Write
- Target Interface
- Watchdog
- Web Server

**MotorWare Blocks**

- Angle Estimator
- Controller Read Property
- Controller Write Property
- Estimator Read Property
- Estimator Write Property
- Motor Control

**Motion Blocks (available separately)**

- Amplifiers
- Controllers
- Filters
- Loads
- Motors
- Sensors
- Sources
- Tools
- Transforms

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