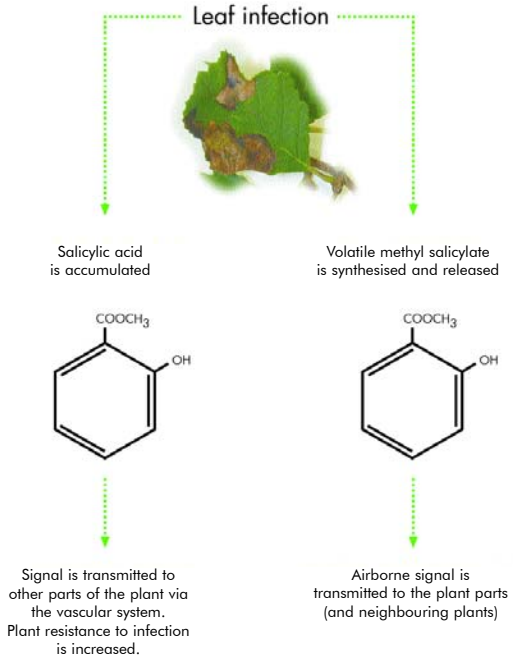
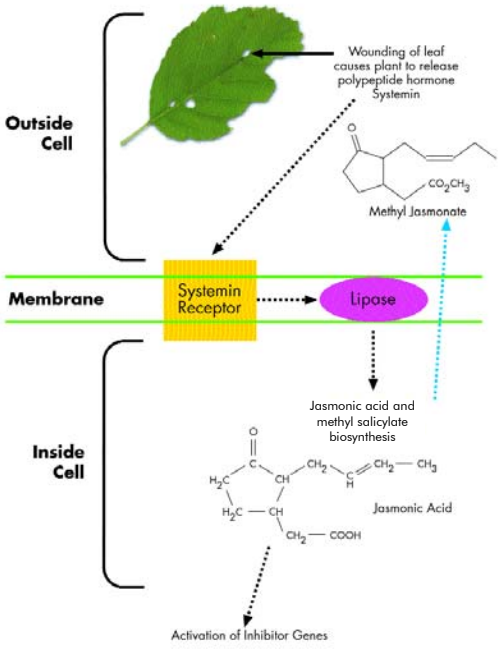
Stress Signals

Volatile organic molecule stress signals

The PLANTS project aims to characterise some of these volatile biomarkers for use in proximal sensing of pathogens and pest. Many other volatile compounds attract pollinators and pest predators. Pathogen-plant combinations produce chemical fingerprints of potential use in detecting and identifying diseased material.

Experimentation will determine whether analysis of these fingerprints can be used in pest and disease forecasting.





Plants produce some universal volatile stress signalling compounds such as ethylene, methyl jasmonate (during pest attack) and methyl salicylate (during pathogen attack) in addition to certain compounds that are specific to species and genera of individual families.

Precision Agriculture

Precision agriculture is a step beyond monitoring the environment to determining the needs of the individual plants within crops

Remote sensing

- Remote sensing (RS), based on analysis of the spectral emissions of crops, offers new possibilities for crop monitoring and management of regional irrigation schemes.
- RS can detect between - and within - field variation in crop type, growth and yield prediction.
- Detection of water stress by RS, in combination with computerised variable delivery systems, permits supply of water to restricted areas rather than using general broadcast applications.

However the practical limitations of using remote sensing are threefold:

- The technology is expensive;
- The data may not be available in real-time; and
- The resolution may not be sensitive enough to detect the early stages of disease development.

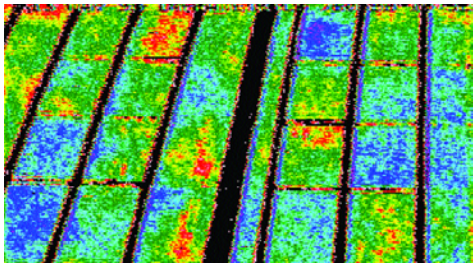
Proximal Remote Sensing

Proximal (close-up) Remote Sensing (PRS) of plant parameters such as temperature and chlorophyll fluorescence can be used to give real time data - an advantage over RS. Proximal remote sensing is being used in the PLANTS project within a society of communicating plants and artefacts for implementation for ultimate dissemination within precision agriculture.

Precision agriculture is a move from monitoring the environment to determining the needs of the crop, thereby delivering inputs to those plants in need of attention. It can be combined with:

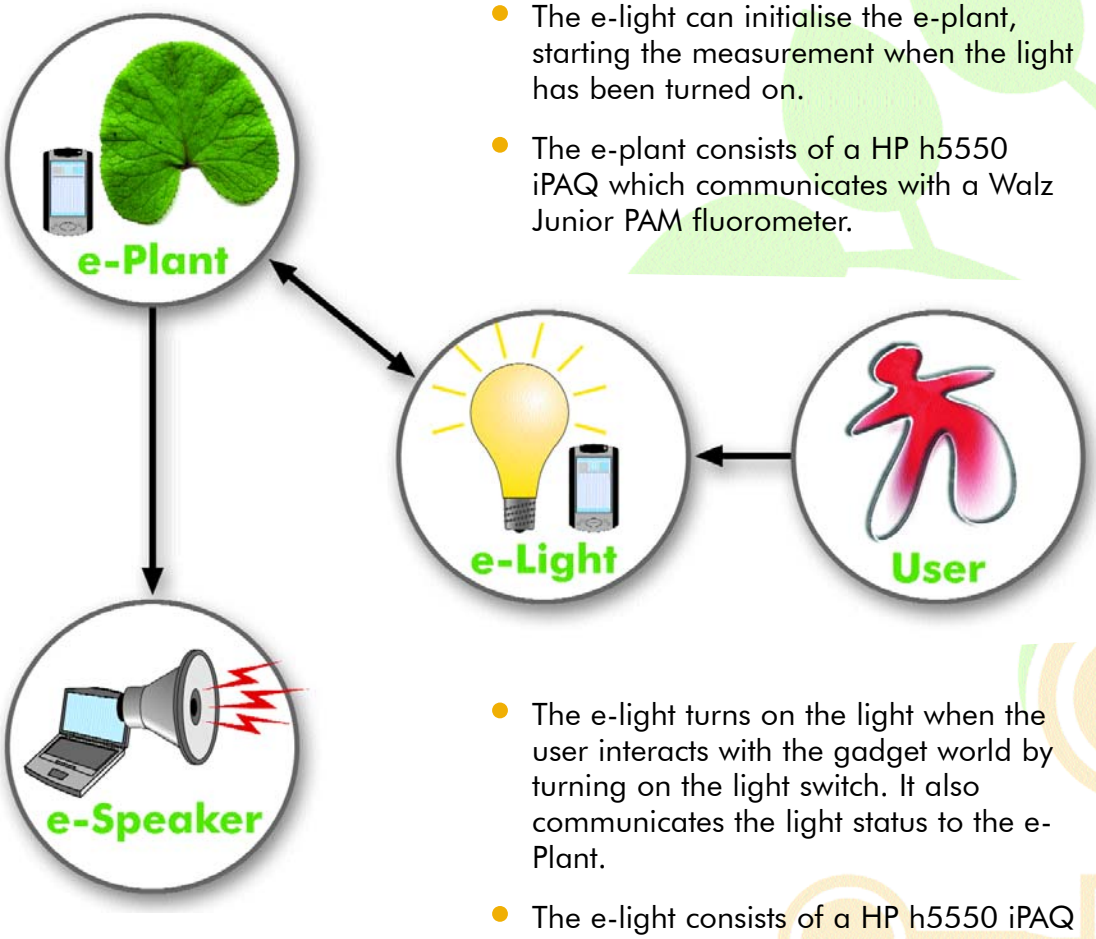
- Conventional plant breeding and genetic engineering for stress tolerance;
- Strategic use of fertilisers;
- Gene deployment and the controlled use of pesticides; and
- Biological control and elicitor sprays for the maintenance of crop yields.

A reduction of pesticide, fertiliser and water inputs through the development of precision agricultural systems contributes to more sustainable crop production.



Remote Sensing between - and within - fields reveals differences in crop temperature: blue indicates the crop is unstressed; yellow highlights moderate drought stress; and red shows high drought stress. (Image available at URL: www.uswcl.ars.ag.gov/epd/remsen/irrweb/thindex.htm)

Demonstrator Description



- The e-plant queries the plant to determine the state of the plant.
- The state of the plant is transmitted to the e-speaker.
- The e-light can initialise the e-plant, starting the measurement when the light has been turned on.
- The e-plant consists of a HP h5550 iPAQ which communicates with a Walz Junior PAM fluorometer.

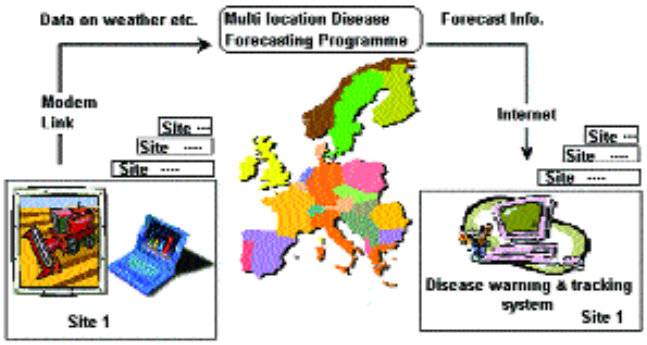
- The e-light turns on the light when the user interacts with the gadget world by turning on the light switch. It also communicates the light status to the e-Plant.
- The e-light consists of a HP h5550 iPAQ which receives a signal from the user and activates the lights via a PIC controller and relay switches.

- The e-speaker is activated by the e-plant to ask the user for help, or to thank the user for interacting with the gadget world.
- The e-speaker consists of a laptop with speakers and an MP3 player.

Agricultural Monitoring

Current Systems

- Agricultural inputs in terms of machinery, pesticides, energy and water have increased dramatically over the past century to improve yields.
- Monitoring programmes rely heavily on measuring the environmental conditions around the plant for example, air humidity, soil moisture and temperature.
- An advance from 'insurance' use of pesticides is networked disease forecasting in combination with strategic chemical application and on site weather forecasting in combination strategic chemical application and the use of gene deployment strategies.



Forecasting disease involves the use of on-farm weather stations. These weather stations may be networked to achieve regional management programmes which have significantly reduced the number of spray applications, e.g. in the case of Potato Late blight.

- Organic farming represents one solution against excess farm chemical inputs, but is only 5% of the current market.
- Genetic engineering offers some solutions but concerns regarding transgenes mean that genetically modified crop production remains at 10% of the global amount.
- Research into alternative chemical pesticides is ongoing to replace the many agro-chemicals that will be removed from general use by EU law. In addition 'bio-pesticides' are also actively being investigated and tested.

The market pull and research push are now present to encourage research into new ways of managing agriculture toward greater economic and environmental sustainability

PLANTS

CTI

Research Academic Computer Technology Institute

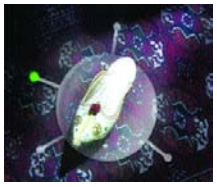
Research Unit 3

Designing Ambient Intelligent Systems (DAISy) group

The DAISy group was founded in 2000 at CTI. **DAISy aims to design distributed intelligent hardware / software systems, which are seamlessly integrated into objects and their environment, and thus are intuitive to use.** These systems are in principle composed of heterogeneous and resource-constrained artefacts which operate over unstable wireless networks.

DAISy is the product of collaboration between computer science researchers, component-oriented software engineers, distributed system developers and innovative interaction designers. Tracks of ongoing research involve:

Modularity: GAS-OS component-based middleware supports the use of artefacts as components of ambient systems; these components can be heterogeneous by nature – to deal with this, GAS ontology has been developed; the eGadgetWorld editor assists end-users in creating and using ambient systems



QoS: several factors that affect QoS are being dealt with: size, consumption, speed, performance, robustness; simulator studies of ambient systems are being conducted

Acceptability: novel concepts are defined to describe the new systems; the Plug/Synapse interaction model has been developed to support the new affordances; new form guidelines are being compiled; people studies are being conducted to measure acceptability of technology

These concepts and software tools originated from the FET/DC project **e-Gadgets (www.extrovert-gadgets.net),** which designed middleware for distributed, peer-to-peer systems that used everyday artefacts as nodes.

The FET/Open project PLANTS **(www.edenproject.com/PLANTS)** provides an opportunity for DAISy to expand the application domain into living systems. We shall demonstrate that using our technology, plants can be enabled to communicate with artefacts and become integral components of hybrid societies.

At the same time, in FET/Open project **Social (www.socialspike.net),** we develop collaborative autonomous agents that can learn and evolve, and investigate methods for engineering emergent collective behaviour in large agent societies.

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Eden Project

Eden Project is a major new visitor and learning centre established in Cornwall as one of the Millennium Commissions landmark projects and is a focus for economic regeneration in one of the poorest regions of the UK.

Eden uses plants to provide a lens through which we can explore the world, making connections between cultures and the resources that have sustained them. This heritage of plant use, reflected in our living collections, underpins stories of history, conservation, development and society.

Set within the last active mining region in Cornwall, Eden's own setting of a worked out china clay quarry allows us to link our past to the search for a sustainable future and to illustrate the choices we can make to foster a better world.

Our primary goal is to inspire people to learn to understand more about the foundation of their lives. Eden is a blend of iconic architecture and dramatic landscape design to provide the setting and the audience of over 1.5 million visitors a year. We work with artists to engage and connect people with our themes, through guides, publications and other media we provide opportunities to learn more.

We dedicate ourselves to breaking the barriers to understanding and engagement for everyone, whatever their current levels of experience and ability. Our work ranges from formal schools programmes to informal and lifelong learning.

We aim to work with partners locally, nationally and internationally to effect change and provide a platform so they can showcase their work.

The role of the Eden Project in PLANTS is to lead the dissemination and exploitation of the project, to showcase the demonstrators and to explain the science behind the project. We aim to demonstrate how the technology may lead to more sustainable agricultural and horticultural practices.

The Eden Project is owned by the Eden Trust, charity number 1093070.

UCC

The Department of Plant Science at the National University of Ireland Cork relocated in October 2000 from campus to a state-of-the-art new building in Distillery Field, North Mall, Cork. Shortly afterward the department merged with Zoology and Ecology to form the Department of Zoology, Ecology and Plant Science (ZEPS- www.ucc.ie/zeps)

The Plant Science building has:

- Dedicated laboratories for molecular biology, radiation research, plant pathology, plant tissue culture, an image analysis laboratory and a general plant science research laboratory;
- Specialised equipment including MALDI-TOF mass spectrometry; GC-MS, flow cytometer, x-ray equipment and thermal recyclers; and
- Extensive growthroom facilities for heterotrophic and autotrophic plant tissue culture.

The Department runs degree programmes in:

- Plant Science;
- Environmental Plant Biotechnology;
- Plant and Microbial Biotechnology (in collaboration with the Department of Microbiology); and
- Partners in the Genetics and Environmental Sciences Degrees.

The Department is an internationally recognized centre for training in Plant Biotechnology and has run training courses for UNESCO and the International Atomic Energy Agency and for local agencies.

Role of UCC in PLANTS:

- To steer the project towards a greater understanding of plant communication by characterising and assessing various parameters (physical and chemical) for suitability as channels of communication
- To investigate volatile signalling and utilise results in developing sensor thresholds