Imaging Partnership Integrated Learning Systems

Innovation Highlights

Medical Technology

Eyesight – Laser Surgery – Eye Examination – MACRO PHOTOGRAPHY – RED EYE

Risks of Laser Surgery – poor night vision – double vision etc – LOW LIGHT PHOTOGRAPHY- FOCUSSING

Surgical Endoscopy –' looking inside' using a borescope – uses fibre-optics – can suffer from PIXELLATION – explore concept of digital photography on screen – how every pixel is made up of only one colour etc. How many megapixels to print on the side of a bus?

Laser Tattoo Removal – Lasers remove tattoos by breaking up the pigment colours of the tattoo with high intensity light beams. Black absorbs all laser wavelengths, making it easiest to treat. Other colours can only be treated by selected lasers based on the pigment colour. HISTOGRAM – how camera sensors respond to light/shadow/colour.

Holography – comparison with photography – light sources – holography uses laser source, photography uses 'normal' light – define normal – WHITE BALANCE

Laser Pen Science Experiments

You can take striking photos of your laser by setting your camera in long exposure mode.

Laser pens have become so inexpensive it is easy to forget that they are small wonders of technology. If you have a laser pen you can perform some simple but striking science experiments. Have some educational fun with the kids, or just revive your sense of scientific wonder by tinkering around with lasers.

See the Laser

Make the laser visible by creating some fog. Because lasers are made of coherent light the beam will travel straight ahead without spreading or scattering. Unlike lasers in the movies, real lasers cannot be seen except when they are being reflected by something. To make a laser beam visible, you can use a fog machine, such as the kind you can find for parties. A bit of dry ice dropped in hot water will create a spooky-looking fog with a mad scientist vibe, too, but use it in a well-ventilated area. For a low-tech and low-budget solution, you can just beat two very dusty blackboard erasers together.

Reflect the Laser

Line up two mirrors parallel to each other, and shine the laser beam between them. By adjusting the angle of incidence carefully you can "trap" the beam between both mirrors making it bounce from one to the other in an intricate accordion pattern. (The angle of incidence is the angle at which the laser touches the surface of the mirror. You can use a protractor to measure it and see that it is equal to the angle of reflection.)

Split the Laser

Shine the beam of your laser pen into a microscope slide set at 45 degrees to the beam. When a laser meets a transparent but reflective surface a part of the beam will get through, but another part will be reflected. Repeat the procedure and create an arrangement of mirrors and slides to create complex paths for the beams to follow.

Diffract the Laser

Create patterns by shining the laser through a fine mesh or a bird's feather and onto a white wall. A laser beam can be described as an array of almost perfectly synchronised waves, and when you use a fine mesh to split the beams you interfere with that synchronisation. As a result, some waves will reinforce each other and some will neutralise each other, creating mesmerising geometrical patterns.

Take Precautions

lasser rojo image by nuryudijes from Fotolia.com
Reduce the risk of eye damage by using a red laser pointer with an output of less than 1 mw (that is, 1 milliwatt, or one hundredth of a thousandth of the power of a common light bulb).

Microscopy – MACRO PHOTOGRAPHY, also PHOTO MICROSCOPY – attaching cameras to microscopes. Looking at problems associated with photo microscopy – minor vibrations amplified, so out of focus. Solutions include – SLOW SHUTTER SPEED, LOCK UP MIRROR, REMOTE TRIGGER, TETHERED SHOOTING.

Spectroscopy – Visible Light Spectrum – every object that has a temperature emits electro-magnetic radiation – the visible part of this spectrum includes the colours of light – WHITE BALANCE

Engineering

Stroboscopic photography is used in wind tunnels etc to record the flow of air/fluids around objects – FLASH, BURST MODE, SHUTTER SPEED, LIGHT PAINTING, PANNING

Also, recording series of events eg for consumer booklets for home assembly

Photography in Marketing/Advertising in bringing a product to market.

Metrology – science of measurement – DEPTH OF FIELD

- **Ophthalmology & Optometry**

  Diagnostic and treatment solutions for ophthalmic diseases.

- **Neurosurgery**

Visualization solutions for surgery of the nervous system.

- **P&R Surgery**

Visualization solutions for plastic and reconstructive surgery.

- **Spine Surgery**

Visualization solutions for surgical procedures of the spine.

Consumer Optics

Looking into areas such as: Aviation, Military, Optics, Space, Underwater

- Optical Design
- Medical Healthcare Imaging
- Pharmaceutical Engineering
- Education Technology
- Aviation engineering
- Civil engineering
- Marine Engineering
- Optometry

- Hemotology
- Bioengineering
- Optical Engineering
- Optical Manufacturing
- Aerospace Engineering
- Ophthalmology
- Optometry
- Spectroscopy
- Aeronautical Engineering
- Medical Imaging
- Nanotechnology
- Aeronautical Engineer
- Medical Physicist
- Photonics
- Genetic engineering
- Holography
- Biophotonics
- Biomedical Technology
- Bioengineering
- Haematologist
- Virology
- metrology, spectroscopy, holography
- Neurosurgery
- Plastic and Reconstructive Surgery
- Spine Surgery

- Careers in Optics programme (10 hours on each programme)

- Camera Designer
- Electrical Engineer
- Electro-Optical Engineer
- Engineering Manager
- Laser Engineer
- Manufacturing Engineer
- Metrology Engineer
- Optical Designer
- Optical Engineer
- Optical Manufacturing Engineer
- Optical Scientist
- Optical Technician
- Aerospace Engineering
- Astronomy
- Medical Imaging
- Nanotechnology
- Pharmaceutical
- Education Technologist
- Spectroscopy
- Biophotonics
- Marine Engineering

- Virology / Hemotology
- Civil engineering
- Optician
- Optometrist
- Ophthalmologist
- Orthoptist

Other fields that we can look into are:

Applications of photonics are ubiquitous. Included are all areas from everyday life to the most advanced science, e.g. light detection, telecommunications, information processing, lighting, metrology, spectroscopy, holography, medicine (surgery, vision correction, endoscopy, health monitoring), military technology, laser material processing, visual art, biophotonics, agriculture, and robotics.

The potential applications of photonics are virtually unlimited and include chemical synthesis, medical diagnostics, on-chip data communication, laser defense, and fusion energy, to name several interesting additional examples.

- Consumer equipment: barcode scanner, printer, CD/DVD/Blu-ray devices, remote control devices
- Telecommunications: optical fiber communications, optical down converter to microwave
- Medicine: correction of poor eyesight, laser surgery, surgical endoscopy, tattoo removal
- Industrial manufacturing: the use of lasers for welding, drilling, cutting, and various methods of surface modification
- Construction: laser leveling, laser range finding, smart structures
- Aviation: photonic gyroscopes lacking mobile parts
- Military: IR sensors, command and control, navigation, search and rescue, mine laying and detection
- Entertainment: laser shows, beam effects, holographic art
- Information processing
- Metrology: time and frequency measurements, range finding
- Photonic computing: clock distribution and communication between computers, printed circuit boards, or within optoelectronic integrated circuits; in the future: quantum computing

<u>Photonics</u>: from Fiber optics and telecommunications to medical imaging and cancer research, optics and photonics are advancing today's critical technologies. Based on the science of light, optics and photonics are specialized fields of physics and engineering. Applications of photonics are ubiquitous. Included are all areas from everyday life to the most advanced science, e.g. light detection, telecommunications, information processing, lighting, metrology, spectroscopy, holography, medicine (surgery, vision correction,

endoscopy, health monitoring), military technology, laser material processing, visual art, biophotonics, agriculture, and robotics.

Precise measurements (metrology) impact our daily lives. The ability to make precise and reliable photonics measurements is what underlies areas as diverse as global positioning systems (GPS), communications, and satellite and aircraft positioning and manufacturing.

Many of today's "must-have" technologies such as digital cameras, high definition TVs and smart phones, were developed through optics and photonics research. Further research is expected to yield even more consumer products designed to enhance quality of life.

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- Fiber optics connect the world through high-speed communications. In fact, the Internet was developed by optics researchers. Today's optics research is bringing higher-speed communications to our homes via fiber technology – enabling advanced data transmissions, like video streaming, and other broadband applications.

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- Holography
- Biophotonics
- Visualization solutions for plastic and reconstructive surgery

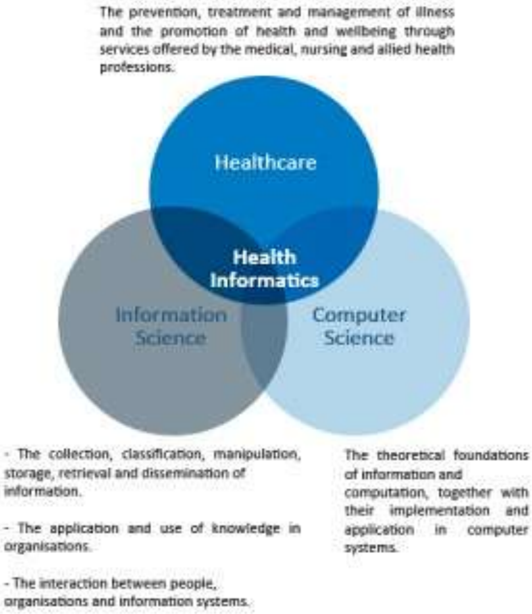
- Ophthalmic diagnostic and therapy systems
- Medical Physicist

- Virology / Hemotology
- Optometry
- Ophthalmology
- Orthoptist
- Research Solutions and Consumer Optics
- Optical Design
- Optical Scientist
- Optical Technician
- Neurosurgery
- Biotechnology
- Visualization solutions for surgery of the nervous system
- P&R Surgery
- Camera technology Innovations for Spine Surgery
- Visualization solutions for surgical procedures of the spine

Optics and photonics are utilized in numerous medical devices that help to save lives. Imaging equipment used for CAT, MRI and PET scans, as well as mammography, aid in the diagnosis of disease. Photonics technologies are already essential for delivery of effective and low-cost diagnosis, treatment and prevention of disease.

Traditionally, optical technologies have been used for long-distance communications and more recently in local communication like the optical mouse. The company/nation that finds a cost-effective consolidation technology— photonic integration—will achieve higher production volumes and gain substantial advantage over competitors.

<u>Informatics</u>



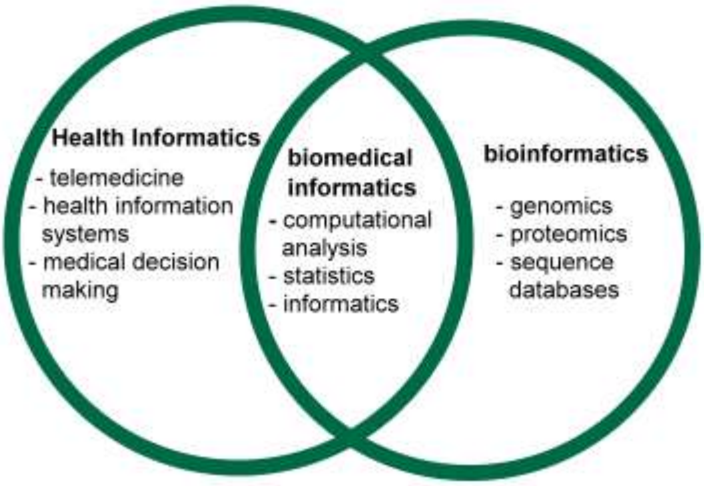


Fig. 1 Biomedical Informatics at a glance

Contributing Disciplines

- Bioinformatics

Biomimetics or biomimicry is the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems.

- Legal Informatics

Legal informatics is an area within information science. Erdelez and O'Hare (1997) define legal informatics as follows:

The American Library Association defines informatics as "the study of the structure and properties of information, as well as the application of technology to the organization, storage, retrieval, and dissemination of information."

- Biomimetic

Biomimetics could in principle be applied in many fields. Because of the complexity of biological systems, the number of features that might be imitated is large. Some examples of biomimetic applications at various stages of development from prototypes to technologies that might become commercially usable include:

Leonardo da Vinci's design for a flying machine with wings based closely upon the structure of bat wings

- Aircraft wing design and flight techniques inspired by birds and bats

- Climbing robots, boots and tape mimicking geckos feet and their ability for adhesive reversal
- Nanotechnology surfaces that recreate properties of shark skin[8]
- Treads on tires[9] inspired by the toe pads of tree frogs
- Self-sharpening teeth found on many animals, copied to make better cutting tools[10]
- Protein folding used to control material formation for self-assembled functional nanostructures[11]
- The light refracting properties of butterfly wings are harnessed to provide improved digital displays and everlasting colour
- Better ceramics by copying the properties of seashells[13]
- Polar bear fur inspired thermal collectors and clothing[14]
- Mimicking the arrangement of leaves on a plant for better solar power collection
- Studying the light refractive properties of the moth's eye to produce less reflective solar panels[16]
- Self-healing materials, polymers and composite materials capable of mending cracks

- Medical / Clinical Informatics

It deals with the resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

It is applied to the areas of nursing, clinical care, dentistry, pharmacy, public health, occupational therapy, physical therapy and (bio)medical research, and alternative medicine too.

Health Informatics Tools

Front-line health informatics tools (sometimes informally called the "Clinical Informatics Toolbelt") generally include, but are not limited to, one of the following:

1. Policies and Procedures - Tools used to define organizational standards and how to achieve them.
2. Procedures - Documents to help learn how to achieve a goal
3. Clinical protocols - Tools used to standardize and automate care in a common clinical scenario.
4. Orders - Tools used to record and transmit detailed instructions to perform a procedure or deliver care
5. Order Sets - Tools used to standardize and expedite the ordering process for a common clinical scenario
6. Clinical Pathways - Groupings of order sets, used to standardize the rounding process for a common clinical diagnosis
7. Guidelines - Documents used to educate general care objectives for a common clinical scenario
8. Clinical Documentation (includes *Notes, Forms, and Flowsheets*) - Documents used to record and transmit a patients' history, condition, responses, therapies, activities, and/or plans
9. Clinical User Profiles - Tools used to personalize and/or gather information about clinical users[1]
10. Clinical Templates - Documents used to standardize and expedite the development of a clinical document
11. Clinical Staff Education Modules - Documents used to educate a staff member about a common clinical subject
12. Clinical Patient Education Modules- Documents used to educate a patient about a common clinical subject
13. Clinical Staff Schedules - Documents used to determine who is responsible for care at a particular date and time
14. Clinical Committee Charters - Documents used to assign responsibility to a clinical committee to perform a particular task
15. Clinical Committee Minutes - Documents used to record the decisions and activities of a clinical committee
16. Telephone Number Lists - Documents used to help contact a clinical

staffmember
17. Wikis - Electronic documents used to collect information and web links for a common clinical group
18. Emails, Posters, and Staff Meetings - Tools used to make announcements and deliver short messages

Digital Healthcare

Digital healthcare (also known as digital health) is an upcoming discipline that involves the use of information and communication technologies to help address the health problems and challenges faced by patients. These technologies include both hardware and software solutions and services.[1] Generally, digital healthcare is concerned about the development of interconnected health systems so as to improve the use of computational technologies, smart devices, computational analysis techniques and communication media to aid healthcare professionals and patients manage illnesses and health risks, as well as promote health and wellbeing.

There are a range of domains that span digital healthcare:

- Assistive technologies and rehabilitation robotics: the use of rehabilitative systems and devices for patients with disabilities so as to aid in their independence to perform daily tasks.

- Clinical decision support: the use of decision support systems to aid clinicians at the point of care. This includes diagnosis, analysis and interpretation of patient-related data.

- Computational simulations, modeling and machine learning approaches: the use of computational and mathematical equations and algorithms to model health-related outcomes.

- E-health: the combined use of electronic means to deliver health information and services so that data can be transmitted, stored and retrieved for clinical, educational and administrative purposes.

- Healthcare technology assessment and monitoring: the use of any technological intervention to prevent, diagnose or treat diseases, monitoring of patients, or for rehabilitation or long-term care. Such technologies include assistive and rehabilitation technologies, unobtrusive monitoring sensors and wearable devices.

- Health systems engineering: the use of engineering applications in health care systems, such as knowledge discovery, decision making, optimization, human factors engineering, quality engineering, and information technology and communication.

- Human-computer-environment interactions: the study of interactions between people, computers and their environment. Human-computer interaction principles tend to be based around user-centered,[5] experience-centered [6][7] or activity-centered designs,[8][9][10] while user interactions with their environments can be understood by Urie Bronfenbrenner's Ecological Systems Theory.[4][13]

- Information management and policy: the continual process of systematically reviewing and providing concise data summaries of high quality evidence on digital healthcare technologies based on principles of information design so as to inform decision and policy making regarding patient care.

- Virtual reality and serious games: the use of 3D virtual worlds and gaming technologies to provide a social and interactive experience for healthcare student and patient education. The popular "Second Life" virtual world is an example.

- Speech and hearing systems: the use of natural language processing, speech recognition techniques, and medical devices to aid in speech and hearing (e.g. cochlear implants).

- Telehealth, telemedicine, telecare, telecoaching and telerehabilitation: the use of telecommunication and information technologies to provide various forms of patient care remotely at a distance.