

RUBY SPICE WRAPPER. N. M. Estes, K. S. Bowley, V. H. Silva, and the LROC team, School of Earth and Space Exploration, Arizona State University, Tempe, AZ (nme@ser.asu.edu)

Introduction: The Lunar Reconnaissance Orbiter Camera (LROC) Science Operations Center (SOC) developed a wrapper for the Navigation and Ancillary Information Facility (NAIF) Spacecraft & Planetary ephemerides, Instrument C-matrix and Event kernels (SPICE) toolkit [1,2] enabling the use of the SPICE toolkit in the Ruby programming language.

In programming, a “wrapper” is a library written to allow access to functions in a different language. The wrapper provides all necessary variable type changes, error handling, and other steps necessary to convert a function call and any returned value from the source programming language to the destination language. In this case, the Ruby SPICE wrapper performs this conversion allowing calls from the Ruby programming language to the C version of the SPICE toolkit.

Yukihiro “Matz” Matsumoto created Ruby with a goal of making a programming language with a syntax that felt more natural to the humans doing the programming [3]. The Ruby language enables rapid software development with a variety of high-level language features that makes it advantageous for quickly developing tools in support of LROC by developers, researchers, and operations staff.

Development of the Ruby SPICE wrapper began before the launch of the Lunar Reconnaissance Orbiter in 2009 and is still maintained today. The Ruby SPICE wrapper works in all versions of Ruby and has been tested in both Linux and OS X operating systems for the x86, x86_64, and Advanced RISC Machine (ARM) architectures (i.e. old PCs, new PCs/iMacs, and Raspberry Pis).

Special Note on the ARM Architecture: Note that ARM is not supported by NAIF, so testing is strongly advised before relying on any calculations done by the ARM version of the Ruby SPICE wrapper. The LROC SOC has successfully used the ARM version on multiple generations of the Raspberry Pi computer platform, such as on the portable “Where is LRO?” display (Fig. 1), but due to the complexity of floating point math in the ARM architecture, results may vary on a case-by-case basis. A compiled version of the SPICE library for ARM is included in the Ruby SPICE wrapper for convenient installation on Raspberry Pi [4] or compatible hardware.

Development: The Ruby SPICE wrapper is written using the C language version of the SPICE toolkit provided by NAIF. The original goal of the wrapper was to support the LROC SOC team, therefore only a

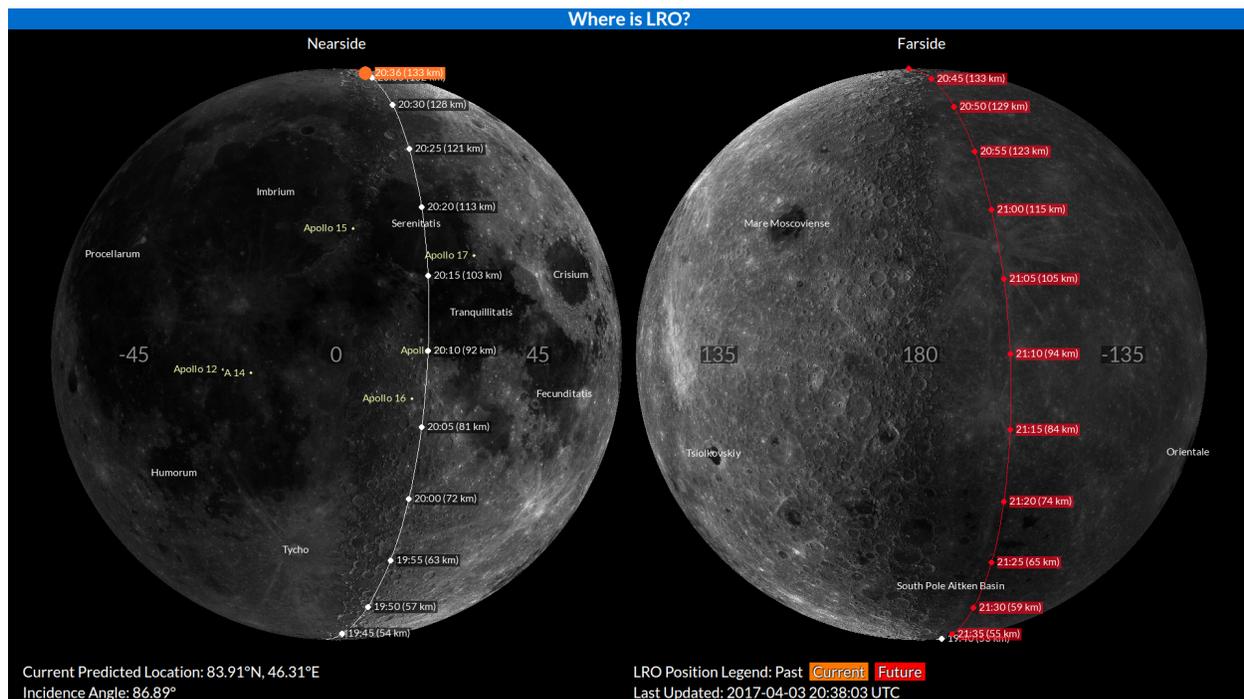


Figure 1: Screenshot from portable “Where is LRO?” calculating LRO’s position using the Ruby SPICE wrapper on a Raspberry Pi.

subset of the SPICE toolkit functions are currently available in the wrapper (List 1). Most SPICE functions are straightforward and can be added to the wrapper quickly. There are also convenience functions to convert between Ruby time objects and ephemeris time. SPICE errors are captured and returned as Ruby exceptions, therefore all normal error handling code in Ruby will function with the SPICE wrapper without issue. Each function within the wrapper ensures type safety and provides conversion between C and Ruby variable types. The LROC SOC developers found that certain errors, that were hard to diagnose, could occur when UNIX process signals are received while inside a SPICE function. To prevent these types of errors from occurring, all process signals are masked during the hand-off to the SPICE functions, and the original signal mask is restored on return to Ruby.

Usage: The LROC SOC uses the Ruby SPICE wrapper in the data processing pipeline to calculate geometry for observations, and by many of the operations tools any time SPICE is needed but a compiled C application would be too cumbersome to create and use. Since development within the Ruby programming environment is relatively quick (and easy to learn), the LROC SOC operations staff uses the Ruby SPICE wrappers for everything from quick one-off scripts, to programs and scripts routinely used in both for observation planning and in the processing pipeline. The Ruby SPICE wrapper is also used by Lunaserv [5] when calculating sub-solar points for the simple day/night (spherical) and DTM-based illumination layer types. Because of the accessibility of the Ruby language, the Ruby SPICE wrapper is also used to train new LROC SOC employees on SPICE basics.

Availability: The LROC Ruby SPICE wrapper is available as open source software as a dependency of the Lunaserv WMS software package. The wrapper is packaged as a standard Ruby library (gem) for ease of installation. The gem includes the compiled SPICE library for Linux (x86 & x86_64), OS X (Darwin), and Raspbian (ARM), but it can be compiled for other architectures by specifying the location of the SPICE library when installing the gem. The gem file for installation and related documentation can be found at: <http://lunaserv.lroc.asu.edu/downloads.html>

Conclusion: Since its initial version in 2009, the Ruby SPICE wrapper has enabled quick development of scripts and tools using SPICE for the LROC SOC. Currently, it enables developers, researchers, and operations staff to focus on solving problems without the overhead of working with a more complex compiled language.

References: [1] Acton, C. H.; Planetary and Space Science; 44(1):65; doi:10.1016/0032-0633(95)00107-7; 1996; ISSN 00320633. [2] NAIF SPICE Toolkit <https://naif.jpl.nasa.gov/naif/toolkit.html> [3] About Ruby; <https://www.ruby-lang.org/en/about/> [4] Raspberry Pi; <https://www.raspberrypi.org/> [5] Estes, N. M., et al.; LPSC 44; p. 2609; 2013.

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| • bodn2c | • latrec | • spkpos |
| • bodvcd | • lspcn | • str2et |
| • ckgp | • m2eul | • subpnt |
| • dpr | • m2q | • subslr |
| • eul2m | • mxv | • sxform |
| • furnsh | • pxform | • ucrrs |
| • gdpool | • q2m | • unload |
| • getfov | • reclat | • vcrss |
| • gfdist | • recrad | • vdist |
| • gfoflt | • rpd | • vdot |
| • gfsntc | • sce2c | • vnorm |
| • gfsep | • scs2e | • vperp |
| • gftfov | • sctiks | • vsep |
| • gfrfov | • sincpt | • vsub |
| • ilumin | • spkcov | • wninsd |
| • kclear | • spkezp | • xf2eul |
| • kttotal | • spkezr | |

List 1: SPICE functions currently available in the LROC Ruby SPICE wrapper.