ENOVISION

INTEGRATED ELECTRONIC NOSE & VISION (ENV) SYSTEM FOR QUALITY ESTIMATION OF BLACK TEA

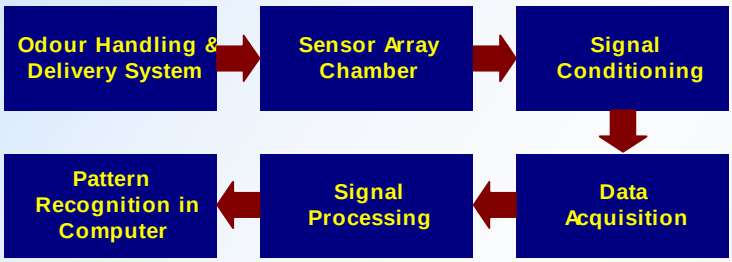
- **ENOVISION** is an integrated Electronic Nose and Vision (ENV) system developed for quantifiable and reproducible assessment of aroma and appearance of India black tea in non-invasive manner.
- The ENV system has two separate and independent parts, namely, E-Nose and E-Vision, which can be used sharing a common PC or Laptop with custom build software.
- The ENV software is designed using graphical front-end software called LabVIEW of NI and can easily be customized by the users as per their requirements.
- The system works on a sensor fusion technology where an array of non-specific Metal Oxide Semiconductor (MOS) Sensors captures the volatile compounds emanated by Black Tea samples and a digital camera captures the image of the sample under a uniform illumination condition.

Sample holder for E-Vision.

Sample holders for E-Nose with and without illumination.

ELECTRONIC NOSE

- **Electronic Nose** is a smart instrument that is designed to detect and discriminate among complex odours using an array of sensors.
- The array of sensors consists of a number of broadly tuned (non-specific) sensors that are treated with a variety of odour-sensitive biological or chemical materials.
- An odour stimulus generates a characteristic fingerprint from this array of sensors.
- Patterns or fingerprints from known odours are used to construct a database and train a pattern recognition system so that unknown odours can subsequently be classified and/or identified.



Block Diagram of Electronic Nose

Electronic Nose Sensor Array

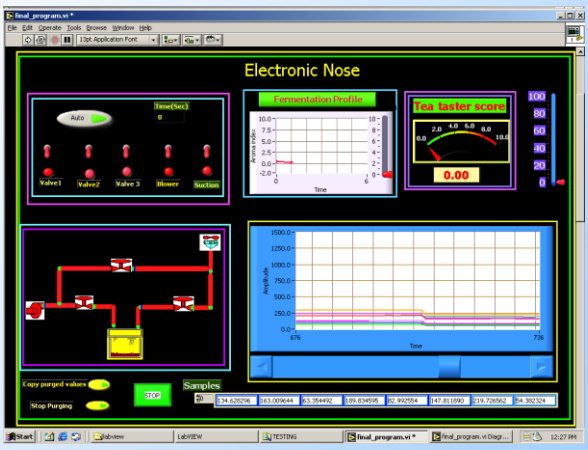
E-NOSE SET-UP

E-Nose for Fermentation Monitoring

- Fermentation starts as soon as tea leaf cells are ruptured in the CTC or Rolling process. Limiting the reactions and chemical transformations during fermentation process to an optimum limit is vital for producing superior quality tea. Tea leaf needs to be allowed to ferment only up to the desired limit so that the complex series of chemical changes within the leaf are accomplished optimally.
- Conventionally, length of fermentation is subjectively estimated by human senses of smell to determine conversion of grassy smell to floral smell of in-process leaves.
- Smell changes during the fermentation process can be reliably and repeatedly detected by Electronic Nose. Even the smell peaks during so called "First Nose" and "Second Nose" can also be clearly detected with this new smart instrument.

E-Nose for Finished Tea Classification

- Flavour and Aroma are important quality attributes of finished tea. Human experts – called "Tea Tasters" – conventionally determine tea quality. Tea tasters usually assign scores to samples of tea under evaluation in a scale of 1 to 10 depending on the flavour, aroma and appearance of the sample.
- Electronic Nose is a unique tool that is capable of sensing the volatile compounds of the tea sample and reliably predicts Tea Taster like scores with a high degree of accuracy.



Electronic Nose Software Screen

Features:

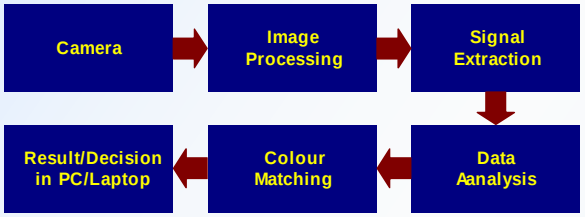
- E-Nose can dynamically indicate olfactory emission pattern in Fermentation.
  - Online display of fermentation progress and completion.
  - Accurate detection of 1st and 2nd Nose Peaks during fermentation.
- Reliable Prediction of Tea Taster-like Quality Scores of Finished Tea.
- Easy to use.
- Instant data acquisition.
- Zero sample preparation.

ELECTRONIC VISION

Electronic Vision is digital camera based image processing instrument, which performs image capturing and feature extraction for quality analysis of tea.

A number of solutions are provided in the System:

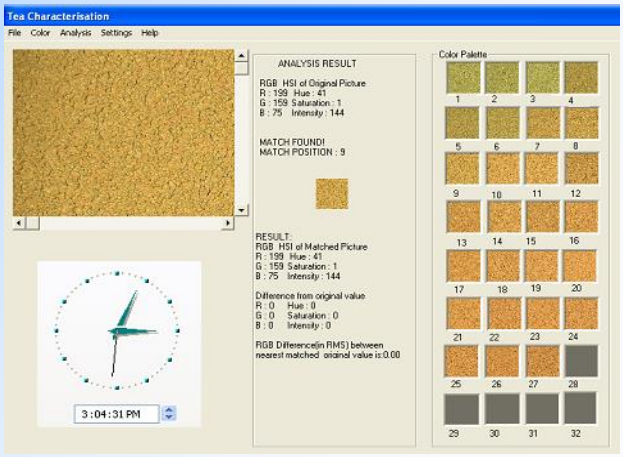
- End Point Detection of Fermentation by monitoring tea leaf colour.
- Mimicking Visual Inspection of Tea Taster by Electronic means.
- Quality Estimation (Tea Gradation) of Manufactured Tea at Drier Mouth.



Block Diagram of Electronic Vision

E-Vision for End Point Detection of Fermentation

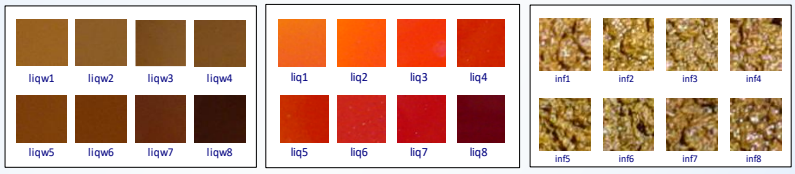
- The E-Vision system has been developed to detect the End Point of Fermentation using a suitable color matching algorithm backed-up with the soft computing technique. During training of the software, a color-palette /image database is required to be created with taking color images of the leaf with various stages of fermentation process. This is called a standard image database.
- During the actual fermentation process, any leaf image at any stage of the fermentation process can be compared against those of the standard database to determine an estimation of the remaining time for fermentation. Being physical, this colour comparison is a very convenient tool to determine end point of fermentation instantly with a high degree of accuracy, repeatability with respect to finished tea quality.



Electronic Vision Software Screen for Fermentation

E-Vision for Tea Tasting

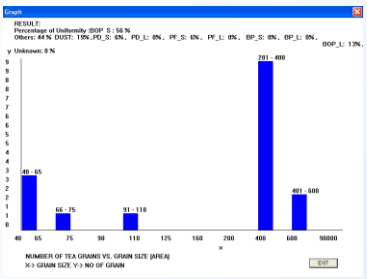
- Color images of tea liquor are analyzed using HSI (Hue, Saturation & Intensity) model because human perception is closely matched with this classification system.
- A suitable color-matching algorithm with soft computing technique has been utilized to determine the nearest match from this image database. Ultimately this color indexing may also be correlated with the tea tastes' grading.



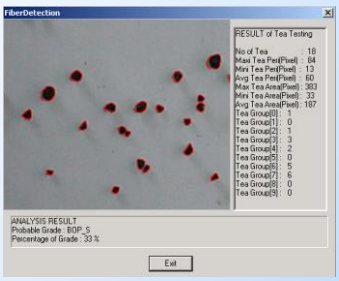
Tea Liquor Tasting (with milk) | Tea Liquor Tasting (without milk) | Infusion Tasting

E-Vision for Tea Gradation, Blackness and Fibre Detection

- Instant estimation of manufactured tea grade at Drier-mouth is one of the desirable requirements for quality tea production. It is very difficult to find out percentage of tea grade at Drier output at any moment of time. An innovative image processing based solution has been developed to determine the percentage of various tea grades at Drier-mouth output as an estimation of consistency in quality tea production.
- E-Vision system can also estimate blackness and fibre content in the made tea.

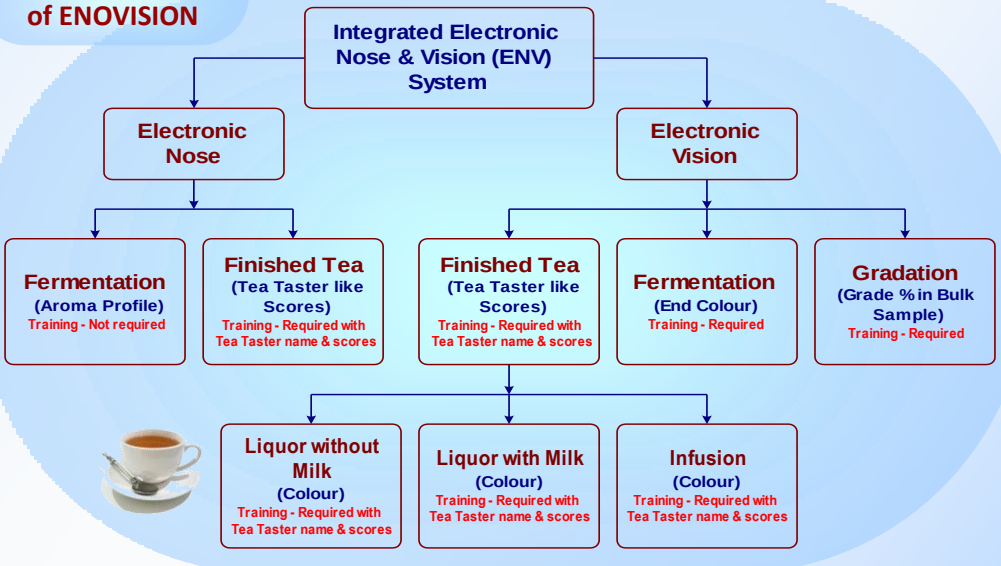


E-Vision S/W Screen for Gradation



E-Vision S/W Screen for Gradation

Utilization Chart of ENOVISION



Technology transferred to::

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2. M/s. Electronics Research & Development Enterprise (ERDE)
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ToT date: 27.02.2014

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