Wireless Sensor Network for Precision Agriculture

Ajay Mittal, Dr. Bhushan Jagyasi, Dr. Arun Pande
TCS Innovation Labs Mumbai
Content

• Services Needed
• mKRISHI Platform – Components
• Sensors for disease prediction
• Human participatory sensing
• Sensor Node and customized farming
mKRISHI Platform - Components

- Local sensor & environment data
- Local language, on mobile, dynamic content, many services
- More than sending Alerts! Communicate – the advice, weather, changing weather pattern, epidemic alert, market prices, Reach out to procure, to sell right molecule, offer many more services
Sensors for Plant Disease Forecasting
Experimental Result motivating Rural Participatory Sensing

Crop: Potato
Disease: Late Blight
Location: Aligarh

Result: High correlation observed in actual attack and model based Risk Forecast

Images received from the farmers indicating Late Blight attacks.

Model Generated Disease risk

Actual Disease attack manually observed by a deployed person
Plant Disease Forecasting using mobile phone

**Aim:** Accurate forecast and minimize the spray of pesticides

**Approach: To Combine**
- Mathematical Models based on Sensor’s observation
- Observed Symptoms communicated by farmers using Rural Participatory Sensing

Compute Cumulative (over last N days) Composite (combining M disease forecasting models) disease Risk Index (CCRI) $C_i$ and classify

- **High Disease Risk ($C_i > TH$)** → Alert Farmer and Trigger Symptoms Collection
- **Moderate Disease Risk ($TL < C_i < TH$)** → Trigger Symptoms collection and Alert only on Positive diagnosis
- **Low disease Risk ($C_i < TL$)** → No Action

A Simplified Mobile phone Application

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August 22, 2011
TCS's Plant Disease Forecast System

State: Maharashtra

District: Aligarh

Crop: Potato

Disease: Late Blight

Farmer: Amandeep Singh

Choices:
- Ajit Singh
- Ajmad Khan
- Amandeep Singh
- Amar SINGH
- AMAR SINGH
- AMAR SINGH
- AMIT KUMAR
- Amrit Yedav
- Amritpal Singh
- eril SDLANKI
- ANIL
A Web Console for the Expert

- Daily Disease Risk Computed by Various Mathematical Disease Forecasting Models
- Cumulative and Composite Risk
- Images captured by farmers of Infected leaves, stem and tuber
- Symptoms personally observed by farmers and communicated using their mobile phone.
- Disease Severity from images and observed Symptoms
### Sensor Based Risk Index Report

**Updated on:** 2010-04-10

<table>
<thead>
<tr>
<th>Model</th>
<th>Risk Index ($R_{jk}$)</th>
<th>Severity ($S_{jk}$)</th>
<th>Cumulative Risk ($CR_{jk}$)</th>
<th>Cumulative Severity ($CS_{jk}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulrich</td>
<td>-6.7392</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fry</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Winstel</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Wallin</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Composite (All Models)</td>
<td>-1.6848</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

### Human Participatory Diagnosis Report

**Uploaded on:** Date: 2010-06-22 Time: 12:47:46

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water soaked, light brown lesion on the blade</td>
<td>1</td>
</tr>
<tr>
<td>Arc lesions spreading</td>
<td>1</td>
</tr>
<tr>
<td>Lesion covering leaf margins</td>
<td>1</td>
</tr>
<tr>
<td>Lesions turning black in color</td>
<td>0</td>
</tr>
<tr>
<td>Whisk fungus on the lower surface of the leaves</td>
<td>1</td>
</tr>
<tr>
<td>Potatoes with brownish or purplish lesions on tuber surface</td>
<td>1</td>
</tr>
<tr>
<td>Diagnostic Severity</td>
<td>0.8233333</td>
</tr>
</tbody>
</table>

### Start date (yyyy-mm-dd) 2009-11-01

### End date (yyyy-mm-dd) 2009-11-30

### Diagnostic Severity Plot

### Symptoms Images

### Send Queries to collect symptoms
### Sensor Based Risk Index Report

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<th>Risk Index (RI_k)</th>
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**Start date:** 2009-11-01  
**End date:** 2009-11-30
Human Participatory Sensing

Mobile App for the Farmer

- Collect Symptoms by asking relevant queries.
- Photographs to guide about the symptoms for reading illiterate farmers.
- Simple Binary Answers
Disease Intensity and Disease Spread Analysis in Time and Space

Last Jan
01.23.11.23 01.23.11.70 01.13.16.04
01.12.12.54 01.12.13.26 01.12.13.99

Last Dec
12.29.20.08

Last Years
02.17. 38.49 01.17.13.21 01.13.10.21
01.11.19.10 01.10.18.02

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Sensor Nodes for Agriculture Applications

TCS Innovation Lab Mumbai and Bangalore has developed Low cost low power Wireless Sensor Node

- Transmission Range – 300 meters in single hop
- Batteries – 3 V power required (works with Two AA batteries)
- Current Consumption – 30 mA for Transmission and Receiving 1 mA in Sleep mode
- Protocol: Self configurable in multihop mesh network.
- Sensor Interfaced: Soil Moisture, Soil Temp, Ambient Temperature and Ambient Humidity
Sensor Nodes Installed at TCS Yantra Park, Mumbai
Small & Marginal farmer getting connected to expert

Mobile based Agriculture Advisory System

<table>
<thead>
<tr>
<th>Farmer's Information</th>
<th>Soil Status</th>
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</thead>
<tbody>
<tr>
<td>Name: Pratap Veeravath Shinde</td>
<td>Sampling Date: 2008-05-14, Analysis Date: 2008-05-15</td>
</tr>
<tr>
<td>Phone: 9226435427</td>
<td>pH</td>
</tr>
<tr>
<td>Place: Nimbalkar, Sangli</td>
<td>7.96</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Petiole Status</th>
<th>Sampling Date: 2008-05-14, Analysis Date: 2008-05-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>P</td>
</tr>
<tr>
<td>1.71</td>
<td>0.27</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fertilizer &amp; Growth Hormone History</th>
<th>Weather Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Fertilizer</td>
</tr>
<tr>
<td>11-05-2009</td>
<td>चाय पौधिक</td>
</tr>
</tbody>
</table>

Contentment (Your Advice)

Soft Keyboard
Question raised by Farmer

Advice Given By Expert

- August 22, 2011
Potato Query – Bichaula, UP

Question raised by Farmer

Advice Given By Expert

आनू में दसर मिटटी में ब्रोकोली की कमी के कारण हो सकती है. इसके लिए ब्रोकोली के समब प्रानुबंध 3 किलो प्रति पकड की दे से झालना चाहिए।

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August 22, 2011
Thank You