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- as to the applicant's entitlement to claim the priority of the
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(54) Title: METHOD FOR REMOTE SYSTEM ONBOARD SOFTWARE UPDATING AND PROTECTION

(57) Abstract: Software updating and protection system comprising: Code repositories; Remote system and/or subsystem boot loader; Pre-compilation; and Power, communications, and processing sensor and communication systems.

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Method for remote system onboard software updating and protection

FIELD OF THE INVENTION

The present invention relates generally to a new method of storing and updating or replacing software code in an embedded computer system, with greatest application to remote systems located some distance from the user such that data communications is limited (for example environmental and equipment monitoring systems, unmanned aerial vehicle, satellites and robots). More specifically, the present invention is a new way of reducing the quantity of data communication necessary for a system to receive and update its operating system and application software. The present invention simplifies the updating of embedded software.

BACKGROUND OF THE INVENTION

Spacecraft Example: Currently, spacecraft software is written before the satellite is launched, is compiled into a binary and loaded into the spacecraft memory before launch. Some spacecraft allow the possibility to update the software by compiling a new binary on the ground and communicating the entire binary file to the spacecraft. Spacecraft are becoming more complex, and the software is becoming larger. The act of communicating the entire binary to the spacecraft takes time. This is especially true for spacecraft operating at great distance from earth.

When writing software it is common practice to store the software code in a code repository or “concurrent versioning system” that resides on a server. Updates made to any one or more software source files by a software developer are sent to the repository, which updates the “head” of the repository. The changes are sent to all other developers. In this way every developer can always be assured of having the latest version of the software code. An important aspect of the repository is that it only communicates the changes in the updated code file, and sometimes considerably less than the entire file. For example if line 2500 and 2501 are changed, only those two lines need be communicated from the developer to the repository.

DETAIL DESCRIPTIONS OF THE INVENTION

The present invention is a new method for updating embedded software by having a code repository on the remote system. To implement changes to the software, only the changed lines of code are uploaded to the embedded system, along with instructions on where in the code these are to be inserted. The code can be compiled and executed within the remote system. Upload verification is also proposed, to improve reliability.

Upload may be compressed by various means, including partial compiling or compiling into object files.

By retaining previous versions of the software, bot pre-compiled code and compiled binary files, it is possible to revert to a known-working version without uploading any code. Reversion can be autonomous, with triggers defined by the software developer or within the compiler or watchdog systems.

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The architecture on which this method is implemented is also part of this invention. A system architecture with multiple processors and memory banks can store code in one or more locations, compile it in one or more locations and execute it in one or more locations, each location being possibly on different subsystem, chip or virtual environment within the remote system.

Watchdog systems may be incorporated at the system level, within subsystems (circuit boards) and in the run environment.

The process of the present invention utilizes several main components onboard the remote system: A) software code repository (binary or text), B) binary system boot loader software and C) software compiler, D) means to execute the compiled code. This combination of non-obvious and unique method of software upload results in higher efficiency as compared with traditional systems and does not require the time-consuming uploading of an entire full-length binary code update.

The invention applies equally to software that must be compiled and to software that must be interpreted. In the later case, the compiler is not present and instead there is an interpreter. Variation on the compiler/interpreter are also possible.

It is envisaged that this invention will enable the field deployment of remote systems with no application software. All software can then be delivered and compiled after deployment.

This can be achieved by the following advances:

1. An algorithm distributing these three elements among the remote system's subsystems for efficiency of the compiler, repository, and reboot functions.
2. A versioning system history program for additional safety mechanisms related to fault protection based on a dual hash check verification process.

The simplicity of this approach – utilizing a code repository storage and self-correction mechanisms – allows for ease of implementation and readily scales to larger remote systems.

In the preferred embodiment, the present invention comprises the following machinery components:

1. Code repositories;
2. Remote system and/or sub-system boot loader;
3. Pre-compilation;
4. Power, communications, and processing sensor and communication systems; and

Although the invention has been explained in relation to its preferred embodiment, it is to be understood that many other possible modifications and variations can be made without departing from the spirit and scope of the invention as herein described including to terrestrial applications such as automobiles, aircraft, sea-going systems, and intelligent housing applications.

CLAIMS

1. Software updating and protection system comprising:
 - Code repositories;
 - Remote system and/or sub-system boot loader;
 - Pre-compilation; and
 - Power, communications, and processing sensor and communication systems.

INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G06F 9/00; G06F 9/06; G06F 12/00; G06F 12/14; G06F 21/00 (2017.01)

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC - 713/1; 713/2; 713/100; 713/189; 713/191; 713/194 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/0129846 A1 (LAMBERT et al) 15 June 2006 (15.06.2006) entire document	1
A	US 2010/0215280 A1 (ABDO et al) 26 August 2010 (26.08.2010) entire document	1
A	US 2010/0205596 A1 (CHUNG et al) 12 August 2010 (12.08.2010) entire document	1
A	US 5,878,432 A (MISHESKI et al) 02 March 1999 (02.03.1999) entire document	1
A	Predki et al, "Intelligent Platform-Management Controller for Low-Level RF Control System ATCA Carrier Board", IEEE Transactions on Nuclear Science, Vol. 58, No. 4, page 1538-1543, August 2011, Retrieved on 10 May 2017 from <URL: http://ieeexplore.ieee.org/document/5778959/ > entire document	1

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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