ANALYTICS

Version (4) 8.04.11

FROM WIKIPEDIA: *The simplest definition of* ***Analytics*** *is "the science of analysis".*

Analytics as it applies to the ***LIBERATOR®*** Camera supports data mining involving extensive computation. Data mining is the process of extracting patterns from data and comparing them to known examples to identify any subject, target or area of interest. As Moore's Law continues its phenomenal impact on computational power data is accumulating and mining those memory files is becoming an important tool to expand our knowledge and immediate access to it via the ever increasing bandwidth of the web.

Analytics is gaining wide use in Security and Surveillance applications that address law enforcement, homeland security and defense, and migrating rapidly to other industries who have recognized the potential of Analytics to increase productivity and add value to products and services. It has been my long standing expectation that Analytics will become pervasive in a broad cross section of industry as Moore's Law multiplies computational capability, shrinks large capacity data storage and SoC (System on a Chip) technology incorporate digital functions and command and control software.

Note: While data mining can be used to uncover patterns in data samples, it is important to be aware that the use of non-representative samples of data may produce results that are not indicative of the domain. Similarly, data mining will not find patterns that may be present in the domain, if those patterns are not present in the sample being "mined". There is a tendency for insufficiently knowledgeable "consumers" of the results to attribute "magical abilities" to data mining, treating the technique as a sort of all-seeing crystal ball. Like any other tool, it only functions in conjunction with the appropriate raw material: in this case, indicative and representative data that the user must first collect. Further, the discovery of a particular pattern in a particular set of data does not necessarily mean that pattern is representative of the whole population from which that data was drawn.

The word **surveillance** may be applied to observation from a distance by means of electronic equipment (such as CCTV cameras). `

(Question, what is Liberty's legal responsibility for any program stored in our camera that may be subject to privacy laws?)

With respect to Liberty Imaging, and its Analytics technology we are not involved in the creation of the computer programs that are employed. Our contribution is to facilitate the implementation of Analytics by providing the engineering architecture and electronics to harbor specific programs that perform the function and then channel the data to the next stage of processing or storage. Liberty camera design technology does not contribute directly in the process of Data Mining.

THE *LIBERATOR*® LTE/WIMAX HDTV (720P) CAMERA ANTICIPATES THE NEED FOR A FLEXIBLE DESIGN TO FACILITATE DEVELOPMENT OF DIGITAL ANALYTICS AT THE "EDGE" OF A BROADBAND WIRELESS VIDEO/AUDIO MOBILE NETWORK SYSTEM REGARDLESS OF THE APPLICATION.

Two versions of this product are planned

1. **Fixed Position (FP) anticipates a camera mounted on a stationary structure with Access Points in general proximity interfacing with a backbone internet supplier.**

2. **Mobile (M) anticipates a camera that can be carried from place to place while connected to a broad area network system of access points linked to a Central Control Center by means of a broadband internet backbone.**

A third Power over Ethernet (PoE) version, not addressed in this paper, is a wired (optical fiber) model that can be used where OC infrastructure exits or contemplated and will include the Analytics feature.

Four critical benefits can be derived from this innovation.

1. **Existing wireless (Wi-Fi) does not always provide sufficient bandwidth to transmit the data files modern analytics programs are capable of producing or sufficient information to be effective,**
2. **Superior image quality, which is the main benefit of HDTV formats, are diminished by heavy compression required for transmission over Wi-Fi networks**
3. **Wi-Fi technology is restricted to a range of approximately 300 feet. This is a major inhibitor to innovative and highly desirable applications. LTE has at least a three mile transmission range and provides 100MBits or more bandwidth.**
4. **The addition of LTE or WIMAX and Analytics extends the concept to developing a camera that offers the flexibility to be utilized across a number of distinct industries.**

Advanced digital signal processors (DSP) incorporate many of the functions previously managed by separate specialized computer chips like compression, bin-sampling to reformat the picture as well as two way communications to govern basic camera functions and remote lens operation. Advance Complementary Metal Oxide Semiconductor (CMOS), Active Pixel (AP) imaging System on a Chip (iSoC) introduced Analog to Digital (AD) conversion at the sensor level facilitating on chip processing that minimizes artifacts and improves imager quality. As a result we now have the ability to design and build commercially affordable cameras that are Programmable providing broad flexibility to implement a broad array of in-camera originated Analytics.

To realize this potential the latest ***LIBERATOR***® incorporates as an integral part of the camera design supplemental digital memory and a daughterboard for analyzing digital video/audio data channeled from the camera for site specific applications. Previously analyzing video/audio data required transmitting the digital data file to a distant location for computer processing and then distributing the results. It is now possible to perform this function in-camera at the outer edge of the system where the information originates and transmitting the Analytics results via the internet (LTE) directly to responsible authorities for evaluation or action. This capability, when perfected, will expedite actionable information on a **real or near real time bases** for site specific decision making. This has lead to a new innovative camera function known as "Analytics at the Edge".

The ***LIBERATOR*** wireless camera adheres to the international IEEE.802.16e WIMAX standard and incorporates "at the edge" Analytics which constitutes three major advancements in the design and operations of advanced security systems:

- **Reduction in lag time between original capture and delivery of meaningful information to command and control centers for evaluation and action.**
- **Reduction in infrastructure cost and construction time, and,**
- **Provides a platform to implement site specific "programmable" Analytics that can be modified by field personal.**

An extended benefit is a programmable processor that will allow for the development of software modifications to Analytics programs to meet niche application requirements. For example: Condition the video color to match special requirements for facial recognition. Thus, the camera can be tailored to meet a wide variety of cross industry applications in science, education, industry, and law enforcement.

Special Task Offered by a LTE/WIMAX-HD Digital, Analytics Enabled Camera

Security and Surveillance:

Improved prevention and deterrence of criminal activity:

The first generation of this **FD** Camera is suitable for specific sites like banks where specialized recognition software can identify typical weapons, demand notes, wardrobe, masks and a limited image file of "active" bank robbers can be downloaded into cameras.

The next generation of refinement would be too revised the data file to include information about potential bank robbers in that city, neighborhood or even the specific branches.

The next generation of refinement that would be extremely useful is when the bank or police have a tip about an eminent robbery attempt. Data like

"last seen warring a yellow cap and red jacket." would be downloaded as soon as the information is known to the cameras in the suspected banks.

Once the suspect is identified alarms and other prevention tactics could be deployed instantly. And notice would be sent to the police who could then be in real time observance of the event.

Because the analyses is locally computed and the results transmitted directly to authorities over the internet using security coded IP addresses it can be sorted and sent to the relevant control center for evaluation and further action. Nearly all of the lag time is removed from the system resulting in notifications in real or near real time. By developing early detection crime prevention strategies can then be imagined.

Sound identification software is becoming a critical component of security strategies but in today's systems it is collected and processed separately. The ***LIBERATOR®*** LTE/WIMAX camera incorporates a digital microphone that can be connected to the Analytics programming system.

Critical detection of sounds that signal an emergency like fire alarms, gun shots, calls for help, explosions, etc. can be detected locally and transmitted to the appropriate authorities in real or near real time. This vary early detection is critical to improving prevention and response times.

In future generation's software will be developed to coordinate the Video and Audio Analytics for optimum results.

Once this system is in place we expect alternative uses will emerge such as safety inspections and identification of a variety of maintenance issues from light bulbs to stuck elevators will emerge with the information routed to the proper department over the internet.

A sampling of cross-industry surveillance applications

Whether the need is video surveillance to secure the safety of people and places, remotely monitor property and facilities, manage industrial and agriculture production or improve quality health care the flexible ***LIBERATOR®*** HD camera with Analytics provides a platform for superior solutions.

Note: This section is a work in progress and will be updated periodically.

In BLUE are examples of potential markets or applications that could be developed in association with institutions into innovative products with the emergence of a HD quality LTE/WIMAX camera system.

Retail: retail in-store marketing

IP Network video systems can significantly reduce loss due to theft, improve staff security and optimize store management. They enable remote and local monitoring of stores at any time and from any place, and offer the shortest return on investment. Analytics is coming on line by combining video surveillance with customer counting, integrated alarm functionality and monitoring of electronic cash registers. HD in up-scale stores will only amplify these benefits.

- Macy's, Inc, including Bloomingdales operates over 800 stores in the US with 167,000 employees. The company maintains a large staff devoted to development and implementations of advanced technologies for in-store security and marketing.
- Retail in-store marketing in association with digital signage is the newest application; with in camera analytics as real time tool new concepts will emerge.

Transportation:
Remote surveillance options enable any authorized security staff to cover everything from check-in areas, platforms and gates, to hangars, parking lots and baggage systems. Analytics in conjunction with higher quality images of HD is going to improve prevention surveillance techniques. Traffic information can also be monitored to reduce congestion and improve efficiency. LTE/WIMAX adds tremendous flexibility and lower cost infrastructure for transportation planners.

- In large urban centers vehicle Congestion Control (NYC, Congestion Pricing)
- US Department of Transportation: Automated Highway Program to monitor and manage traffic flow and reduce accidents on US Interstate Highways.
- Rapid transit worldwide will benefit from a mobile security system.

Education:
From day-care centers to universities, video analytics will improve deterrence of vandalism and increase the safety of staff and students. Where infrastructure cost is critical to upgrading LTE/WIMAX may provide an affordable pathway to a superior solution. Analytics will provide critical warnings like motion detection that can generate alarms and give security operators accurate, real-time images on which to base decisions.

- Various federal and state programs to support advanced video / audio security systems in public schools K-12, junior collages and universities.

City surveillance:
Security Rings such as the one being deployed by New York City of IP Networked cameras is one of the most useful tools for fighting crime and protecting citizens, acting both to detect and deter. In emergencies, network cameras can help police or fire-fighters pinpoint where their assistance is most needed. LTE/WIMAX will facilitate rapid deployment of video security for events and emergencies while Analytics is certain to become a major tool in crime fighting.

- Urban centers designated as high priority targets like New York, Washington DC, Chicago, etc. Example: NYPD "Ring of Steel Program" to protect NYC Financial District.

Government:
Valuable assets like public buildings, museums, offices, libraries and prisons require reliable 24/7 security at entrances and exits to record who comes in and out. This application is a natural venue for advance Analytics to meet any number of objectives from preventing terrorist penetration to collecting statistical data on visitors.

Banking & finance:
LTE/WIMAX, HD and advanced Analytics are expected to greatly improve state-of-the-art surveillance systems that can monitor any number of branch offices from a central location, as well as visually verify alarms to security staff and law enforcement.

INDUSTRIAL APPLACATIONS

Automated-Precision Farming:

GPS guidance, CPU/software, pneumatic actuators and sensors have facilitated unmanned tractors, fruit pickers, crop control and autonomous harvesters. These are a few of innovations that have motivated the fastest adoption rate of ANY technology in the history of agriculture. The automated version of farming has been dubbed "Precision Agriculture" by MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) although the industry prefers "Precision Farming" which is a more inclusive term.

- John Deer Corporation has introduced first generation Automated Tractor
- Federal Land Grant Universities are centers of engineering and agricultural development.
- Connell University Ithaca, NY is New York State's land grant university.
- Cornell College of Veterinary Medicine and College of Agriculture and Life Sciences often work in concert with Collage of Engineering.

The Tractor is: SENSOR AND ACTUATOR
This simultaneous computer based innovation is producing massive systemic productivity gains across all forms of farming:

- Farming machines can run day, night or in fog
- No need for experienced drivers
- Enables PRECISION farm practices
- There are no new acres overall, increasing yield is paramount
- Protects capital investment
- Raises the human to supervisory level
- Precision Farming is a Carbon Negative process

A Mobile LTE/WIMAX HD Analytics camera with connectivity to a tractor based **Global Positioning System** (**GPS**) receiver offers the potential for further innovation in Precision Farming even in the midst of the massive automation revolution.

In current systems cameras are being introduced to guide tractors but in most cases operators are still required to control the agricultural functions. The ***LIBERATOR®***

camera can contribute to technology solutions still facing Precision Farming scientist in areas like:

- Navigation
- Continuity vs. Accuracy
- Greatly Increasing Range
- Soil Conditions
- Farmer's Optimal Control Problem
- Objective Function = Profit

The agricultural industry is experiencing a period of exploration and intense R&D as it pursues development of (Automated) Precision Farming technology. These categories have been identified as potential users of imaging:

Automated Machines,	Irrigation, Catfish Farming,	Crop Farming,
Potato Farming,	Pearl Farming,	Machinery Management,
Chickens,	Security Systems,	Automated Truck Scales,
Christmas Trees,	Fish Farming,	Livestock,
Fertilizer Management,	Automated Gates,	Mushrooms,
Automated Processing,	Egg Sorting,	Packaging and Shipping.

Healthcare:

HD LTE/WIMAX in hospital networks will provide flexible system for cost-effective, high-quality patient monitoring providing authorized hospital staff a live patient view from multiple locations, detect activity, provide remote assistance, and Analytics will provide an extensive menu of specialized programs to assist in treatment.

- Weill Cornell Medical College, Medical Center and Cornell College of Engineering in New York City.
- Columbia-Presbyterian Hospital/ Columbia University College of Engineering and Medical Research Laboratories
- NYU Department of Emergency Medicine coordinated multi-hospital disaster preparedness safety net for New York City.
- New York City Health Department
- New York City, Emergency Services / Fire Department

Medical:

High resolution imaging is enjoying very rapid acceptance among medical research and development products designers. Those applications that employ full motion video are eager to upgrade to HDTV resolution, especially the tenfold improvement in color selection (palate) that SMPTE standards provide.

MegaPixel formats are essential for research and some diagnostic specialties plus IR, X-Rey and Ultrasound imaging There remains a very large segment of the industry that will innovative applications that take advantage of interoperable standards like SMPTE

and IEEE offer and at the edge Analytics of ether version of the *LIBERATOR*® that can then be transmitted to specialist for evaluation in real or near real time.

Some examples of attractive ROI applications that fit this model and can greatly expand access to quality care and contribute significantly to productivity gains in medical cost are:

- video assisted automated surgery including remote surgery,
- distant care for geriatrics,
- remote diagnoses for dermatology,
- remote patent recovery monitoring,
- veterinary diagnostics, and,

Emergency Medical Services (EMS-Cam):

The Defense Department has developed a new medical field, "Battlefield Triage". A number of techniques, including video/audio to assist trained medics in applying life saving therapy to critically wounded worriers to improve their survival rate during transport to field hospitals have been perfected. At that stage of treatment more satisfactory satellite HD systems are employed to involve additional medical specialist to assist in developing a treatment protocol to father improve survival rates. This high tech dependent procedure has proven to be so successful that death rates from battle wounds have been improved by an estimated 60%. But it has come at a very high cost and complexity. However many of the lessons learned can now be applied to a civilian sector version that could have a similar impact on injuries resulting from accidents and other medical emergencies.

To achieve the goal it is essential that the Camera be a delivery platform for HD resolution, progressive scan digital images, accurate color rendition and sufficient wireless range to reach the emergency trauma team at the hospital the EMS truck is assigned too. Analytics to support accurate evaluation, diagnoses and vital sign detection plus innovations to asset EMS personal in applying critical therapy are contemplated. Current portable video cameras lack this combination of assets consequently specialized equipment for this critical application is not yet available.

A mobile version of the *LIBERATOR*® LTE/WIMAX Analytics equipped camera can be configured to deliver an EMS-Cam platform.
Some of the emergency triage medical benefits would be:

- True progressive HDTV two megapixel native format verses conventional NTSC/PAL that eliminates interlacing.
- Progressive formats are rapidly becoming a requirement for advanced medical applications to improve image quality and avoid systemic artifacts associated with interlace.

- A tenfold improvement in color rendition. This is of critical importance in initial evaluation of emergency patients. Examples are: skin tone, obstructions, external lacerations, expression, verbal communication, blood color and infections.
- LTE/WIMAX has a range of up to three (3) miles that facilitates development of a captive HD EMS video triage system within existing hospital infrastructures based on universal standards that can be interoperable with other medical specialist for consultation and with national data bases for up to date information.
- Further with an interoperable system hospital staff can exchange critical data in real time with relevant agencies outside the hospitals infrastructure.

Garment Manufacturing and Fashion

Fashion industry is in the grips of the GPS revolution and web-based customization accessible from anywhere in the world. No more frantic trips to Southeast Asia with look books, inventory management, quality control, etc. It's fast becoming a virtual world of designing options and approval to keep pace with up-to-the-minute trends and image rich press releases and impossible deadlines. Systems have the ability to log the initial style request all the way to end of the process to cutting out the press hit then creates public relations and advertising reports to immediately determine a company's performance and then analyze the monetary value of the public relations efforts.

HD is in the system today but not much has been done with at the edge Anylitics. Quality control at the manufacturing level is a major opportunity.

- Parsons The New School for Design. in concert with NYU Advanced Imaging Libratory

Just-in-time Warehousing

Automated Warehousing is based on Automatic Storage and Retrieval Robotic Systems (AS/RS). Solutions are tailored for industry purposes such as production storage, Work-In-Process Inventory (WIP) warehouse, cold or deep-freeze storage and distribution centers. The general benefits of AS/RS include maximizing use of storage space, scalability, productivity gains and minimizing stock on hand. All of these factors have contributed to the wide acceptance of "just in time manufacturing" which continues to have a profound effect on productivity gains.

Modern warehouse system design offers infinite innovative possibilities. The main factors taken into consideration are product type, product diversity, and number of articles, gradations and performance requirements.

Automated warehousing uses intelligent machines to take over the warehousing function for physical products. As machines become more intelligent additional productivity gains will be realized and the practice will expand through innovation.

Two potential adaptations of LTE/WIMAX HD cameras with Analytics are apparent:

1. Job specific direction when upgrading and retrofitting antiquated installations with minimal or no-shutdown time.

2. Flexibility to reposition cameras quickly as job functions change.

Automated (Robotics) Manufacturing

Robotics enables manufacturers to highly Automat plants with a variable production mix. Multiple engineering disciplines use a software based virtual environment to plan and validate manufacturing systems that range from single units to complete production lines. Machine vision systems have been in place for some time.

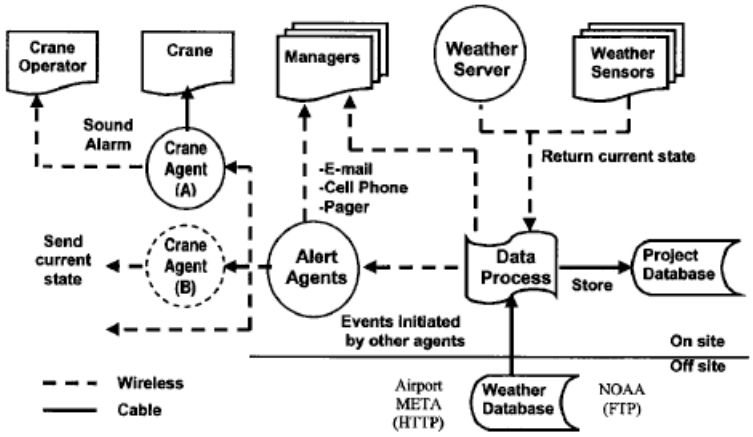
Automated manufacturing is known as an early adopter of technology that promises improvement in accuracy or speed of the production line. A small gain can leverage a disproportioned improvement in productivity, cost control or yield. While cost can be high to retrofit a production line with new advanced control systems it is absorbed quickly by the productivity gains.

The availability of a LTE/WIMAX HD Analytics camera introduces the prospect of fine grain accuracy and mobile products with the capability to change functions and job orders on the fly.

Construction/Natural Resources Extraction

Unmanned construction, mining and drilling is work performed by remotely operated construction machinery that corresponds to an operator controlled robot. A high technology approach to the challenges of systematic implementation is fairly new but the potential results are significant:

- Improved safety
- Reduction of temporary work costs and safety measure costs
- Improved operating rate (shortening construction periods) Productivity gains
- More precise higher quality operations



At this time Collaborative Multi-Agent systems for Real-Time Monitoring and Planning Construction systems are being developed.

By using agents, wireless communication, and field data capturing technologies an up-to-date 3D model of the construction site is created. Real time data is processed by the Multi-agent system to detect any possible collisions or other conflicts related to the operations of the equipments, and to generate a new plan in real time. The potential advantages of the proposed approach

are: more awareness of dynamic construction site conditions, a safer and more efficient work site, and a more reliable decision support based on good communications.

Further wireless communication technologies are needed for agents to communicate with each other on site. A broadband LTE/WIMAX network would solve many of the communication problems caused by the “islands of information” in construction. The dotted lines in the figure on the right show wireless communication between different components of an agent based crane alert model.

By the addition of a Security System that included Analytics much greater control of the of the operation can be developed.

Defense

The DOD has accepted 720p and 1080p as HD system formats to be used to develop battlefield applications. There are any numbers of manned and unmanned machines that can gain greater capability in completing there mission by the availability of a LTE/WIMAX capable camera.

Analytics at the edge will refine and expand the current mission objectives.