Touch Data Capture

Touch-based systems allow the input and control of a process by the use of infrared, capacitive, or resistive panels, SAW, screens, or buttons. For the purpose of this paper, touch screens, buttons, and pen-based computing will be covered in this section.

Since the 1970's, touch screen input has been used in manufacturing, retail (POS), banking, government agencies, restaurants, medical, and pre/post sales applications. When touch screens are employed in the restaurant or POS environment, the order taking process has been noted to speed up, leading to better customer service. Manufacturing companies have put touch screens on the shop floor to enter machining centre data, work orders, SPC data, set-up times, time and attendance; to track WIP and scrap, and to adjust continuous processes. Banking institutions, retail establishments (POS), gaming operations, health care agencies, and government agencies utilise touch screen kiosks to provide an interactive medium for products and services offered.

Touch screen input has proven to provide an exceptional means to easy, understandable, and quick operator input for entering data, and controlling a process or machine. A review of the literature found that touch screen input from a finger, stylus, or mouse took very little end-user training. A touch screen is less efficient than a keyboard or keypad for entering numerical data, but once the data is in the system, a touch screen - supported by tailored software - might just be the fastest way to manipulate data. Productivity increases have been achieved by providing operators with more and better information in real time. Simple and easy to use interfaces make a big difference in end-user acceptance. The growth of the touch screen market has been fuelled by the general public's expanded understanding of microcomputers and their associated input devices.

Touch memory buttons, on the other hand, are physical devices that are directly attached to an object and must be read by direct physical contact with a reading device. Touch button memory systems consist of button-size stainless steel containers with a memory chip sealed inside. The buttons have the ability to read or write data through momentary passive or active contact. Touch memory buttons have been utilised to control access ; store documentation or diagrams; track cows, medical samples, containers, pallets, gas cylinders, and other physical assets or hazardous waste. One might choose to use touch memory buttons instead of another ADC technology when identification must withstand harsh environmental conditions, and/or when the physical space to attach an identification is very limited. Memory buttons are manufactured with a unique pre-programmed serial number and are sealed to resist moisture, temperature extremes, and even radiation.

Pen-based data capture has a very strong vertical market that cuts across all industries and businesses. Pen-based computing applications shine best when traditional data collection is automated to fill in electronic forms. Pen-based computers can be used for public service departments, transportation, recording quality control information, health care, product delivery, tracking WIP and customer pre/post sales force automation, field inspection, and job costing that includes equipment, supplies, materials, and direct labour. The basic hardware issues are size, weight, speed, battery technology and life, cost, screen technology and raggedness. Many pen-based computers have either built-in bar code scanners or provide an interface to attached wands or laser scanners. Since pen-based computers are handheld portable data capture devices, the ergonomic feel of using the device is important. Furthermore, portability increases the chance of physical abuse of this device subjecting it to extreme temperatures, dust, and rain. Backlighting a screen to make the pen-based application easier to read has tradeoffs. Both reflective and backlit displays suffer from extremely limited viewing angles. When reviewing pen-based computers, PCMCIA interfaces, connectivity to host computer systems, and programming environment are important issues to consider. Many pen-based computers on the market are DOS compatible, allowing programming in existing languages or very fast and powerful pen-based application generators. Additionally, a majority of systems on the market today provide real-time RF/DC connectivity to host computer systems and applications.

Handwriting recognition is used in limited applications to record data. Applications that use handwriting recognition tend to use numeric recognition rather than alpha or alphanumeric recognition. Most handwriting is sloppy, making it extremely hard for humans, let alone a software algorithm, to figure it out. Pen-based computing presents one of the most exciting and promising areas of data collection to come along since the desktop personal computer.

Optical Data Capture

Automatic data collection technologies based on optics can include optical character recognition (OCR), one-and two-dimensional bar codes, and machine vision systems. Optical character recognition is a means by which a mark, character, illustration, or bar code is decoded and then directly entered into a computer system for identification or manipulation. OCR data capture allows scanners to read envelopes, full pages of text including broken characters, and even common typefaces or fonts. Reading the printed word or page is something that is taken for granted. However, OCR scanners capture the printed page into a bit map image and then into ASCII characters through the help of OCR software. The OCR process takes an image and matches it to a sophisticated pattern-recognition algorithm, giving digital conversion. The ASCII characters can then be imported into a specified document, form, word, database, spreadsheet, or graphical processing application.

The nature of OCR algorithms requires the most powerful processor and memory a computer system can handle. Initial OCR attempts looked at intensive learning programs based on the typeface, fonts, or characters needed to recognise. Once trained, the scanned document would be compared to these resident images to find a match. If a match were not made, the character, word, or image would be "flagged" so human intervention could take place before or after the document was imported into the application needing the data. Omnifont OCR programs do not require a prerequisite training period. Omnifont technology evaluates the overall shape of a character, determining how many lines or curves it contains. Accuracy for translating characters is what OCR is bench-marked against. Current programs can provide 99% and higher recognition rates. However, there are variables for the use of any technology. For example, the type of font, quality of the original image, or whether the scanner is handheld or flatbed in design can make it harder to discern characters. OCR scanners are available in sheet-feed, flatbed, handheld, and overhead configurations. Depending upon the type of data to be scanned, any one of the listed scanners can be bi-tonal (binary), grey scale, or colour.

OCR systems become truly useful only when their accuracy closely approaches 100 percent. The lower the accuracy rate, the more time will be spent proofing the document. It should be noted that the characters per minute (cpm) an OCR system can handle has a direct correlation to overall system efficiency. Additionally, OCR systems can be designed to do more than input reams of documents. OCR technology did attempt to infiltrate the point-of-sale (POS) retail application, but market growth has gone the way of the bar code.

The data collected from billing statements and invoices using OCR is strong and still growing. Additionally, OCR scanners can absorb photos, charts, and other graphics for storage as pure image files in variety of formats (TIFF/PCX/EPS/BMP, etc.). The image files can be cropped, altered, and imported into the application in need. If graphic images are the scanned object of choice, it is recommended that the OCR system, software, and intended application all conform to the TWAIN format which is a software interface standard that allows the sending of bitmaps and the output of character recognition programs directly into many software.

Since 1991, most of the improvement in OCR software has been in refining the ability to decode "dirty" documents. Dirty documents would include pages that have been photocopied many times or are of poor fax quality. Even an error rate of 1 percent would require the end-user to correct every word out of 100. The different methodologies to identify and decipher characters can be broken into two groups, template-based and feature-based methods. Template methods maintain a collection of sample characters and identify the ink mark in question by determining the closest -matching template. Feature methods try to break an ink mark into a assortment of "features" by classifying where strokes join and curve symbolically. Near-term OCR identification will probably be based on contextual-analysis. Contextual-analysis is based on encoded spelling rules and common grammar, punctuation, and syntax patterns. Matching the appropriate OCR scanner with software is mission critical. The speed of the OCR system can be directly correlated to the amount of random access memory (RAM) and the type of microprocessor used.

Bar code data capture is one of the best known forms of ADC by the shear volume of its use in the retail world to mark and identify physical objects for sale or purchase. On October 20, 1949, Norman Woodland and Bernard Silver filed a patent application in the United States which disclosed the first optical bar code symbology as well as an automatic scanner. In countries were bar coding is utilised, retail applications are by far the most noticeable form of ADC to the general public. The use of bar coding has become so diverse that bar codes are used from tracking animals to aligning NASA's largest radio frequency satellite receiving dish ! The magnitude of bar code applications has led large and small companies into implementing this ADC technology to increase production, reduce cycle time, reduce inventory and data collection, and improve management decision making. Popular bar code applications include Work-In-Process (WIP), produce tracking, statistical process control (SPC), receiving and shipping, time and attendance, invoicing, tool tracking, serial/part number control, patient identification, access control, and gas cylinder tracking. Bar coding is easy to learn and use, and relativity inexpensive to get into in comparison with other manual data capture methods.

Bar code technology is based on the use of optics. For a bar code symbology to be read, a laser (either visible or infrared) must be passed across the vertical bars and spaces. The vertical bars within the bar code absorb light and the spaces reflect the light. The reflected light of all the spaces is captured by the bar code scanner and measured to thousandths of an centimetre and then decoded by an algorithm. The results of the algorithm can be expressed as numeric, alpha characters, or ASCII characters.

There are at least two considerations with respect to printing the bar code label itself : will the bar code label be printed on-site or off-site ? Bar code symbols can be printed with a wide variety of printing technologies. On-site printing of bar code labels is created "in-house" on the factory floor at the time and place where they will be used. On-site printers are commonly referred to as demand printers, printing labels in sequential order, in massive quantities of identical labels or in unique labels. The challenges of demand printing for just-in-time (JIT) operations are enormous. On-site printing coupled with JIT obviously requires the label and printing right now ! The printing technology chosen must be able to perform in a variety of industrial or business conditions and environments. The most common on-site bar code data capture printers are direct thermal and thermal transfer. Other printing technologies, such as dot matrix, laser, and ink jet, are also available. The label substrate and bar code location and application determines the appropriate printing technology.

It can be argued that the most critical bar code data capture system component is the printed bar code symbol or label. No matter which on-site printing technology is used, in the final analysis, the printed bar code symbols must be verified. Bar code verifiers are intended to determine the symbol's dimensions. If the printed bar code symbol is within ANSI guidelines, it can be controlled, allowing the symbol to be read or decoded by a variety of input devices used by customers. This is, in fact, the quality control of bar code printing.

Off-site printing of bar code labels is completed by a commercial printing vendor for future use on objects or products. Off-site printing is cost effective in very large printing quantities, on preexisting packaging, and for symbologies where a strict x-dimension tolerance must be maintained. It should be noted that a sincere and accurate scheduling method must be adhered to so the correct labels are ready in time for the objects/items that will receive the bar code labels.

Off-site commercial bar code printing vendors offer excellent experience, quality control, and production capacity that can meet needs in time, and in bar code label design flexibility. Two of the most common off-site printing techniques incorporate flexography and photo-composition. Additional off-site technologies include lithography, letterpress, and laser etching. Pre-printed labels can offer the advantage of higher density and specific tolerances. Off-site printed bar code labels can be produced on non-paper substrate material and even laminated. One economic advantage the end-user gains is that capital investment need not be tied up in bar code printing hardware, software, or consumables. The crux of any quality off-site printed label is the film master that will be placed on the printing plate. It is important to make sure during the pre-production run of the labels that the contracted printer can supply bar code verification data.

Two-dimensional (2-D) bar codes have the ability to encode information not only in the x-dimension like a linear bar code, but also in the y-dimension. Imagine stacking a bunch of linear bar codes on top of one another to get the idea of how a 2-D bar code looks. 2-D codes were introduced to compress large amounts of data into a single bar code occupying very little space. Depending upon the bar code in question, some 2-D codes not only provide error detection like linear bar codes, but also employ error correction. Should the printed 2-D bar code become damaged or torn, information that is missing can be reconstructed by the scanner or camera and decode algorithm.

Machine vision systems have played a significant role in identifying and inspecting objects at high rates of speed where a human operator would become fatigued and less accurate. Machine vision uses some of the basic abstractions that OCR uses, including optics, scanning an object, and interpreting the object pattern. The components of a vision system include a camera, graphical interface, and a processor to capture the image, comparing it to one already held in memory. A logic algorithm typically rules to determine what action, if any, should take place in the comparison and analysis.

Machine vision systems try to duplicate what the human eye sees. One of the most critical elements of this system is the lighting technique used to illuminate the object or area in question. Careful attention and detail must be maintained. When machine vision is focused on the object in question, the system can measure or analyse dimensions to micro inches. Combining this output with machines, robots, or any other process control equipment, engineers and technologists can augment inspection or assembly operations, Machine vision systems do not get tired or fatigued doing the same repetitive task hour after hour, day after day, etc.. Humans can distinguish up to 60 different colours, but vision systems can resolve hundreds.

Vision systems are evolving from conventional passive inspection applications to providing real-time control with feedback loops to a variety of operations. Developments in machine vision systems have incorporated artificial intelligence (AI), three-dimension capabilities, and improved processing abilities and graphical user interfaces.

Magnetic Data Capture

Magnetic technology as used in the ADC industry commonly involves the use of magnetic stripe cards. Millions of people all over the world use this invisible ADC technology each and every day. In 1994 alone, shoppers made 6.3 billion credit card transactions and 8.3 billion debit transactions. Magnetic stripe (magstripe) technology can be applied to time and attendance cards, security control of selected rooms or buildings, airline tickets, mass transit and turnpike tickets, debit/credit card transactions, factory floor data collection cards, and even drivers' licenses.

The magstripe itself is made up of tiny permanent bar magnets called domains. Each domain is about 20 millionths of an inch long. These bar magnets are mixed into a binder (paint) and shaped into what has been referred to as a slurry. Before the slurry is dry, the magnetic particles are polarised so they can be encoded with data by the card issuer. The slurry can be attached to virtually any substrate or media material. The most common substrate materials are polyvinyl chloride (PVC), polyester, or paper. The magstripe itself holds information within tracks on the slurry.

Tracks are predefined widths on the magstripe. Much like a bar code having a start/stop character to define the data string, so do magstripes. Magstripes use a start sentinel and a stop sentinel to define a data string. The average marketplace life for consumer (i.e., credit cards) magstripe cards is 16 months. This can vary greatly, depending upon the application, type of substrate material, and magstripe coercivity employed.

Reading data from a magstripe card can use devices in the form of manual swipe/insert readers or motorised swipe/insert readers. To read or encode data from or on a magstripe, the magnetic head must be in physical contact with the magstripe itself. Most magstripe applications involve head-to-stripe speeds between 3 and 60 inches per second. There are a few terms to be familiar with when discussing magstripe technology. One term that gets a lot of press time is coercivity. Coercivity is measured in Oersteds (Oe). The MasterCard or VISA in your wallet or purse has a typical coercivity of about 300 Oe (low coercivity/LoCo). In comparison, an employee ID badge may have a coercivity approaching 4000 Oe (high coercivity/HiCo). The first assumption that might be made is that the higher the coercivity, the better. This is wrong. AIM USA has defined coercivity as the property of a magnetic material which resists demagnetisation. However, the application for which magstripe is being considered may not even need a coercivity approaching 4000. There are technical, cost, and standards tradeoffs. Work with a competent magstripe manufacturer or VAR to get the best "swipe" for the dollar! The magstripe industry is an established, strong, vibrant, and fun contact sport to play.

Magnetic ink character recognition is another type of magnetic data capture that can be referred to as MICR ("my-cur"). MICR is most widely used by the banking industry to increase the through-put of check clearing and cancelling of over 120 million checks each night. At the bottom of a personal check is a character set printed with a magnetised ink. When checks are fed through a reading machine, the magnetic signal strength is sensed for each character to determine, for example, the check number, account number, and banking institution. An advantage of this ADC technology is that pencil or pen markings over any of these characters does not render it useless. Since the characters are read magnetically rather than optically, they can still be read and decoded. Secondly, not only are the characters readable by machine, but also by humans.

MICR has been in use for over 30 years. The substrate materials for MICR fonts can be printed on paper and card stock, in either single sheet or continuous forms. The MICR fonts can be read magnetically or optically. Thirteen different characters can be used in the ANSI X3.2-1970 standards.

MICR fonts can be placed on the substrate via a magnetic ribbon. MICR readers sense the magnetic field strength of the printed characters to decode the fonts. If MICR fonts are printed with a non-magnetised ribbon, optical character recognition equipment would be needed for the decode. The laser printing of MICR fonts has been argued to be cheaper and faster when compared to conventional check printing techniques.

Electromagnetic Data Capture

Electromagnetic data capture methods include radio frequency identification (RF/ID) and radio frequency data communication (RF/DC). For almost 20 years, RF/ID has been used to identify physical objects by the use of two-way communication. Radio frequency identification tags can have read only or read/write capabilities. A growing market of applications where line of sight is not available, physical objects are in constant motion, or in harsh environments that surround the process makes RF/ID a preferred choice for data collection. The components of an RF/ID system include the tag or transponder, antenna or transceiver, and reader or control board. The tag is secured to the physical object to be tracked or monitored. RF/ID systems can be classified by how the tag is energised. RF/ID tags are referred to as either active or passive. The tags contain memory or a code from which an identification can be acquired.

Batteries are installed in active tags. When the tag enters the electromagnetic field (transmission zone) generated by a reader, the tag goes high (on), and data can be written to, or read from, the tag. Active tags can be expected to have a life of 10 years or 4-5 million read/write operations before the battery expires. Active tags can transmit data further than passive tags.

Passive RF/ID tags do not use a battery. Typically, passive tags can only be interrogated for a unique pre-programmed serial number once the tag has entered the transmission zone of the RF/ID system. To write information to a passive tag's memory, an electrically erasable programmable read only memory (EEPROM) chip can be employed. The application of RF/ID tags include data storage media, tracking manufactured products; pallets, automatic guided vehicles, access control, time and attendance, animals, and vehicles; merchandise control ; public transportation tracking and control ; toll booth/plaza utilisation; and remote vehicle security control or animal tracking using surface acoustical waveform (SAW) technology, to list just a few.

The use of radio frequency data communication (RF/DC) does not identify physical objects ; rather, it is a mode of data communication. RF/DC allows real time data communication from a selected ADC technology to a host computer system. Radio frequency data communication replaces traditional wires for sending information. The use of selected bandwidths is commonly referred to as narrow and spread spectrum. Narrow band typically operates in the 450-470MHz range and spread spectrum in the 902-928Mhz, 2.4GHz, and the potential near future 5.6GHz range. Radio frequency data communication systems are classified by the power they emit from their base radios.

Power used in RF/DC systems is expressed in watts ; spread spectrum RF/DC transmits at 1 watt over simultaneous channels so that interference on one channel does not keep data from getting through on other channels. Narrow band RF/DC uses a single frequency to transmit data at up to 2 watts of power. To use narrow band RF/DC, a site license frequency must be approved by the FCC or its designee. Spread spectrum does not require an FCC license. The decision to use narrow band or spread spectrum is purely an application choice. Narrow band will transmit data over greater distances but at lower through-put rates (9.6Kbps). Spread spectrum cannot transmit data as far narrow band ; but through-put rates can reach 121Kbps on a 900MHz system or over 1Mbps on a 2.4GHz system. The true speed of an RF/DC system can be determined by the transaction time. Transaction time is measured from the moment information has been entered into the ADC technology coupled to the RF/DC network, goes to the host computer database or software application, and then is confirmed back on the ADC technology that sent the information. Whichever RF/DC system is decided upon for installation, a site survey by the RF/DC manufacturer or value-added reseller (VAR) is highly recommended.

Biometric Data Capture

Biometrics focus on the examination of permanent physiological traits or physical human characteristics. This form of ADC refers to bio, meaning living creature, functioning with unique physical attributes. The use of biometrics has been traced back as far as the Egyptians, who measured people to identify them. For example, every person has a unique fingerprint, voice pattern, and retinal blood-vessel pattern.

Biometric systems have sensors that pick up a physical characteristic, convert it into a digital pattern, and compare it to stored patterns for identification. Whether someone places a finger or hand on a touch pad, looks into an ocular light source, signs his or her name, keyboards a predefined sequence, or speaks words, a positive identification is made of your physical trait. Without a match, identification or access is denied. Biometric characteristics are unique to each person, making the system virtually foolproof. Theoretically, biometrics are the most reliable form of identification. Biometric measurement systems typically include voice recognition/verification, fingerprint/thumbprint identification, palm prints, hand/wrist vein patterns, retinal/iris eye scans, hand geometry/topography, keystroke dynamics or typing rhythms, and signature verification.

The underlying advantages of biometric identification include elimination of common problems such as illicitly copied keys, lost or broken mechanical locks, and forged/stolen personal identification numbers (PINs) which can lead to automatic teller machine (ATM ; Bancomat)) and checking fraud. Applications for biometric technology can be divided into two groups, identification and security. Biometric systems can be used for identification purposes involving security access systems in management information services departments, government agencies, ATMs/banks, law enforcement, prisons, international border control, and military agencies.

Of all the electronic biometric technologies, the use of hand geometry has been in greatest use for the past 20 years. Finger/thumbprint identification systems usually scan and digitise the unique patterns of whorls and ridges on specific parts of the hand. The use of fingerprint matching has been traced back to 1903 in Europe. With finger or thumb prints stored as a digital image in a database, it is possible to compare 16,000 prints per second. The employee would press his or her finger against an input device for verification in order to gain access. Within seconds, access is either granted or rejected, based upon stored fingerprints.

Retinal eye scanners work by directing a low-intensity infrared light through the pupil to the back of the eye. Within seconds the retinal pattern is compared against the database of stored images. No two people, or even the same pair of eyes, have the same web of capillaries running through the retina. Retinal scans are one of the best biometric performers on the market, with low reject rates and a nearly 0 percent false-accept rate. Both fingerprint and retinal eye scan technology is commonly used to verify and identify a person to permit or deny access to a specific area or to record specific information about the person.

Speech identification or voice verification systems can allow remote identification of a person. This technology operates by building a digital representation of a person's vocal track. Applications that have been demonstrated include ATM transactions ; telephone usage ; and access into computer systems, buildings, offices, and laboratories. Going a step beyond speech identification, voice recognition data collection systems work best when the end-user has his or her eyes and hands free to perform a given task. The two broad categories of voice recognition are speaker dependent and speaker independent systems. As the name implies, speaker dependent relies on each end-user to train the system first, before using or entering data. Each end-user typically creates what is referred to as a grammar file. The grammar file can be a list of numbers, letters, words, and/or phases stored in the voice recognition host computer system that will be used in the given application. Speaker independent systems can understand the end-user without any pre-training or use of a predetermined grammar file. Speaker independent systems typically cost more than speaker dependent technology.

Speaker dependent systems have the upper hand for the majority of installed VR systems. The different number and quantity of characters, words, and phases that a VR system can handle can be correlated to the amount of memory the host computer has to operate it. Additionally, VR systems can be split-up between discrete, connected, and continuous systems. Discrete requires speaking one character or word one at a time. Connected voice data entry mandates that end- users speak in predefined characters. Continuous allows strings or sentences of words to be entered at once. Voice recognition systems are found increasing productivity in a variety of businesses and organisations. Currently, the majority of installed VR systems are located in manufacturing and product processing enterprises.

Near-term biometric technologies being developed for the marketplace include facial features, facial thermography, and iris scanners. The cost of biometric identification technologies continues to decrease as technology becomes more powerful and less costly to manufacture.