Chapter 1. MATLAB/Simulink as a Technical Computing Language
1.1 Introduction
1.2 History of MATLAB Creation and Development
1.3 Capabilities and Resources
1.4 Aerospace Application Tools
1.5 Overview of MathWorks Products
1.6 Installing Mathworks Products
1.7 MATLAB Online
Fast Facts

- Founded in 1984
- Software installations at over 80,000 business, government, and university sites
- Customers in over 180 countries
- There are more than:
  - 2 million users of MATLAB worldwide
  - 4 million files downloaded from File Exchange on MATLAB Central in 2016
  - 225,000 contributors worldwide to MATLAB Central apps
  - 500 third-party solutions that build on MATLAB and Simulink
  - Over 2,000 MATLAB based books in 28 languages
MATLAB News & Notes - December 2004

The Origins of MATLAB

Jack Little left his job at the consulting company and bought a new COMPAQ portable computer at Sears. The machine had only 256 KB of memory and no hard disc; Jack had to swap 5-1/4-inch floppies to compile programs. Jack and Steve took a year and a half to rewrite MATLAB in C, adding new features they had envisioned. Steve wrote the parser/interpreter, and Jack wrote the math libraries, including translations to C of about a dozen routines from LINPACK and MATLAB. Jack also wrote the first Control System Toolbox. Some of their original code is still used in MATLAB today.

In 1984, Jack, Steve, and I founded The MathWorks. The first mailing address was a rented A-frame cabin where Jack lived in the hills above Stanford University in Portola Valley, California.

1983 MATLAB rewritten

Jack Little used the COMPAQ portable to develop MATLAB 1.0.

1984 The MathWorks founded

The MathWorks released MATLAB 1.0, implemented in C for MS-DOS PCs. MATLAB made its commercial debut at the IEEE Conference on Design and Control in Las Vegas, Nevada.

The Growth of MATLAB and The MathWorks over Two Decades

www.mathworks.com/company/newsletters/news_notes/clevescorner/jan06.pdf

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted, unless for course participation, in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the Publisher and/or Author. Contact the American Institute of Aeronautics and Astronautics, Professional Development Programs, 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191-5807.
MATLAB Product Family

Simulink Product Family

Application-Specific Products

MATLAB Product Family

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted, unless for course participation, in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the Publisher and/or Author. Contact the American Institute of Aeronautics and Astronautics, Professional Development Programs, 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191-5807.
Latest Release Highlights

- **R2012b** – new Desktop features (Toolstrip interface that replaced menus and toolbars, Apps gallery presenting apps from the MATLAB product family, redesigned Help system), command line suggestions; new Simulink Editor, smart signal routing and simulation tools
- **R2013b** – new types of data (table data container, categorical array)
- **R2014a** – new way to display Command History window (pop-up window rather than static window)
- **R2014b** – new graphics system, new types of data (datetime, duration, and calendarDuration), suggested corrections for syntax errors in the Command Window, packaging a sharing tool, big data analysis tools (datastore and others)
- **R2016a** – Live Editor to create and run live scripts with embedded output), suggested corrections for syntax errors in the Command Window, App Designer
- **R2016b** – new types of data (timetable data container, timeseries objects, string array), working with missing data (fillmissing) and big data (tall)
- **R2017a** – MATLAB Online to use MATLAB through the web browser, working with outliers (filloutliers and others)
- **R2017b** – MATLAB Drive providing a common free cloud-based storage of 250Mb), plotting in geographic coordinates, wordcloud function, contextual hints for function arguments in Live Editor
- **R2018a** – improved graphic (axes, legend)
- **R2018b** – new plotting functions (xline, yline, geoaxes, stackedplot, scatterhistogram and others), axes toolbar, Deep Learning Toolbox
- **R2019a** – new tabular data reading functions (readmatrix and others), parallelplot, graphics export, object detection using you-only-look-once (YOLO) v2 detectors, Reinforcement Learning Toolbox
- **R2019b** – Simulink Toolstrip and other tools, Git integration with MATLAB, map-based data visualization, Live Editor Tasks, function argument validation, Navigation, Robotics System and ROS Toolboxes
<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axes Transformations</td>
<td>Transforms axes of coordinate systems to different types</td>
</tr>
<tr>
<td>Flight Parameters</td>
<td>Computes various flight parameters, including ideal airspeed correction, Mach number, and dynamic pressure</td>
</tr>
<tr>
<td>Quaternion Math</td>
<td>Assures common mathematical and matrix operations on a quaternion</td>
</tr>
<tr>
<td>Unit Conversion</td>
<td>Converts common measurement units from one system to another, and enables time calculations, including Julian dates, decimal year, and leap year</td>
</tr>
<tr>
<td>Environment</td>
<td>Simulates various aspects of aircraft environment, such as atmosphere conditions, gravity, magnetic fields, and wind</td>
</tr>
<tr>
<td>Gas Dynamics</td>
<td>Provides various gas dynamics tables</td>
</tr>
<tr>
<td>Trajectory and Attitude Visualization</td>
<td>Allows constructing FlightGear animation objects to be used in virtual reality animations</td>
</tr>
</tbody>
</table>
Aerospace Blockset Libraries

- 6DOF
- 3DOF
- Point Mass
- Equations of Motion
- Propulsion
- Actuators
- Flight Instruments
- Pilot Models
- GNC
- Control
- Guidance
- Navigation
- Atmosphere
- Celestial Phenomena
- Gravity
- Wind
- Environment
- Aerodynamics
- Mass Properties
- Flight Parameters
- Utilities
- Animation
- Animation Support Utilities
- Right Simulator Interfaces
- MATLAB-Based Animation
- Axes Transformations
- Math Operations
- Unit Conversions

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted, unless for course participation, in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the Publisher and/or Author. Contact the American Institute of Aeronautics and Astronautics, Professional Development Programs, 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191-5807.
Mathworks for Academia

Teach and Learn with MathWorks
The tools used at more than 5000 universities worldwide.

Research with MATLAB and Simulink
Researchers in engineering and science rely on platforms that let them explore and express new ideas, solve difficult problems, and create tools, leveraging a robust and flexible computational foundation. MATLAB and Simulink are widely used across industries for research and product development, so you can apply your research to interesting and challenging real-world examples.

Educate Students
Use the tools of technical exploration – in the classroom and throughout the industry. With MATLAB and Simulink, students develop skills they'll use throughout their careers.

Download MATLAB Courseware
Teach system dynamics with Arduino, MATLAB, and Simulink.

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted, unless for course participation, in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the Publisher and/or Author. Contact the American Institute of Aeronautics and Astronautics, Professional Development Programs, 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191-5807.
1. **MATLAB Student** version Includes MATLAB only, with the option to purchase add-on products for a variety of courses and applications.

2. **MATLAB and Simulink Student Suite** includes full-featured versions of MATLAB and Simulink (the student version of Simulink enables you to create models that include over 300 blocks) along with the key functions from:
   - Control System Toolbox
   - Curve Fitting Toolbox
   - DSP System Toolbox
   - Image Processing Toolbox
   - Instrument Control Toolbox
   - Optimization Toolbox
   - Parallel Computing Toolbox
   - Signal Processing Toolbox
   - Statistics and Machine Learning Toolbox
   - Symbolic Math Toolbox

Runs on Windows, Mac and Linux
Explore the wide range of product capabilities, and find the solution that is right for your application or industry.

**Data Analytics**
Develop data-driven insights that lead to improved designs and decisions.
» Learn more

**Internet of Things**
Connect embedded devices to the Internet and gain insight from your data.
» Learn more

**Medical Devices**
Model and simulate algorithms, and prototype your diagnostic and therapeutic designs.
» Learn more
An open exchange for the MATLAB and Simulink user community

A place where you can get answers, challenge yourself and others, and share your knowledge. Tap into the knowledge and experience of over 100,000 community members and MathWorks employees.

Ask and Answer  Get & Share Code  Read and Learn  Play  Explore IoT Data

CONTRIBUTORS  ANSWERS PER DAY  DOWNLOADS PER DAY  SOLVERS PER DAY
From GPS measurements to ENU measurements: sample code

This code was written in MATLAB

**Step 1: Convert GPS to ECEF**

```matlab
function [X, Y, Z] = latlon2xyzTest(lat, long, h)

% Convert lat, long, height in WGS84 to ECEF X, Y, Z
% lat and long given in decimal degrees.
lat = lat/180*pi; % converting to radians
long = long/180*pi; % converting to radians
a = 6378137.0; % earth semimajor axis in meters
f = 1/298.257223563; % reciprocal flattening
e2 = 2*f - f^2; % eccentricity squared

chi = sqrt(1-e2*(sin(lat)^2));
X = (a/chi + h).*cos(lat).*cos(long);
Y = (a/chi + h).*cos(lat).*sin(long);
Z = (a*(1-e2/2))/chi + h).*sin(lat);
```

**Step 2: Convert ECEF to ENU**

```matlab
function [e, n, u] = xzenuTest(Xr, Yr, Zr, X, Y, Z)

% convert ECEF coordinates to local east, north, up

phiP = atan2(Zr, sqrt(Xr^2 + Yr^2));
lambda = atan2(Yr, Xr);

e = -sin(lambda).*((X-Xr) + cos(lambda).*((Y-Yr));
n = -sin(phiP).*cos(lambda).*((X-Xr) - sin(phiP).*sin(lambda).*((Y-Yr) + cos(phiP).*((Z-Zr);
u = cos(phiP).*cos(lambda).*((X-Xr) + cos(phiP).*sin(lambda).*((Y-Yr) + sin(phiP).*((Z-Zr);
```

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted, unless for course participation, in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the Publisher and/or Author. Contact the American Institute of Aeronautics and Astronautics, Professional Development Programs, 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191-5807.
MATLAB Code Generation Tools

Integrate algorithms with custom software
Prototype algorithms on PCs
Accelerate algorithm execution
Implement algorithms on embedded processor

Prepare > Test > Generate

C/C++
MEX

MATLAB Code Generation Report

Radar Tracking Using MATLAB Function Block

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted, unless for course participation, in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the Publisher and/or Author. Contact the American Institute of Aeronautics and Astronautics, Professional Development Programs, 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191-5807.
Simulink Model V&V Tools

- Collaboration: modeling standards checks
- Track design changes: traceability analysis
- Structural verification: model coverage
- Formal verification:
  - test generation
  - static error detection
  - requirements proving

Simulink Verification and Validation

- Design Component
- Generate Harness and Import Tests
- Harness Model
- Simulate
- Model Coverage Results

Simulink Design Verifier

- Increase Model Coverage
- Detect Potential Design Errors
- Validate Requirements
Access **MATLAB Online** with your Mathwork’s account at [www.matlab.mathworks.com](http://www.matlab.mathworks.com)

Enjoy Cloud Storage and Synchronization

- **MATLAB Drive** gives you up to 5Gb (250Gb free) to store, access, and manage your files from anywhere with MATLAB Online
- **MATLAB Drive Connector** enables synchronizing your files between your computers and MATLAB Online, eliminating the need for manual upload or download then

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted, unless for course participation, in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the Publisher and/or Author. Contact the American Institute of Aeronautics and Astronautics, Professional Development Programs, 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191-5807.
Installing MathWorks Products


Between-release updates

The End of Chapter 1

Questions?