DATALOGIC
AUTOMATIC DATA CAPTURE

WHITE PAPER

# SMARTPHONES AND DATA CAPTURE: IS THIS A SMART IDEA?

## Introduction

Bar codes are everywhere. Since the successful adoption of the Universal Product Code (UPC) in the retail/grocery sector in the 1970s, the use of bar codes has exploded. Bar code tags and labels are used in almost every industry, for almost every conceivable type of data collection application. Everything from Grocery Check-out to Asset Management, Field Service to Logistics, IT Equipment Tracking, Warehouse Management, Automotive Manufacturing and Document Management.

While bar codes have become nearly ubiquitous, bar code scanning technology has, until recently, been limited to purpose-built devices used in business and enterprise settings. The introduction of digital imaging technology and the spread of smartphones has led to the use of these consumer devices in data capture.

The availability of low-cost, relatively high-resolution digital camera modules in mobile phones has essentially put a bar code scanner in the hands of anyone with a smartphone; or about half of the mobile subscribers in the U.S., according to Nielsen. By downloading a simple mobile app for the phone, consumers can scan almost any bar code to look up prices, access data, or in the case of the popular Quick Response (QR) code, access online content by scanning a QR Code found on printed marketing materials.

With this type of technology available in a relatively low-cost package, enterprise managers are considering scrapping their purpose-built scanning equipment in order to deploy smartphones in the field or in the warehouse.

Is this a smart idea? The answer is, largely, no.

The bar code imaging technology used in commercial scanners is designed to scan large numbers of bar codes in rapid succession, often in the poorest of working conditions. Smartphone cameras, on the other hand, are encumbered by a number of technical limitations that make them unsuitable for most line-of-business applications. In this white paper, we'll explore the mechanics of properly scanning a bar code, and how these two types of technologies compare in terms of performance.

## How Bar Codes Work

Any discussion of bar code scanning performance has to begin with the mechanics of how bar codes work. Bar codes, whether they are linear or two-dimensional (2D), optically represent data. With linear bar codes (such as the familiar UPC code), data is encoded in parallel lines and spaces of varying widths. The 2D bar codes, or matrix codes, feature square or dot-shaped modules arranged in a grid.

During the scanning process, bar code scanners illuminate the code, then decode the signal coming back from that scan, convert the information into ASCII text, and feed that information into whatever type of computer the scanner is communicating with. The reflected light from the code is sensed by a photo detector that generates an analog signal with varying voltage that fluctuates based on the reflected light coming back from the white spaces in the code. The output is a voltage waveform that includes peaks (for white spaces) and troughs (for black spaces).

Most modern bar code scanners utilize imaging sensors based on either CCD (charge-coupled device) or CMOS (complementary metal-oxide semiconductor) technology. The scanners capture an image (essentially taking a picture) of the bar code for the decoding process.

Imaging scanners, camera phones and regular digital cameras all operate on the same principle, and all can theoretically capture a serviceable image of a bar code for decoding purposes. Their performance when it comes to bar code scanning, however, varies significantly because of the underlying technology.

## Bar Code Imagers vs. Smartphones

There is one area where smartphones have proven effective for bar code scanning: QR Codes used in marketing and customer loyalty campaigns. Plenty of consumers successfully scan these codes on a daily basis and the codes themselves are becoming very common in catalogs, advertising, direct mail pieces, and in restaurants and retail stores.

One of the reasons QR Code was chosen for this particular application is that the codes can be very large; with larger 'dots' in the codes, they are more tolerant of motion blur and help compensate for the smaller depth-of-field found in consumer-grade camera phones. QR Codes were picked specifically because they would create less consumer frustration with the scanning process. It's fairly easy to get a good scan of a large QR Code using a mobile phone, but trying to scan a high volume of normal sized UPC codes would be extremely frustrating using a smartphone camera.

Why is this? There are a number of factors at work.

## Color vs. Black-and-White Imaging

Bar codes (at least those used in business applications) are black and white, and purpose-built bar code imagers are black-and-white devices. The camera in a smartphone is a color imager. While these cameras provide high resolution images, the relative small size of the pixels in the images means that each pixel is less sensitive than in the case of a traditional bar code imager.

## Depth-of-Field

The depth-of-field is the distance between the maximum and minimum plane in which a reader is capable of reading a bar code symbol. It is dependent on how the camera focuses and the amount of light being gathered to create the image. Purpose-built bar code scanners typically have a very long depth-of-field, so that codes can be scanned accurately from a range of distances without the need to focus the imager.

Depending on whether the camera in the phone is fixed or auto-focus, there are a number of obstacles to achieving the necessary depth-of-field. Auto-focus cameras allow users to collect more light, but can only focus on a relatively small area at one time. Auto-focus cameras in phones take time to focus on the right area, and provide a relatively small depth-of-field. This creates problems when trying to scan a bar code at an angle. In order to have a larger depth-of-field, the camera would have to have a smaller aperture, which is the case with a fixed-focus camera.

A fixed-focus camera provides a long depth-of-field, but with a smaller aperture the camera would collect less light. Light gathering matters because it determines how fast a code can be scanned, and how still the camera has to be in order to capture a good image of the code. With less light, the image can be marred by motion blur.

Dedicated bar code imagers are based on global shutter technology; all of the pixels capture light at the same moment. Phone cameras use what is known as rolling shutter technology, meaning every row in the image is exposed one at a time in a sweeping motion. That's what creates motion blur artifacts in the images captured by these phones. Blurring or slanting the image will impact the ability of the device to scan and interpret the bar code.

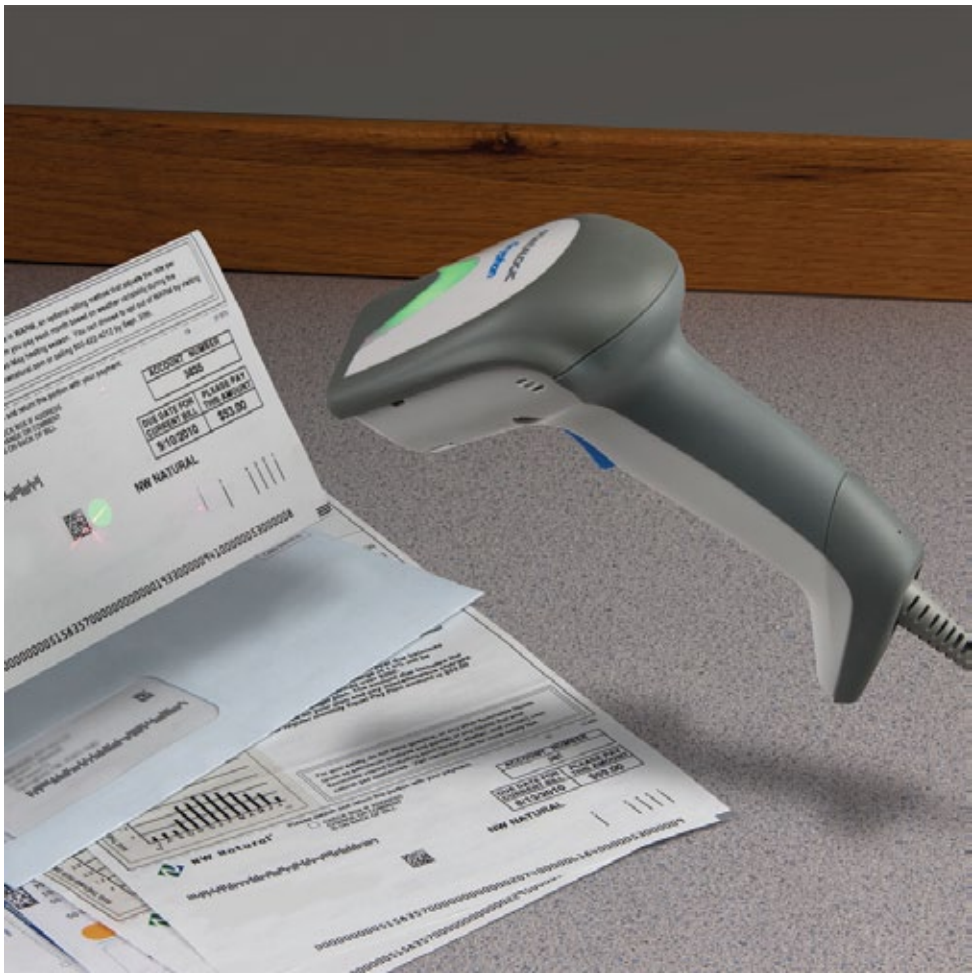
Anyone who has tried to scan a bar code using a phone camera (or even take a snapshot using such a device) knows that it can be challenging to hold the phone still enough to grab a clear image. It may take three to four seconds to capture a proper image, and the success rate at scanning the code can vary widely by the user. Bar code imagers provide a long depth-of-field, while simultaneously providing sufficient illumination to eliminate motion blur.

## Illumination

Motion blur can be corrected when using artificial illumination. Most camera phones take images using ambient light, which affects exposure times. Bar code imagers use LED pulse lighting. A bright, short pulse of light illuminates the code, allowing the scanner to capture the image without any motion blur. The flashes used on consumer cameras, on the other hand, often produce over-exposed images that wash out the picture and could impact scanning accuracy.

Bar code imagers also include targeting beams that help ensure the correct scan in applications where the scanner may encounter several codes in the same field-of-view. Combined with bright illumination, this guarantees fast, accurate scanning.

There are other factors that give purpose-built bar code readers an edge as well, unrelated to the imaging engine. Bar code reading and decoding is a complex process, requiring significant processing power from the handheld scanner involved. Dedicated bar code scanners and mobile computers also include all of the application software necessary to use the bar code data. A smartphone used in these applications would need to be outfitted with specialized software that may or may not be available for that particular platform.




## Specific Applications and Ergonomics

Bar code scanners are also equipped with complex algorithms that make it possible to read damaged, torn or otherwise incomplete bar codes. In the harsh conditions of most line-of-business applications (the warehouse, the loading dock, an oil field, etc.), this functionality is critical because the bar codes themselves are not always in optimal condition for scanning.

Ergonomics is another issue. The types of rugged mobile computers and scanners used in Warehouse Management, Logistics and Field Service applications have been designed so that end users can point, scan, and in some cases key-enter data in a way that reduces the risk of repetitive motion disorders and general discomfort. Trying to scan hundreds of bar codes over the course of a shift using a smartphone would, at best, result in a sore wrist and a cramped hand.

## What About Low-Frequency Scanning Applications?

There is potentially a case to be made for using smartphones in applications where bar codes are scanned infrequently or intermittently. Management-level employees or supervisors, for instance, may occasionally need to scan a bar code in a warehouse or maintenance environment, and a smartphone could conceivably be used for that purpose.

However, even in Field Service, Asset Tracking or Maintenance applications, where bar code scanning is of the low-volume variety, a purpose-built device has significant advantages. In most of these applications, the bar codes being scanned are on installed equipment - air conditioning units, printers, computers and other assets. Often these codes are very small and located in dark, hard-to-reach areas. The scan process in these applications would be too sensitive to blurring and lighting conditions to use a smartphone. Even though technicians would be scanning a relatively low volume of bar codes, working conditions would dictate the use of a professional-grade imaging scanner.

## Conclusion

Although smartphones are capable of scanning and decoding bar codes, the underlying camera technology in these devices would make it nearly impossible to utilize them in any kind of high-volume, high-velocity, poor lighting or small bar code scanning application because of the challenges in properly focusing, illuminating and reading bar codes in a timely manner. Purpose-built bar code scanners or scanner-equipped mobile computers can quickly and accurately read hundreds of bar codes per shift. They are ergonomically designed with this type of repetitive work in mind and are rugged enough to withstand the harsh conditions of most data collection applications. They include displays that are both rugged and easy to read in all lighting conditions, provide longer battery life and are equipped with the processing horsepower and applications to utilize the scanned data in enterprise applications.

While smartphones are suitable for many areas of the enterprise, the front line of most data collection applications is not one of them.

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Datalogic ADC is the world leader in the Automatic Data Capture market, offering state-of-the-art solutions with fixed position retail scanners, handheld scanners and mobile computers. Datalogic ADC's range includes in-counter and on-counter point-of-sale scanners, general purpose and ruggedized handheld scanners, rugged mobile computers, industrial PDAs and vehicle mount computers.

The Solutions business unit of Datalogic ADC is a leader in the development of solutions for the retail industry. Stores can benefit from the latest in vision-based technology solutions, analytical tools, self-shopping solutions and consumer relationship technologies.

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