Pocket-size solid-state iPOD and flash drives for gigabyte storage, display and transfer of digital medical images: Technology Update

Sir,

The original paper with the above title (as review and work initiated) by the author was earlier published in JMP[1]. This paper described a comprehensive Windows XP desktop home computer system, with useful peripherals and features, connected to the iPOD Classic/Flash Drive. The application of the iPHONE for storing, viewing and manipulation of images using the open-source OSIRIX educational software (meant for diagnostic reads) was only briefly touched upon, with references. Since then, further developments/innovations have taken place in this new field of medical imaging/software and a technology update is in order now. This letter highlights these advancements with some of which the author had hands-on experience. It is hoped this information will be useful for radiologists, medical professionals and physicists (particularly new entrants) based in countries in this region. The advancements in devices comprise: Notebook Laptops, Tablet PC’s, Smart phones, Flash drives and Digital cameras. The applications and practical uses of a new MIM software will also be briefly outlined.

Laptop computers: Several models of less expensive, compact, light, ultra-thin, portable laptops (also called ‘notebooks’ ‘netbooks’ or ‘ultrabooks’) with Full high definition (HD) LED/plasma/OLED displays (the latest of them with touch-screen facility) and based on McIntosh and Windows 7 operating systems, have been recently introduced to replace the bulky desktop computers. For medical imaging and education, laptops of excellent display resolution (1920 x 1280 pixels or better), having built-in speakers and Blu-Ray DVD players, enable connection to the iPOD and Flash Drive as well as to the HD TV units. Internet access through broadband/Wi-Fi modems and 2G/3G/4G cellular networks facilitates quick browsing and downloading of a variety of medical images for education and training. Radiologists can also get email access to, or download, medical images from other medical institutions/professionals. Digital cameras can be interfaced for access to photos related to medical applications, stored in them.

Digital light photography (mentioned in the author’s earlier paper) has been employed also for a variety of medical diagnostic applications.[2-4] Several of these images can be edited using higher-end software like Photoshop and stored in laptops (with storage capacity upto 500 GB and above) and later transferred to the Flash Drive directly or to iPODs through Apple iTUNES software. Dynamic videos, displayed on the laptops with moderate resolution, can be viewed still more clearly and sharply by connecting to a large screen high-definition HD TV (with OLED display) with fast response (e.g., refreshing rate of 600Hz, for reduced motion blurring). The author had later added an inexpensive high-resolution color/BandW all-in-one printer-scanner-copier (HP DeskJet printer F4288) to his earlier system. In addition to scanning/copying medical documents/reports, this was found very useful for print-out of high-resolution medical images on a glossy paper. A compact laser transmission-type film scanner (F4288 is a reflective-type scanner), for scanning radiographic films, will be a useful addition. Among the latest compact laptops, the Intel-core processor/Windows 7-based ‘Ultrabook’s (the Acer Aspire S3/S5 and Lenovo Ideapad U300), the quad-core Nvidia Tegra processor/Google-Android-based Asus Transformer Prime (laptop-cum-tablet) and the Intel-core i5/i7 processors/Mac OS X-based Apple Macbook Air deserve special mention.

Tablet PCs: For many purposes in imaging, we do not need the full computing power of a desktop or a laptop. Recently, several stylish and lightweight tablets, with touch-screen interface and large displays with good resolution, have been developed for utilities such as quick browsing, shopping for and reading e-books, processing/sending emails, creating and editing documents, taking and storing several photos/images, etc. using quality applications. Tablets replace the mouse with the facility of swiping across the screen, enabling rapid scrolling through websites, pages on books, stored photos, videos etc. Tablets also enable connectivity to broadband/Wi-Fi, 2G/3G/4G, Bluetooth (EDR) and other networks and also to laptop/desktop. They are usually provided with built-in back and front high resolution (megapixel) cameras, which dispense with external cameras. Besides, other features, such as the built-in earphone/speaker and facility of 1080p video recording/playing, are also provided. However, there are usually no USB ports to connect an external camera, iPOD or Flash Drive. Also, DVDs and CDs cannot be read/played with tablets; nor are they readily compatible with scanners/printers, etc. (although the iPAD2 tablet can be remotely connected to Wi-Fi operable printer). Three of the popular tablets, with comparable features, which are useful for medical imaging, are: Apple iPAD2, Samsung Galaxy 10.1 and Lenovo Ideapad K1. The first of them
Smart phones: These devices are pocket mobile phones with gigabyte storage and displays with moderate resolution making them superior to iPods for many imaging applications. Apple introduced the first of these iPhone devices, which has undergone further generation developments (iPhone 4S is the latest model). Smart phones with similar display/storage/browsing/transmission features and built-in megapixel camera(s) have been recently marketed also by other companies. These, with comparable features for medical imaging, include (operating systems in brackets): Samsung Galaxy S2 (Android 2.3 Gingerbread)/S3, Nokia Lumia 800 (Windows 7), Google Galaxy Nexus (Android 4), HTC Sensation XL (Android Gingerbread), Motorola Razr, (Android 2.3.5), Sony Ericsson Xperia pro (Android Gingerbread) and many others. The iPod Touch (4th generation) may also be included among these devices in spite of its lack of phone facility. The screen sizes and display (AMOLED or retina types) resolutions range from 3.5 to 4.7 inches and 800 x 480 to 1280 x 720 pixels respectively. The battery life (talk time) is in the range of 6 – 14 hrs. All of them have good storage capacities (8 – 64GB/micro SD card). More details are available from the manufacturers’ technical literature. They share many of the features of tablets, such as broadband/Wi-Fi, 2G/3G/4G, GPS, Bluetooth, etc. networking, video recording and viewing, ease of display orientation etc., stated earlier. For instance, the iPHONE/iPOD Touch share the iCloud and iMessage features of the iPAD2. With an external wireless router, the iPOD Touch can send/receive the message through Wi-Fi network (the author has successfully used the Belkin¹¹ Wireless N Router SURF N500, in conjunction with the Mumbai Mahanagar Telephone Nigam Limited (MTNL) broadband (speed up to 2Mb/sec.) network modem described in the earlier paper). Smart phones enable radiologists to access patient images (videos, movies or photos) at any point (at home with the iPod Touch, where the wireless router/modem may be located), from hospital professionals through other Apple devices or the internet and share these and/or converse with other medical professionals. Although the size of the screen is less than that of the tablet, the resolution offered is adequate for analyzing and interpreting images (using the MIM software, see below) at home or on-the-go. For better image details, an HDTV (with fast response for viewing videos as stated earlier) can be connected. The iPhone 4S and some other smart phones have another impressive feature: SIRI – a software-based personal assistant which enables simple voice-based commands. The iPhone 4S is perhaps the most expensive of all smart phones. Mobile devices have made ubiquitous access to patient data a reality for many physicians treating patients at the point-of-care or on a consultative basis. They provide accessibility especially in an emergency situation. One can also use them for consultation, collaboration, and teaching purposes.

Flash drives: A wide variety of inexpensive flash drives in different shapes and configurations with the built-in facility of display of files contained in them, are now available for use in medical imaging.

Digital cameras: The improved point-and-shoot camera technology (such as autofocus, zoom and low light features) in smartphones from Apple, Nokia and others
has apparently made redundant the use of a separate digital camera. Nevertheless, new cameras with facilities for uploading images and videos directly to online sharing sites, including Facebook, Flickr, Picasa and YouTube and to wirelessly send images to TV and computer, etc. have, once again, brought them into main focus. A scientific and ingenious miniature camera, called Lytro, recently released employs light-field photography, enabling to shoot a picture and refocus at any point on the computer screen later.

MIM software: The FDA (USA) during February 2011 approved iPad devices and iPhone type mobile phones (and by implication also laptops) to view CT scans, Nuclear Medicine-based (SPECT and PET scans) and MRI images. Very recently, the approval has been extended to viewing X-ray and Ultrasound images and for Radiation treatment planning studies as well. The FDA, however, clarified that these devices should not be used as a replacement for a proper medical workstation, but the picture details they provide are good enough to be used for when doctors want to analyze images on-the-go or at home. The Mobile MIM software (also approved by the FDA), developed by a company called MIM Software Inc., allows medical professionals to send the sophisticated medical imagery to an iPad, iPhone, or iPod Touch to analyze them. This important mobile technology provides physicians with the ability to immediately view images and make diagnoses without having to be back at the workstation or wait for film. It allows the physician to measure distance on the image and image intensity values and display measurement lines, annotations and regions of interest. The software program is used for the registration, fusion, and/or display for diagnosis of medical images from the following modalities: SPECT, PET, CT, MRI, X-RAY and ULTRASOUND. The software is not to be used for mammography. Mobile MIM provides wireless and portable access to medical images. The MIM Cloud feature accesses images from any internet connection; enhances teleradiology and multi-institution reading operations; shares images with referring physicians, partner institutions, and patients; collects or contributes images for clinical trials; distribute images to other users, etc. This software, along with another, VueMe, designed specifically for patients can be downloaded from Apple stores. The author could download a variety of sample patient images (US, X-ray, CT/PET and MRI/ PET fused images, RT planning, etc.) on his iPod Touch and successfully use the several controls to manipulate these images, e.g., window/level, zoom/pan, crosshairs-localization, multi-planar reconstruction; built-in tools to verify lighting; select Measure, Annotate and SUV with variable ROI; display DVH and isodose curves; cycle between the image series (includes fusion and MIP movies) and the three plane views with coordinate display, etc. The initial gray-scale calibration with test pattern for best image viewing and color range selection for image display are other novelties of this software. Unlike the OSIRIX software, which is tuned towards the Mac, the MIM software is compatible with both Mac and Windows systems.

The author, as in his earlier paper, checked the qualities of the images on the Apple iPad and iPod Touch devices by downloading and displaying some of the medical imaging color test patterns offered by some companies as well as by the SMPTE, from the internet and found them to be satisfactory. As stated earlier, this was also corroborated by viewing a variety of patient images downloaded from Apple stores (including cine movies) on iPod Touch. For testing/viewing other images, the author first created an account with MIM and using the Upload Utility tool, uploaded some patient/phantom image data sets, in DICOM format (from available sample studies on their website), into their MIMcloud (one can also import/download DICOM image data from CD, any open-source database on-line or from any workstation). He could then download from the cloud and review the images on his PC (MIM Viewer) and iPod touch. Imaging professionals now have a portable solution away from their workstations (Pocket workstations have now indeed become a reality). They can consult with peers for difficult cases and overreads; reduce image distribution delays; enhance referring physician and patient interaction; give hands-on image access to tumor board or class members, etc. Patient data protection is extremely essential in using the above devices. This is achieved by passcode enforcement coupled with encryption of all network transfers to and from the servers.

In this brief article, the other device applications, not useful for medical imaging, such as music player, radio, video games, maps, weather and a host of other features are left out. The author states, the actual selection of a particular model will depend on the features required such as storage/RAM size, display type, size and resolution, sharing the images with other medical professionals, high speed network availability, price etc. From this point of view, the author opines, the models cited in this article will be perhaps most suited for medical imaging, using the MIM software or other FDA-approved compatible software. Presently, a bewildering variety of models by other companies are also entering the tablet and Smartphone arena and better less expensive ones (possibly non-Apple tablets and phones hopefully based on the Android and Windows 8 operating systems) are anticipated. Readers may note that the latest innovative laptops, tablets, smart phones and HDMI computer TV systems were displayed at the Consumer Electronics Show (CES), Las Vegas, USA as well as at the Mobile World Congress (MWC), Barcelona, Spain, held during January 2012 and February – March, 2012 respectively.

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Sankaran Ananthanarayanan
Ex-Radiological Physics and Advisory Division,
Bhabha Atomic Research Centre,
Mumbai – 400 085, India

Address for correspondence:
Dr. Sankaran Ananthanarayanan, Flat No.604, Indraprastha Complex CHS, Plot 13/14, Sector 29, Vashi, Navi Mumbai – 400 703, India
E-mail: a_sankar@vsnl.com; a_sankar@mtnl.net.in

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6. MIM Software Inc., 25200 Chagrin Blvd, Suite 200, Cleveland, OH +1(216).978.9315 or 866-421-2536] website: www.mimsoftware.com
7. See the website: www.mimcloud.com for more details

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