The Rochester Computer Society, Inc.

a computer/tech club open to everyone

MONITOR

Vol. 36, No. 12 December 2018

Founded 1982
www.rcsi.org

"Your Computer User Group of the Air", Saturdays from 12:00 pm to 2:00 pm with Nick Francesco, Dave Enright, and Steve Rae. Broadcasting on JAZZ 90.1 FM from Rochester, NY.
Call 966-JAZZ (585-966-5299) or 800-790-0415

The RCSI '**Monitor**' newsletter can be found in most public libraries in Monroe County. *Free* copies can also be found in the following computer stores: Microworx, Just Solutions, TSC Electronics, and Pod Computers. Digital copies may be obtained from **www.rcsi.org** or my cloud storage at **http://tinyurl.com/tonydel-rcsi-newsletters/**.

Some Past Presentations:

Open Source and Free Software
Protecting Your Identity
Keeping Mobile Devices Secure
3D Printing, ENABLE project
Flash Drives-Not Just for Storage
Features, Mac OS X & Windows
Tablets, the Programs and Uses
Personal Finance Software
Amazing Browser Tips
Linux is Like Cars
Close up Photography

Member of apcug
An International Association of Technology & Computer User Groups

Tues, January 8, 2019

6:30 Help's Half Hour, 7:00 Business, 7:15 Main Presentation
our meetings end between 8:30 and 9:00 pm

In This Issue

Ask Leo !
By Leo Notenboom, https://askleo.com/
Technology With Confidence
Making Technology Work For Everyone

Don't Lose Your Phone: Here's What Can Happen (and How to Prepare)

Given how much we've come to rely on them, are you prepared to lose your mobile device?

Mobile phones are amazing devices. They're much more than just having your email or social media at your fingertips; they're truly portable general-purpose computers that also happen to be able to make phone calls.

TSC

Computer
and Electronics
Repair

Custom Computers - Electronic Surplus and Recycling
Home Service - Small and Mid Size Business IT Mgmt.

765 Elmgrove Rd. Ste 2
Rochester, NY 14624

Phone (585) 429-6880
Fax (585) 429-7671

www.tscelectronics.com

Special Interest Group

Linux Sig

The workshop is the **third Saturday of each month**, at Interlock Rochester, 1115 East Main St.
www.interlockroc.org
Enter through door #7 on the end of building, near *Comics Etc* and Goodman St. Find 'Interlock' on the intercom directory to get buzzed in and go upstairs to suite #200. We have experts on hand to fix problems and answer questions about Linux and FOSS (free and open source software). Bring your system in so we can help you get the most out of it. Hope to see you there.

Special Request

This is your newsletter. Are there articles you would like to see more of **or** possibly less of. Is there a topic of interest that you would like me to research and put into print. In other words, is this newsletter benefiting you.

tonydel@techie.com

We do a lot with our phones. Because they're always with us, they're one of our primary means of content consumption — everything from social media to news to maps to ebooks and more — as well as our primary means of communication (though ironically, rarely by actually using the telephone) and one of our primary content-creation devices as well, in the form of photos and videos.

As tiny computers, we've come to rely on them to store data, act as security keys, wallets, fitness trackers, automotive trackers, and dozens of things I can't even think of right now.

Given everything we use our phones for, to say that we shouldn't lose them is stating the obvious. And yet lose them we do. I'm going to review some of the things you need to be aware of when (not if) you lose your phone, and some of the ways you can mitigate the damage when it happens.

Summary:

- You lose access to data on the phone.
- You lose control of data that can be accessed by the phone.
- You risk losing access to any account that can be accessed by the phone.
- You risk losing access to your accounts via other means.
- You risk someone being able to impersonate you.

- Back up all data on your phone.
- Set a PIN
- Use a tracking service, ideally with remote-wipe.
- Have backup mechanisms in place for two-factor authentication.
- Contact your carrier immediately.

If it's in only one place

The first thing most people think of when they lose their phone is the collection of photographs and videos they keep on it. Most commonly, these are images they've taken using the device and haven't bothered to copy anywhere else.

In other words, they're not backed up. They exist only on the phone. When the phone is lost or stolen, so are all the photos.

While a few items might have been shared either directly or via social media or other means, you can't count on it. You also can't count on those that were shared having been saved, or having been shared in original quality.

Remember, of all the other data you keep, particularly on your phone, photos and videos are the only ones that cannot be re-created.

If it's on your phone, it's in their hands

If your phone is stolen, the data on it is now in someone else's hands. *All* of the data stored on your phone: your emails, contacts, texts, chats, documents, photos and videos, and everything else.

And yes, it's sometime difficult to know what's on the phone and what's online in "the cloud". As a result, you must assume it's all been handed to the person now holding your phone. Besides, as we'll see shortly, the distinction between what's on your phone and what's online may well be irrelevant.

RCSI Officers

Pres: Steve Staub 429-9877
srstaub1@rochester.rr.com
VP: Mark S. Lawson . . . 544-5377
mslawson51@peoplepc.com
Treas: Dennis P. McMahon
. . . . 235-1260
denmac733@gmail.com
Secretary: www.rcsi.org
Help's Half Hour . . Jan Rothfuss

Board Members at Large

Tony Dellelo 734-6149
tonydel@techie.com, 9/21
Bob Avery 385-4491
webmaster@rcsi.org, 9/20
Jan Rothfuss 347-6020
jan_rothfuss@hotmail.com, 9/19

Standing Committees

Linux SIG: . . . Carl Schmidtmann
unixgeek@faultline.com
Programs and *Monitor* editor: . . . .
. . . . Tony Dellelo
Webmaster: . . . . Bob Avery
Membership: . . . . Steve Staub

Planning Meeting

Held on 1st Tuesday of each month at 7 pm, at St. John's Meadows, Briarwood building.

Newsletter Printing

The newsletter was printed at St John's/Chestnut Court by the printing group, with the help of Don Wilder (computer and printer operator). *We will try and print on the 1st or 2nd **Thursday morning**, following the monthly meeting.*

If your phone is your key

Security experts and not-so-experts strongly recommend two-factor authentication as a means of securing your online accounts. Without a doubt, for maximum security you should avail yourself of this option if it's available for any account you consider important.

Phones are common and convenient two-factor authentication devices. Be it via code-generating apps that run on the phone, to codes in text messages that you receive when logging on elsewhere, your ability to provide those codes on demand "proves" you have the phone — the second factor — in your possession. Thus, you must be who you claim to be.

When a phone is stolen, the first thing people worry about with two-factor authentication is that the thief now has their second factor. That's typically not as huge a problem as you might think: they need both factors — your password and the phone — in order to sign in as you elsewhere. *Typically,* getting access to the phone won't gain them access to your passwords as well.

The real, larger problem is *you no longer have your second factor*. Unless you've prepared, you may not be able to log in to the accounts so protected.

Your phone becomes their portal

Much of the data we access using our phone is not actually stored on the phone. Using various apps and interfaces, our phone is a portable gateway to our online world. Email is the most obvious, but cloud-storage services, note-taking apps, music players and more all work primarily by fetching your information from your accounts online.

Once a thief has access to your phone, they have access to this portal. They can — and often do — proceed to immediately change your email password so as to take control of that account, and at the same time remove their need for your phone to continue; they can access your email anywhere now. Since your email is also often your backup/recovery account for other online services, just getting access to that opens a second portal for the thief to then wrest control of those accounts as well.

They might become you

Stealing your mobile device is one of the best ways hackers and thieves begin to impersonate you, possibly even leading to outright identity theft. Not only by stealing your accounts, as I've discussed above, but by literally impersonating you. Calls they make, or perhaps more realistically, text messages they send, appear to have come from you. They can use that ability to fool everyone from online services and banks to your friends and family.

So, what to do?

Now that I've laid out the great risk we embrace by relying so heavily on these portable and easily lost or stolen devices, what should we do?

Certainly returning to luddite ways and abandoning the technology is not an option. Oh, I know it will be for some people, but it's their loss.

And there's no need. There are several simple steps you can take to protect yourself.

Back up your phone

Particularly when it comes to photos and videos, there's simply no excuse. Most cloud storage apps like Dropbox, OneDrive, and others offer to *automatically* upload the photos and videos you take. Depending on your choice, they can upload immediately regardless of where you are as long as you have an Internet connection, or they can upload the next time you're connected to Wi-Fi, so as to save on your mobile data plan.

If you do nothing else, back up your photos.

When it comes to the rest of the information on your phone, solutions vary. By virtue of being linked to an online account, for example, email and contacts are often automatically backed up. Many mobile providers automatically track which apps you have installed and reinstall them if you move to a replacement phone.

The data stored by the various apps you have installed, however, is a wild card. For each app with which you have a significant investment of data, make sure you understand where that data is stored and what happens if your device disappears. If additional backups are called for, look to the app developer for guidance.

Set a PIN

One very simple step to protecting the information on your phone is to set an unlock code or PIN, and make sure your phone automatically locks after some amount of time.

In order to access the device, the correct PIN must be entered. Without it, accessing what's on your phone becomes difficult, if not impossible.

Also, consider configuring your phone such that if the wrong PIN is entered too many times — say ten times — then the phone automatically wipes all data.

A PIN isn't perfect — it's sometimes easy to guess or "shoulder surf" (watch someone enter their pin) — but it's an excellent first level of defense when it comes to protecting the information on and accessible by your mobile device.

Consider a tracking service

You may or may not need an additional tracking service for your phone — you may already have one, courtesy of your platform (iPhone or Android) or your mobile carrier. In my opinion, it's important that such a service have the following features:

- The ability to locate your phone using its GPS.
- The ability to remotely lock and/or wipe your phone of all data.
- The ability to display a message on the phone's screen.

Remote wipe is critical, in my opinion, as it's the only way to protect yourself should a thief gain access to your device.

Personally, in addition to the facilities made available via Android and my carrier, I use Prey to protect my phone, my wife's phone, and the laptop with which I travel most.

Set up two-factor properly

It's not enough to set up two-factor authentication. Whenever possible, you need to set up a recovery mechanism.

Most services that use two-factor have alternate approaches available when your second factor, such as your phone, isn't available. They're often more cumbersome and time consuming, but they're infinitely preferable to not being able to access your account at all. Some of the recovery mechanisms include:

- Additional second factors, such as additional devices or text-message numbers to which a code can be sent.
- One-time passwords. These are created and saved somewhere safe. Should you not be able to log in using your second factor, you can use a one-time password instead. As the name implies, each can be used exactly once. If you run out of these passwords, you return to the service to generate more. The critical thing to realize is that you need to create one-time passwords before you need them, and keep them in a safe place.

Articles by RCSI members may be reprinted by other user groups, without special permission, provided they are unaltered and the publication emails a copy to the author. Articles by authors from other organizations retain their original copyright. Articles provided by the Association of Personal Computer User Groups (APCUG) may be reprinted if credits remain intact.

Computer Recycling

Some Residential Drop off Locations: **Call first**, to find out what is accepted, especially for 'tube type' tvs or monitors.

Pod Computers accepts most electronic waste (no tv's or crt's), located at 1925 South Ave, the wedge where South Ave and East Henrietta Rd meet. 244-2240.

Monroe County *ecopark*
(Cathode Ray Tube TVs and monitors - $10 each credit/debit card only) 10 Avion Drive
Rochester, NY 14624
Phone: (585) 753-7600 (Option #3)

Best Buy stores accept most electronic waste (CRT and some other TVs include a fee of $25 each)

Maven Technologies offers *free* residential drop off, 9:00 am – 4:00 pm (M-F), 1450 Lyell Avenue, Rochester, NY. The processing center is located on the NW corner of Lyell and Mt Read, behind the 'strip mall'. Go to the customer entrance. 458-2460.

- Recovery email address(es). Again, these must be set up beforehand, but they act as a type of second factor: prove you can access this pre-defined account, and you must be who you say you are.

Regardless, make absolutely certain that if you lose your two-factor device, you have an alternate way in.

Contact your mobile provider as soon as possible
Finally, if your phone has been lost or stolen, contact your mobile provider as quickly as possible. There are two reasons you don't want to waste time on this:

- They can disable the phone, preventing it from accessing the mobile network (though the phone will likely still be able to access the Internet via a Wi-Fi connection).
- They will be aware of all the security options — from remote wipe to simply locating the phone — that may be preinstalled, and be able to help you make the wisest decisions about what steps you need to take.

Given how much we use them and what we use them for, losing your mobile device is no small matter. It pays to prepare beforehand and act quickly when disaster strikes.

* * * End of Article * * *

Model paves way for faster, more efficient translations of more languages

by Rob Matheson | MIT News Office

New system may open up the world's roughly 7,000 spoken languages to computer-based translation.

MIT researchers have developed a novel "unsupervised" language translation model — meaning it runs without the need for human annotations and guidance — that could lead to faster, more efficient computer-based translations of far more languages.

Translation systems from Google, Facebook, and Amazon require training models to look for patterns in millions of documents — such as legal and political documents, or news articles — that have been translated into various languages by humans. Given new words in one language, they can then find the matching words and phrases in the other language.

But this translational data is time consuming and difficult to gather, and simply may not exist for many of the 7,000 languages spoken worldwide. Recently, researchers have been developing "monolingual" models that make translations between texts in two languages, but without direct translational information between the two.

In a paper being presented this week at the Conference on Empirical Methods in Natural Language Processing, researchers from MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) describe a model that runs faster and more efficiently than these monolingual models.

The model leverages a metric in statistics, called Gromov-Wasserstein distance, that essentially measures distances between points in one computational space and matches them to similarly distanced points in another space. They apply that technique to "word embeddings" of two languages, which are words represented as vectors — basically, arrays of numbers — with words of similar meanings clustered closer together. In doing so, the model quickly aligns the words, or vectors, in both embeddings that are most closely correlated by relative distances, meaning they're likely to be direct translations.

In experiments, the researchers' model performed as accurately as state-of-the-art monolingual models — and sometimes more accurately — but much more quickly and using only a fraction of the computation power.

"The model sees the words in the two languages as sets of vectors, and maps [those vectors] from one set to the other by essentially preserving relationships," says the paper's co-author Tommi Jaakkola, a CSAIL researcher and the Thomas Siebel Professor in the Department of Electrical Engineering and Computer Science in MIT's Institute for Data, Systems, and Society. "The approach could help translate low-resource languages or dialects, so long as they come with enough monolingual content."

The model represents a step toward one of the major goals of machine translation, which is fully unsupervised word alignment, says first author David Alvarez-Melis, a CSAIL PhD student: "If you don't have any data that matches two languages … you can map two languages and, using these distance measurements, align them."

Relationships matter most

Aligning word embeddings for unsupervised machine translation isn't a new concept. Recent work trains neural networks to match vectors directly in word embeddings, or matrices, from two languages together. But these methods require a lot of tweaking during training to get the alignments exactly right, which is inefficient and time consuming.

Measuring and matching vectors based on relational distances, on the other hand, is a far more efficient method that doesn't require much fine-tuning. No matter where word vectors fall in a given matrix, the relationship between the words, meaning their distances, will remain the same. For instance, the vector for "father" may fall in completely different areas in two matrices. But vectors for "father" and "mother" will most likely always be close together.

"Those distances are invariant," Alvarez-Melis says. "By looking at distance, and not the absolute positions of vectors, then you can skip the alignment and go directly to matching the correspondences between vectors."

That's where Gromov-Wasserstein comes in handy. The technique has been used in computer science for, say, helping align image pixels in graphic design. But the metric seemed "tailor made" for word alignment, Alvarez-Melis says: "If there are points, or words, that are close together in one space, Gromov-Wasserstein is automatically going to try to find the corresponding cluster of points in the other space."

For training and testing, the researchers used a dataset of publicly available word embeddings, called FASTTEXT, with 110 language pairs. In these embeddings, and others, words that appear more and more frequently in similar contexts have closely matching vectors. "Mother" and "father" will usually be close together but both farther away from, say, "house."

Providing a "soft translation"

The model notes vectors that are closely related yet different from the others, and assigns a probability that similarly distanced vectors in the other embedding will correspond. It's kind of like a "soft translation," Alvarez-Melis says, "because instead of just returning a single word translation, it tells you 'this vector, or word, has a strong correspondence with this word, or words, in the other language.'"

An example would be in the months of the year, which appear closely together in many languages. The model will see a cluster of 12 vectors that are clustered in one embedding and a remarkably similar cluster in the other embedding. "The model doesn't know these are months," Alvarez-Melis says. "It just knows there is a cluster of 12 points that aligns with a cluster of 12 points in the other language, but they're different to the rest of the words, so they probably go together well. By finding these correspondences for each word, it then aligns the whole space simultaneously."

The researchers hope the work serves as a "feasibility check," Jaakkola says, to apply Gromov-Wasserstein method to machine-translation systems to run faster, more efficiently, and gain access to many more languages.

Additionally, a possible perk of the model is that it automatically produces a value that can be interpreted as quantifying, on a numerical scale, the similarity between languages. This may be useful for linguistics studies, the researchers say. The model calculates how distant all vectors are from one another in two embeddings, which depends on sentence structure and other factors. If vectors are all really close, they'll score closer to 0, and the farther apart they are, the higher the score. Similar Romance languages such as French and Italian, for instance, score close to 1, while classic Chinese scores between 6 and 9 with other major languages.

"This gives you a nice, simple number for how similar languages are … and can be used to draw insights about the relationships between languages," Alvarez-Melis says.

Reported on the MIT website, www.news.mit.edu, October 30, 2018.

The most prolific planet-hunting machine in history has signed off.

by Mike Wall, space.com senior writer, Oct 30, 2018

NASA's Kepler space telescope, which has discovered 70 percent of the 3,800 confirmed alien worlds to date, has run out of fuel, agency officials announced today (Oct. 30). Kepler can no longer reorient itself to study cosmic objects or beam its data home to Earth, so the legendary instrument's in-space work is done after nearly a decade.

And that work has been transformative.

"Kepler has taught us that planets are ubiquitous and incredibly diverse," Kepler project scientist Jessie Dotson, who's based at NASA's Ames Research Center in Moffett Field, California, told Space.com. "It's changed how we look at the night sky."

NASA's prolific Kepler Space Telescope has run out of fuel, agency officials announced on Oct. 30, 2018. The planet-hunting space telescope discovered thousands of alien worlds around distant stars since its launch in 2009. Today's announcement was not unexpected. Kepler has been running low on fuel for months, and mission managers put the spacecraft to sleep several times recently to extend its operational life as much as possible. But the end couldn't be forestalled forever; Kepler's tank finally went dry two weeks ago, mission team members said during a telecon with reporters today.

"This marks the end of spacecraft operations for Kepler, and the end of the collection of science data," Paul Hertz, head of NASA's Astrophysics Division, said during the telecon.

Leading the exoplanet revolution

Kepler hunted for alien worlds using the "transit method," finding the brightness dips caused when a planet crosses its star's face from the spacecraft's perspective.

Those dips are tiny — so tiny, in fact, that NASA officials were originally dubious that a spacecraft could make such measurements. The driving force behind Kepler, Ames' Bill Borucki, had four mission proposals rejected in the 1990s before finally breaking through in 2000, after he and his team demonstrated the instrument's sensitivity at a test-bed facility on Earth. (Borucki retired in 2015.)

It still took a while for Kepler to get aloft. The spacecraft launched in March 2009, on a $600 million mission to gauge how common Earth-like planets are throughout the Milky Way galaxy.

Initially, Kepler stared continuously at a single small patch of sky, studying about 150,000 stars simultaneously. That work was incredibly productive, yielding 2,327 confirmed exoplanet discoveries to date.

In May 2013, however, the second of Kepler's four orientation-maintaining "reaction wheels" failed. The spacecraft couldn't keep itself steady enough to make its ultraprecise transit measurements, and Kepler's original planet hunt came to an end.

But the spacecraft wasn't done. Kepler's handlers soon figured out a way to stabilize it using sunlight pressure, and, in 2014, NASA approved a new mission called K2. (Sending astronauts to service Kepler is out of the question; the spacecraft orbits the sun, not Earth, and is millions of miles from our planet.)

During K2, Kepler studied a variety of cosmic objects and phenomena, from comets and asteroids in our own solar system to faraway supernova explosions, over the course of different 80-day "campaigns." Planet-hunting remained a significant activity; the K2 alien-world haul stands at 354 as of today.

Kepler's observations over both of its missions suggest that planets outnumber stars in the Milky Way and that potentially Earth-like worlds are common. Indeed, about 20 percent of sun-like stars in our galaxy appear to host rocky planets in the habitable zone, the range of distances where liquid water could exist on a world's surface.

"Kepler's exoplanet legacy is absolutely blockbuster," Dotson told Space.com.

But the mission's legacy extends to other fields as well, she stressed. For example, Kepler's precise brightness measurements — which the telescope has completed for more than 500,000 stars — are helping astronomers better understand the inner workings of stars. And the instrument's supernova observations could shed considerable light on some of the most dramatic events in the universe.

"We've seen explosions as soon as they happen, at the very beginning," Dotson said. "And that's very exciting if you'd like to figure out why things go, 'Boom!'"

Not done yet

Even though Kepler has closed its eyes, discoveries from the mission should keep rolling in for years to come. About 2,900 "candidate" exoplanets detected by the spacecraft still need to be vetted, and most of those should end up being the real deal, Kepler team members have said.

A lot of other data still needs to be analyzed as well, Dotson stressed.

And Kepler will continue to live on in the exoplanet revolution it helped spark. For example, in April, NASA launched a new spacecraft called the Transiting Exoplanet Survey Satellite (TESS), which is hunting for alien worlds circling stars that lie relatively close to the sun (using the transit method, just like Kepler).

Some of TESS' most promising finds will be scrutinized by NASA's $8.9 billion James Webb Space Telescope, which is scheduled to launch in 2021. Webb will be able to scan the atmospheres of nearby alien worlds, looking for methane, oxygen and other gases that may be signs of life.

Kepler's death "is not the end of an era," Kepler system engineer Charlie Sobeck, also of NASA Ames, told Space.com. "It's an occasion to mark, but it's not an end."

* * * End of Article * * *

* * * * * SOFTWARE and HARDWARE * * * * *

Dan's Desk

Computer Fundamentals #2

By Dan Douglas, President
Space Coast PCUG, FL

Here is part 2 of my series on "Computer Fundamentals" - a series of articles to explain the fundamentals of computers, programming and their usage that will hopefully deepen your understanding of how it all works and why things are the way they are.

This time we will examine two core parts that make any computer more than an assortment of electronic components:

1. the operating system (OS)
2. a program (app or application)

Both are software, that is many lines of programming code that performs a set of functions that must be loaded onto a hardware platform to operate. Hardware is the real set of electronic components that make up a computing device. A typical hardware desktop has the following core parts:

- a motherboard
- a central processing unit or CPU
- one or more memory chips
- storage devices (DVD/CD/hard drive, etc.)
- a video display
- input devices – keyboard, mouse, touchscreen, etc.

The OS is the programming code that allows the hardware to do something. Without an OS you get a blinking cursor and nothing else. It is often called the system software to differentiate it from application software. The OS allows the hardware to process application programs written in any number of languages to operate on a given hardware platform. In essence, the OS translates certain instructions from the app to perform specific tasks using the hardware. The OS controls hardware devices using 'drivers' which translate instructions into commands that a specific piece of hardware can perform. The OS also controls the allocation of the system memory, usually called Random Access Memory or RAM. RAM is the memory sticks or chips that every computing device contains that is required to load instructions into to trigger some activity. Typically, a desktop or laptop computer contains around 4GB today. All the most popular operating systems can also allocate a file on a disk drive to serve as 'virtual memory' which effectively doubles the amount of memory available for the OS to assign to program tasks.

An app is the piece of software that works in conjunction with the OS to allow a user to process some input, do something with it and produce some output. Each app on your smartphone is a specialized piece of software designed to do something such as look up the cheapest gas stations to my location or tell me what the movie times are at the local cinema. The user interface on a PC typically uses icons (those shortcuts on your desktop) for the user to click on, using a mouse or a keyboard or to touch on a touchscreen, to start a specific program. The OS intercepts the start action and loads the program into the correct amount of memory for it to execute. The program will ask for certain files to be opened or created and the OS uses device drivers to access the storage media or the network to create or access the file information. The program will then take some action using that data, such as displaying some information, calculating something using the data, or printing a map. Perhaps you will choose to print the results of the data being processed in which case the OS will use a device driver to pass the desired report to the printer in a format that that specific printer can understand and handle as a printed report. As a final step you may instruct the program to save any updates that you made at which point the OS will again access the storage media and tell it to write the data in a file.

In the next part we'll look at the evolution of operating systems and basic file systems.

From the April 2018 issue, The Space Coast PC Journal, www.scpcug.org, datadan@msn.com.

Tidbits of probably useless information

A sneeze travels out your mouth at over 100 mph.
Your ribs move about 5 million times a year, every time you breathe.
In the White House, there are 13,092 knives, forks and spoons.
Slugs have four noses.
Recycling one glass jar, saves enough energy to watch tv for three hours.
Lightning strikes about 6,000 times per minute on this planet.
Owls are one of the few birds that can see the color blue.
The average American/Canadian drinks about 600 sodas a year.
It was once against the law to slam your car door in a city in Switzerland.
There wasn't a single pony in the Pony Express, just horses.

Digital Camera Anatomy

By Dick Maybach, Member
Brookdale Computer Users Group, NJ

This is the first of three articles on digital cameras covering their anatomy, how their processors control them, and how they process the captured images. An early Kodak slogan was, “You press the button; we do the rest.” Today, modern digital cameras can make the same claim. Most of us have pressed the button; let’s look at the rest of the process.

The First Digital Camera

In 1975, Steven Sasson at Eastman Kodak developed the first digital camera, shown in Figure 1. He used off-the-shelf parts: a movie-camera lens, a newly-developed sensor from Bell Labs, a cassette tape for storage, and a TV monitor to display the images. The camera had a 1/20 second shutter speed but needed 23 seconds to transfer a 100 by 100-pixel black-and-white image to tape. Kodak wasn't interested, because they feared digital cameras would reduce their profits from photographic films. They were right, and in 2012, they filed for bankruptcy.

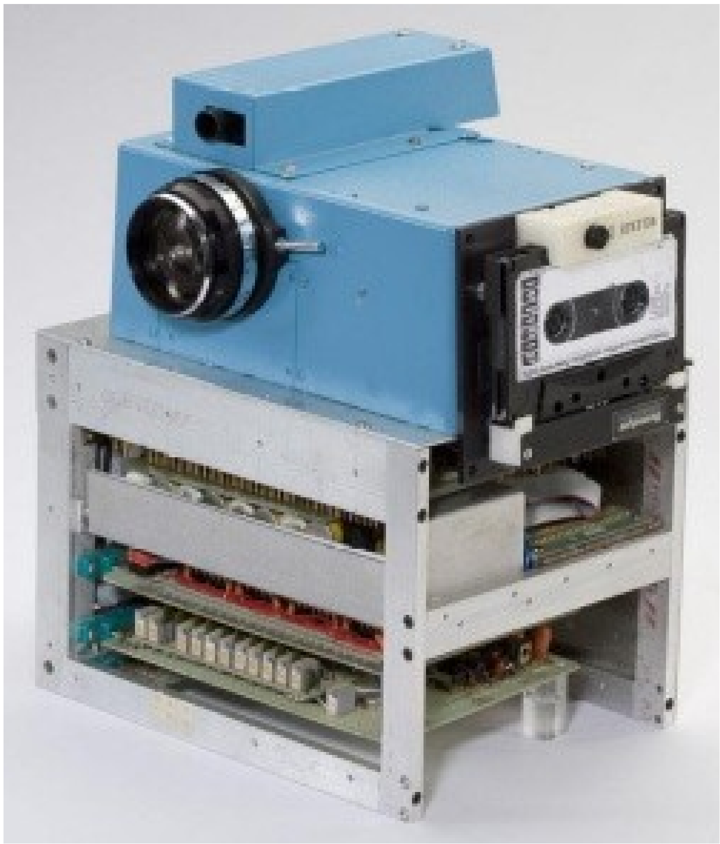


Figure 1. The First Digital Camera.

Camera Types

Figure 2 shows a simplified view of a consumer digital camera architecture; the lens focuses the incoming light onto the photo sensor, which takes the same roll as photographic film. In all but the simplest cameras, a diaphragm with a variable area limits the amount of light entering the camera. (Notable exceptions are cell-phone cameras.) The shutter opens only when you wish to take a picture. Located as shown, it’s called a focal-plane shutter, because it’s very near the plane where the lens focuses the light. The shutter can also be near the lens or it can be integrated into the sensor (which is the case for cell-phone cameras). There are thus two ways to control the amount of light striking the sensor, with the diaphragm and with shutter. Although only a simple lens is shown here, more complex ones are common.

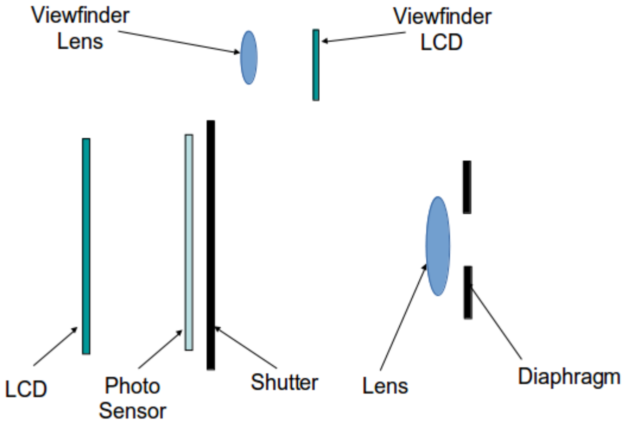


Figure 2. Basic Camera Components.

The liquid crystal display (LCD) shows you where the camera is pointed and lets you look at the pictures you have taken. It also displays the camera status and set-up menus. On higher-end cameras, a second LCD that shows the same information as the one on the rear panel allows for viewing in bright sunlight. The result is called a viewfinder. In older cameras the viewfinder was purely optical, with its own lens, but this is rare now. The sensor must operate all the time, whether to provide an image for composing or one for storage, although its resolution is usually reduced for composing. You may have noticed a problem; when the shutter is closed, light can’t strike the photo sensor, and the LCD has nothing to display. Cameras with mechanical shutters hold them open to allow a display, close them briefly when you press the button to allow the photo sensor to be reset for picture taking, and open them for the exposure, and perhaps close them while the image is transferred from the sensor.

A digital single lens reflex (DSLR), shown in Figure 3, places a mirror in the light path to reflect the light into the optical viewfinder whenever the camera is not taking a picture. To take a picture, both mirrors momentarily flip up. Normally, DSLRs also have focal plane shutters since they must be located out of the way of the mirror. Their high-performance sensors often have both mechanical and electronic shutters.

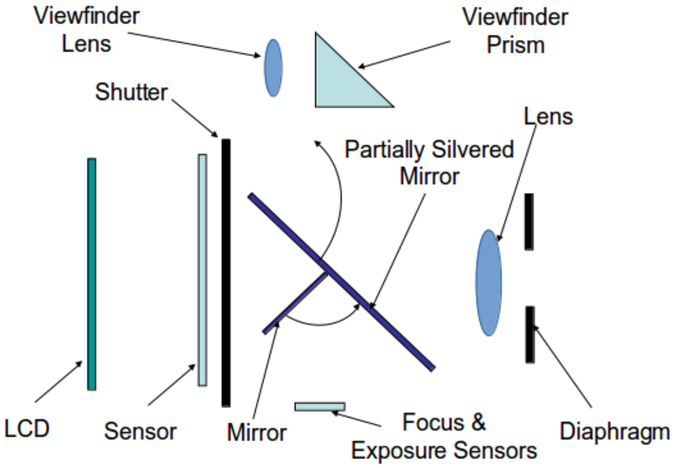


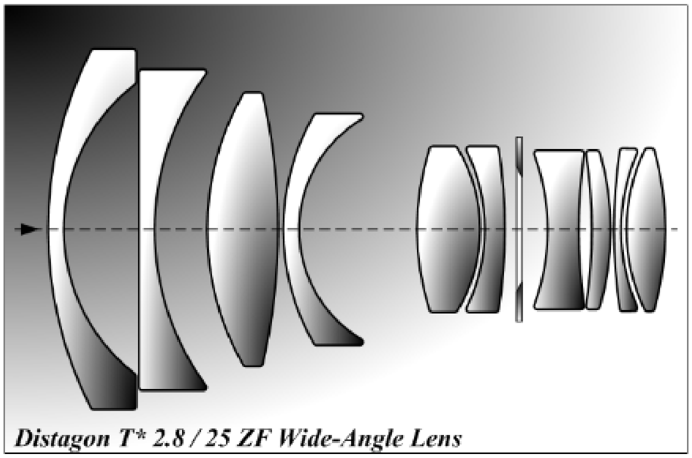
Figure 3. Digital Single Lens Reflex Architecture.

Because the sensor receives light only when taking a picture, the LCD can display only the pictures already taken. Live viewing requires an auxiliary sensor, often located in the viewfinder, as both the shutter and mirror block light from the main sensor. The main mirror is partially silvered to allow some light to pass through it and be reflected down to the focus and exposure sensors by the second mirror. These sensors are optimized for their particular uses since they aren't used to capture images. This arrangement implies a high price. Besides its mechanical and optical complexity, its lens must be far away from the sensor to clear the mirror. Its main advantages are high-quality pictures and fast operation. Because of its cost, SLR architecture is used only for high-end, interchangeable-lens cameras.

Lenses

The complexity of Figure 4 is typical of modern lenses, although cell-phone and Webcam lenses often have only a single element. Point-and-shoot lens complexity lies between these extremes. The added lens elements correct distortion, keep the light intensity constant across the sensor and reduce color aberration.

Figure 4. High-end lens.



Digital Sensors

We will now shift gears to look at how the camera records an image. You may be surprised to learn that its sensor does not use the red-green-blue (RGB) format. A computer in the camera changes the recorded information into the desired output format.

Bayer Color Filter Array

Each pixel on a digital camera sensor contains a light sensitive photo diode which measures the brightness of light. Photo-diodes are monochrome devices, unable to sense color. Therefore, a mosaic pattern of color filters is positioned on top of the sensor to allow only red, green, or blue light to illuminate a single pixel. The most common filter used in digital cameras is the GRGB Bayer Pattern, named after a Kodak engineer. The result is a color filter array, shown in Figure 5. By breaking up the sensor into red, blue and green pixels, it is possible to get enough information in the general vicinity of each sensor to make an accurate estimate of the true color there. By contrast, our eyes contain two types of sensors: rods, which are much more numerous, detect only intensity and are most sensitive to green light, and cones, which detect color.

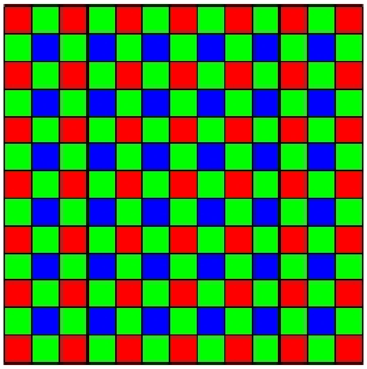


Figure 5. Bayer Filter.

In the Bayer filter pattern, the colors are not evenly divided – there are as many green pixels as there are blue and red combined, because our eyes are more sensitive to green detail than the other colors. The advantages of this method are that only one sensor is required, and all the color information (red, green and blue) is recorded at the same moment. The raw output from a sensor with a Bayer filter is a mosaic of red, green and blue pixels of different intensities. After a raw image has been obtained from a photo-sensor blanketed by a Bayer pattern of color filters, it must be converted into standard red, green, and blue format, usually sRGB or Adobe RGB. A computer in the digital camera determines the correct color for each pixel in the array by averaging the color values of neighboring pixels. This process is called demosaicing.

CMOS Sensor

The Complementary Metal Oxide Semiconductor (CMOS) sensor, shown in Figure 6, is now the dominant type. This sketch shows one CMOS sensor pixel containing a photosensitive area (photo-diode), busses, microlens, Bayer filter, and three support transistors. Each pixel in a CMOS image sensor contains an amplifier transistor, which converts the charge generated by the photo-diode into a voltage. In addition, the pixel also features a reset transistor to control photon accumulation time, and a row-select transistor that connects the pixel output for readout. All this circuitry reduces the photo-diode area. In operation, the first step is to use the reset transistor to drain the charge from the photosensitive region. Next, the integration period begins, and light interacts with the photo-diode region of the pixel to produce electrons, which are stored in the silicon potential well lying beneath the surface.

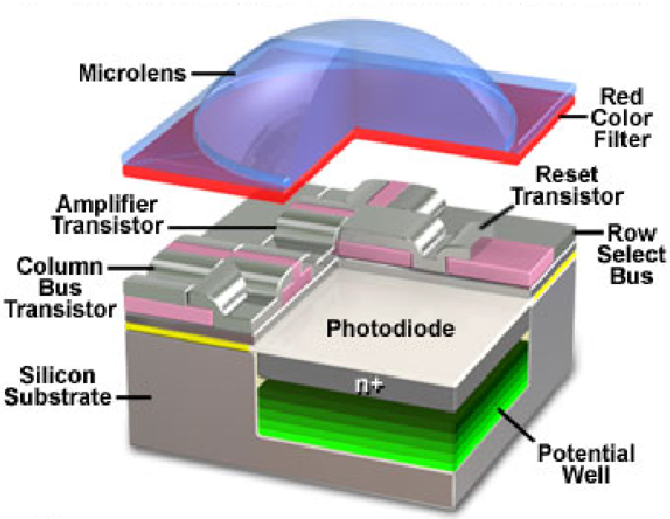


Figure 6. CMOS PixelCell Anatomy.

After the integration period has finished, the row-select transistor is switched on, connecting the amplifier transistor in the selected pixel to its load, thus converting the electron charge in the photo-diode into a voltage. The resulting voltage appears on the column bus and can be detected by the sense amplifier. This cycle is then repeated to read out every row in the sensor in order to produce an image. Keep in mind that even simple cell-phone cameras have millions of these cells on their sensors.

Figure 7 shows a complete CMOS image sensor that contains an active image area of 640 x 480 pixels. The photo-diode array, located in the large reddish-brown central area of the chip, is covered by a Bayer color filter array and a micro-lens array. The inset reveals a highly magnified view of the filter and micro-lens array. Also included on the sensor is the analog signal-processing circuitry to collect and interpret the signals. These then go to the analog-to-digital conversion circuits, located adjacent to the photo-diode array on the upper portion of the chip. You can see the peripheral circuitry located on the edges of the chip.

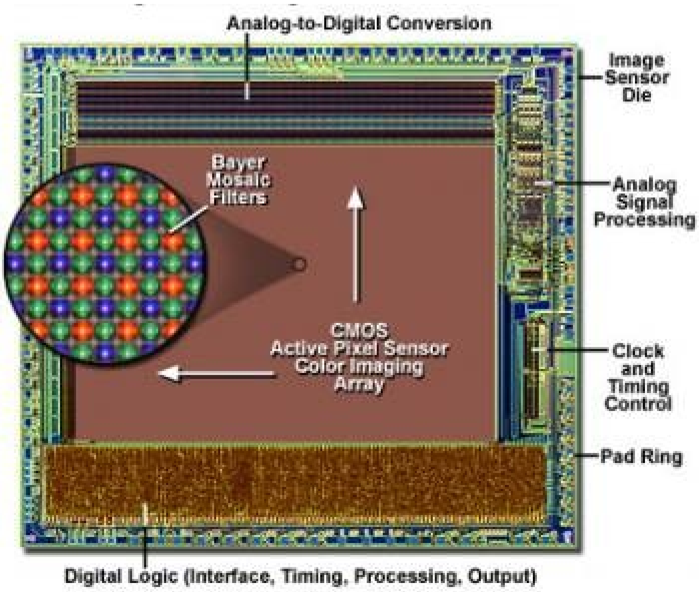

Analog-to-Digital Conversion
Image Sensor Die
Bayer Mosaic Filters
Analog Signal Processing
CMOS Active Pixel Sensor Color Imaging Array
Clock and Timing Control
Pad Ring
Digital Logic (Interface, Timing, Processing, Output)

Figure 7. CMOS Image Sensor Integrated Circuit Architecture.

CMOS Functions

In addition to converting photons to electrons and transferring them, the CMOS sensor might also perform image processing, noise reduction, and analog to digital conversion. This functional integration onto a single chip reduces the number of external components needed. Using such an integrated CMOS sensor allows the digital camera to devote less space to other chips, such as digital signal processors (DSPs) and ADCs. CMOS is the dominant semiconductor technology, so these devices enjoy huge economies of scale.

To read out the array, a row is selected, which connects one pixel in each column to the column bus. Each column is then selected in turn, which sends the pixels one at a time to the output amplifier. Figure 8 shows the circuit blocks to accomplish these functions.

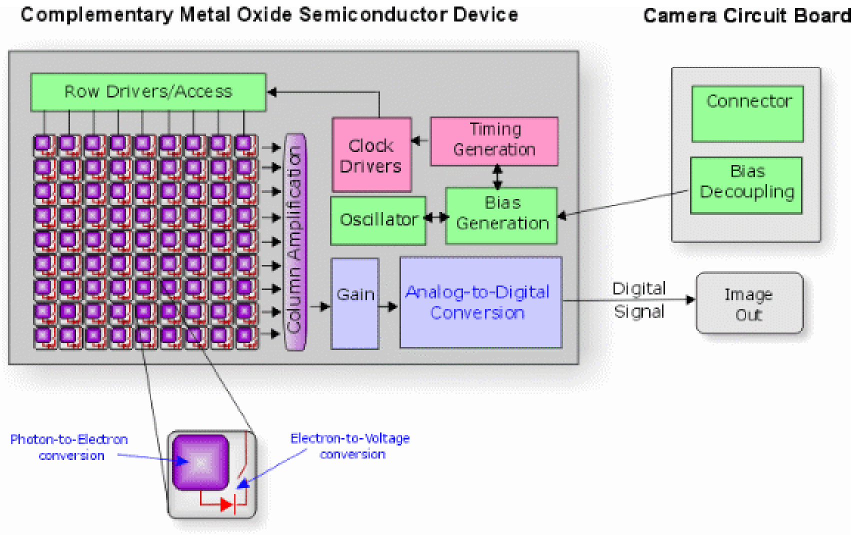
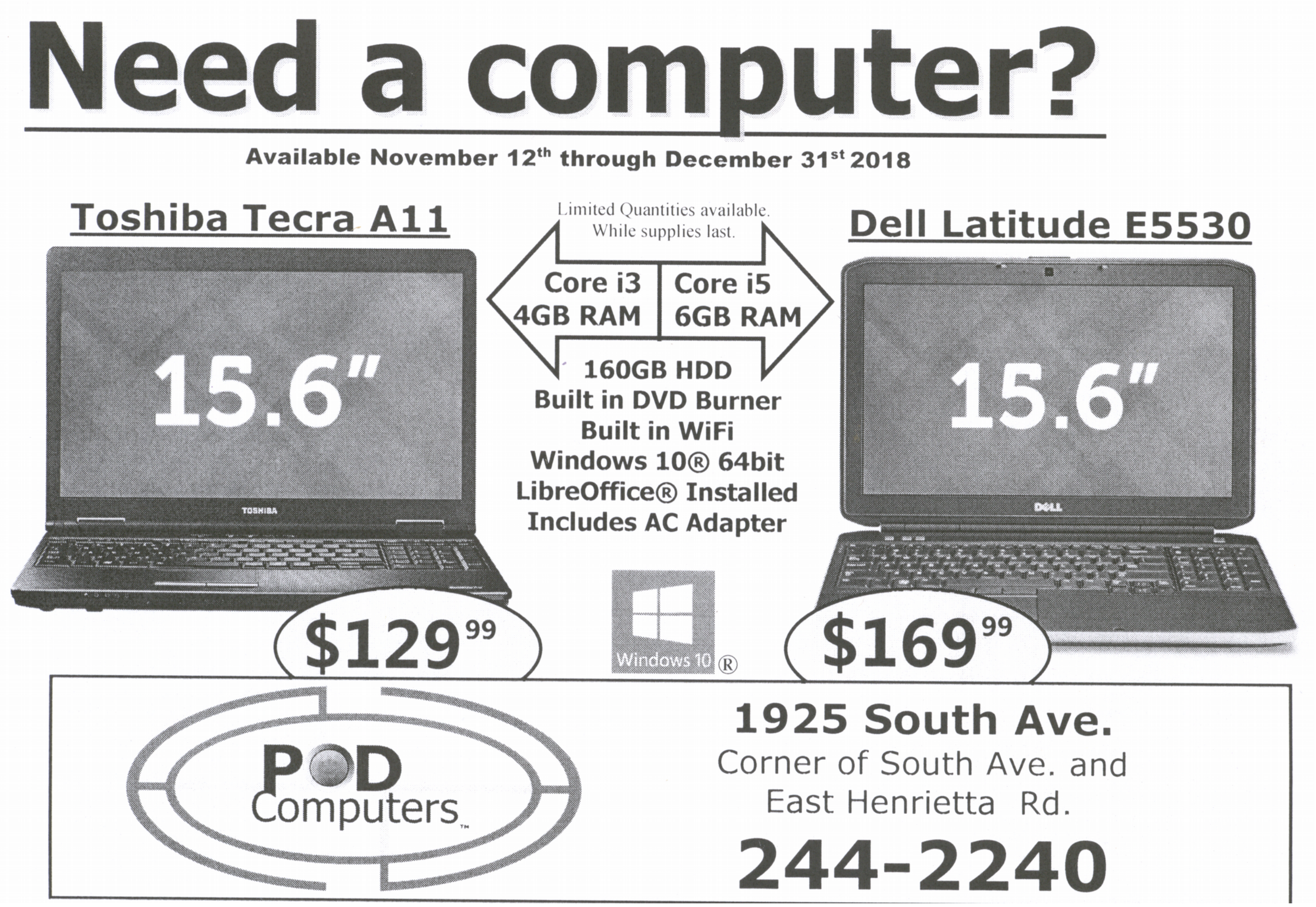


Figure 8. CMOS Functional Diagram.

Although this introduction was quite brief, it does show that digital cameras, even the simple ones found in cellphones are far more complex than you probably suspected. Their optics are relatively simple, about the same as in a consumer film camera of 50 years ago, but their electronics boost their performance far beyond these early devices. Since optics are expensive and circuitry cheap, the result is impressively cost effective.

Next time, I'll discuss camera control and image capture.

From the April 2018 issue, BCUG Bytes, www.bcug.com, n2nd@att.net.


Need a computer?

Available November 12th through December 31st 2018

Toshiba Tecra A11

Limited Quantities available.
While supplies last.

Dell Latitude E5530

Core i3
4GB RAM

Core i5
6GB RAM

160GB HDD
Built in DVD Burner
Built in WiFi
Windows 10® 64bit
LibreOffice® Installed
Includes AC Adapter

$129 99

Windows 10®

$169 99

POD Computers™

1925 South Ave.
Corner of South Ave. and
East Henrietta Rd.

244-2240