Introduction to GumStix Computers

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OVERVIEW

GumStix are computers whose motherboards are very similar in size to that of the average stick of gum. In 1982, Dr. W. Gordon Kruberg began developing a computer so small that it could fit into any articulating joint of a robot[1]. Development continued until 2003 when Dr. Kruberg partnered with Craig Hughes to transform his small device into a Fully-Functional Miniature Computer (FFMC). From this joint endeavor came GumStix computers.

These computers are preinstalled with a version of the Linux 2.6 Operating System and have a variety of feature-rich expansion components for adding WiFi, BlueTooth, Ethernet, and many other capabilities. Though small, speeds of these computers range between 200 and 600 MHz and support 64 or 128 MB of SDRAM. They do not support hard disk drives but store data in Flash memory – available from 4 to 32 MBs. Though the GumStix come preloaded with Linux, Windows CE has been successfully placed on GumStix[2].

The various configurations of CPU, RAM, and Flash memory storage are based on the design of three different types of motherboards. Because of the difference between motherboard designs, many expansion components are compatible with only certain models. Therefore, before buying a specific motherboard one must first understand which capabilities are necessary. Keep in mind that "gum packs" and cases for models are available to make product selection easier.

Though not very well pronounced in society as of yet, GumStix have already been appearing in areas of research and that of industry. Manufacturers in over 60 countries

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[1] http://gumstix.com/company.html#facts
[2] http://docwiki.gumstix.org/Wince

have already begun integrating GumStix into products[3]. With the investment of such interest, it is just a matter of time until they will become more ingrained into the commercial aspects of companies.

COMPONENTS

As aforementioned, the GumStix FFMCs contain various hardware components. Decisions need to be prior to acquisition to properly select the model of motherboard since this circuited device dictates CPU, RAM, storage space, and expansion capabilities.

Three basic motherboard designs are available: Verdex, Connex, and Basix. Different models based upon these designs have additional features integrated into the board. Typically, the Verdex is the most powerful of the three designs, Connex is the most expandable, and Basix is the most basic GumStix model.

The expansion capabilities available for the GumStix are what make the small design idea so flexible for projects. The expansions allow for audio, general purpose input/output (GPIO), additional serial ports, Compact Flash cards, USB connectivity, BlueTooth, Ethernet, Robotics Microcontrollers, WiFi, and different power sources. For this reason, extendibility, GumStix are ideal for computer and electronics development.

The idea of the "gum packs" is to include all the components and accessories needed for a specific type of project into a single purchasable item. They also decrease the cumulative price of the individual components. This decreases the price and time in the decision-making process.

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[3] http://docwiki.gumstix.org/Gumstix_images_OEM

PROJECTS

GumStix have been more than sufficient for projects ranging from hobbyist-level interests to educational experimentation and even advancement in present technologies. Due to their compact design, extensive functionality, and communicative capabilities GumStix has aided in the design and development of an impressive assortment of devices. With the progress that users have made, a stage is being established through documentation for future enthusiasts by presenting the details of achieving goals with the GumStix's capabilities.

The compact design of GumStix provides power with reduced physical limitations. The dimensions and weight play an important role in many projects that require minimal size and controllable processing capability. Projects that previously required custom parts and programming can now utilize onboard computers programmable in typical high-level languages without sacrificing mobility. This extends their use for such things as personal audio players[4], mobile phones[5], and even small-scale robots[6].

Projects have also been taking advantage of not only the GumStix size, but also their functionality in regards to processing capability and expandability. Many of these projects have been focused in areas of robotics and interaction with other entities: robot-robot interaction[7], robot-animal interaction[8], and animal simulation[9]. Others have been

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[4] http://www.srcf.ucam.org/~jac208/dokuwiki-2006-11-06/doku.php
[5] http://www.hbmobile.org/wiki/index.php
[6] http://cs.gmu.edu/~eclab/projects/robots/flockbots/pmwiki.php
[7] http://fas.sfu.ca/newsitems/vaughan-chatterbox/
[8] http://www.cs.sfu.ca/~vaughan/projects/RSP.html
[9] http://cswww.essex.ac.uk/staff/hhu/

focused on autonomous vehicles that include fixed-wing[10] and rotating-wing[11] aerial devices as well as a submersible[12] one that was used in a competition.

In recent years, GumStix have begun sporting a variety of communication capabilities that have allowed for WiFi, Bluetooth, Ethernet, and GPS. With these abilities, individuals have successfully used GumStix to detect network intrusions[13], host a webserver[14], play laser-tag[15], and track a high-altitude helium balloon[16]. Due to the additional boards supporting this plethora of communication venues, almost anyone can harness the protocols used today for their own custom-built devices.

To many, GumStix have proven their mettle. Considering the assets that GumStix have in expansions and accessories, the possibilities are virtually endless. Future projects may lead to the betterment of human life like GumStix being used in "Smart" prosthetic limbs that could react to nerve signals or being used in devices to explore and operate in hazardous areas via remote control or autonomously with the use of GPS. Some possibilities are more mundane uses could be self-guided tours of areas or electronic "bulletin boards" that can save and serve messages to / from Bluetooth-enabled cell phones. All that's needed is the knowledge of how to program it and the imagination to think outside the box.

[10] http://art1.mae.ncsu.edu/index.php
[11] http://www.pabr.org/chromicro/doc/chromicro.en.html
[12] http://www.auvsi.org/competitions/06journal/VT.pdf
[13] http://public.cabit.wpcarey.asu.edu/enips/index_main.html
[14] http://wiki.tuxedo-es.org/SEGumstix
[15] http://secs.elwiki.com/Main_Page
[16] http://www.pegasushabproject.org.uk/

PROGRAMMING

Many programs come preloaded on the GumStix[17]. Basic modifications can be performed just by logging into the device via serial (Windows) or BlueTooth (Mac), making the preferred changes, and recompiling the kernel. Additionally, programming GumStix can be accomplished by a cross-compilation toolchain[18]. This allows the development to be performed on a more powerful separate computer then transferring the completed binaries to the device.

Buildroot, a system configuration and update utility, is used for handling the development process[19]. A few things are necessary in order to operate this program: a Linux operating system (can be used in VMware or Colinux), a Subversion client, a C compiler, a network connection, and 150 MB of disk space. Using Buildroot also has the added benefit of allowing access to other users' provided code. Therefore, one should investigate what Buildroot has available before setting out to develop additional programs.

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[17] http://docwiki.gumstix.org/Frequently_asked_questions/Software#General_Listing
[18] http://docwiki.gumstix.org/Programming
[19] http://docwiki.gumstix.org/Buildroot

NOTABLE SITES

GumStix Procurement
The main site for GumStix - http://gumstix.com

GumStix Information
GumStix Wiki - http://docwiki.gumstix.org/
GumStix Schematics - http://docwiki.gumstix.org/Schematics
GumStix Benchmarks - http://docwiki.gumstix.org/Benchmarks
GumStix Power Usage - http://docwiki.gumstix.org/Power_spec
GumStix FAQ - http://docwiki.gumstix.org/Frequently_asked_questions

GumStix Development
GumStix Web-Capable Subversion site - http://websvn.gumstix.com/
GumStix SDK - http://docwiki.gumstix.org/Software_development_kit
WinCE on GumStix - http://www.codeplex.com/gumstix
Setting up a GumStix computer - http://docwiki.gumstix.org/Tutorial

Miscellaneous
Ideas for "better" GumStix - http://docwiki.gumstix.org/Next_gen_gumstix
Projects using GumStix - http://docwiki.gumstix.org/Customer_projects

MOTHERBOARD SPECIFICATIONS

Model	CPU	RAM	STORAGE	Connection	Features
Basix 200	200 MHz PXA255	64 MB	4 MB Flash MMC	Hirose	None
Basix 400xm	400 MHz PXA255	64 MB	16 MB Flash MMC	Hirose	None
Basix 400xm-bt	400 MHz PXA255	64 MB	16 MB Flash MMC	Hirose	BlueTooth
Connex 200xm	200 MHz PXA255	64 MB	16 MB Flash	Hirose Bus	None
Connex 400xm	400 MHz PXA255	64 MB	16 MB Flash	Hirose Bus	None
Connex 400xm-bt	400 MHz PXA255	64 MB	16 MB Flash	Hirose Bus	BlueTooth
Verdex 400xm[1]	400 MHz PXA270	64 MB	16 MB Flash	Hirose MOLEX Flex	USB CCD
Verdex 400xm-bt[2]	400 MHz PXA270	64 MB	16 MB Flash	Hirose MOLEX Flex	USB CCD BlueTooth
Verdex 600xl Pro[3]	600 MHz PXA270	128 MB	32 MB Flash	Hirose MOLEX Flex	USB CCD

PXA255 processors are manufactured by Intel and use XScale technology.
PXA270 processors are manufactured by Marvell and use XScale technology.
All RAM modules are SDRAM.
MMC indicates a MMC/SD adapter is present on the motherboard.
Hirose indicates a 60-pin Hirose I/O connector is present – used for Basix expansions.
Bus indicates a 92-pin Bus I/O header is present – used for Connex expansions.
MOLEX indicates a 128-pin MOLEX connector is present.
Flex indicates a 24-pin Flex connector present.
BlueTooth indicates that the motherboard supports BlueTooth and includes antenna.
USB indicates that a USB host signal can be utilized.
CCD indicates that a CCD camera signal can be utilized.
[1]: "Verdex 400xm" also goes by the title "Verdex 400XM4".
[2]: "Verdex 400xm-bt" also goes by the title "Verdex 400XM4-bt".
[3]: "Verdex 600xl pro" also goes by the title "Verdex 600 XL6P".

EXPANSION BOARDS

Model	Connector	Features
AudioStix 2	Hirose (A)	LCD, Audio I/O, Mini-B, GPIO, Power, 3.5-5V
Breakout-gs	Hirose (A)	Mini-B, GPIO, Power, 3.5-5V
Breakout-vx	Hirose (V)	LCD, Mini-B Host, GPIO, I2C, Power, 3.5-5V
Cfstix	Bus (C)	CF, Power, 3.5-5V
Console-hw[1]	Hirose (B)	Mini-B, 2 Serial, Power, 3.5-6V
Console-st	Hirose (A)	Mini-B, 2 Serial, Power, 3.5-6V
Console-vx	Hirose (V)	Mini-B Host, 3 Serial, LCD, GPIO, Power, 3.5-5V
GPSstix	Hirose (A)	GPS, Audio I/O, Mini-B, GPIO, LCD , Power, 3.5-5V
netCF	Bus (C)	Ethernet, CF, Power, 3.5-5V
netDUO-mmc	Bus (C)	2 Ethernet, MMC, Power, 3.5-5V
netMMC	Bus (C)	Ethernet, MMC, Power, 3.5-6V
Roboaudio-TH	Hirose (A)	I2C, SPI, Audio, 5-6V
RoboStix	Hirose (A)	I2C, SPI, Power, 5-6V
RoboStix-TH	Hirose (A)	I2C, SPI, Power, 5-6V
thumbStix[2]	Hirose (A)	Type-A
Tweener	Hirose (A)	Serial, Power, 3.5-5V
Wifistix-CF-EU	Bus (C)	CF, Wifi, 1-13 channels, Power, 3.5-6V
Wifistix-CF-FCC	Bus (C)	CF, Wifi, 1-11 channels, Power, 3.5-6V
Wifistix-EU	Bus (C)	Wifi, 1-13 channels, Power, 3.5-6V
Wifistix-FCC	Bus (C)	Wifi, 1-11 channels, Power, 3.5-6V

Connector shows type and motherboard: A – any, B – Basix, C – Connex, V - Verdex
?-?V indicates power consumption of the component.
1-1X channels indicates number of Wifi Channels available.
Audio indicates component can process audio data.
Audio I/O indicates component has audio input/output outlets.
CF indicates component can interface with Type II Compact Flash cards.
Ethernet indicates component has a RJ-45 port for 10/100BaseT cables.
GPIO indicates component possesses support for GPIO lines.
GPS indicates component has GPS capability.
I2C indicates an Inter-Integrated Component Bus onboard.
LCD indicates component has capability to handle LCD signals.
Mini-B indicates a Mini-B USB socket.
Mini-B Host indicates a Mini-B USB Socket that is capable of sending host signals.
MMC indicates interface capability with MMC/SD cards.
Power indicates a power jack is onboard.
Serial indicates a RS-232 MiniDin8 serial port onboard.
SPI indicates a Serial Peripheral Interface is present onboard.
Type-A indicates a Male Type-A USB socket.
Wifi indicates that the component is capable of 802.11(b/g) communication.
[1]: The Console-hw also goes by the name "waysmall HWUART" and should only be used by Basix motherboards without BlueTooth. Otherwise, use the "Console-st".
[2]: Thumbstix uses the Type-A USB socket to provide power. The power use is not sufficient for boards with an Ethernet port.