

Human Computer Integrated Model for Information Building and Sharing in Rural Communities

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ABSTRACT

Food is an essential component to human survival. Agriculture production needs to increase 110% by 2050 to meet food demand but is forecasted to only reach 38%. Pest infestation accounts for almost 50% of crop losses worldwide and is one of the toughest problems for farmers globally. The unavailability of accurate dataset and lack of information sharing is one huge cause. It is especially prominent for rural regions which are responsible for about 70% of agriculture produces.

Issues such as uncertainty in production, middlemen extortion and health risk from pesticides also contribute to increasing suicidal rates of farmers. These real-life risks can be significantly reduced with data driven approaches. While high-end sensing technologies are expensive for rural communities to adopt, we leverage on the increasing penetration of mobile platforms to deliver solutions that tackle core issues of pest management and information sharing.

Our study develops a unique human and computer integrated architecture for information collection, sense making and information dissemination that involves and benefits various stakeholders. By integrating machine learning, image recognition technology, onsite observations and domain expert knowledge, our system facilitates knowledge contribution from different parties to provide intelligent and efficient insights for pest management and rural development.

In general, the architecture consists of three main parts:
1)End users make enquiries through data input, and serve as human sensors that collect large amount of information.
2)Automated data processing system with machine learning capability. System takes in query input and immediately returns results to users. It also takes in crowd-sourced validation from experts and automatically retrains the system accuracy. Data inputs and results are stored in a cloud database and disseminated to relevant stakeholders.
3)Domain experts validate or correct machine processed results by labeling. These labels serve as a 2nd layer of input for learning and retraining to improve system accuracy.

Pure computer-based infrastructure is automatic and scalable but incapable of learning by itself without human validation inputs. Inaccurate results remain wrong. Human experts learn over time but not scalable to handle big amount of data concurrently. This human-computer integrated model leverages on the advantages of both technology and human to achieve a self-learning, automated and scalable system.

When a farmer encounters a pest, he will send a report with a photo of the pest through our developed mobile application, which captures multiple data entries such as user profile, coordinates, date, time, crop and environment parameters from nearest weather station. The collected data are used for pest image recognition and predictive analytics to forecast pest infestation and provide customized alerts.

Once the image is sent in, the active classification system performs feature extraction and factor weighing to identify the pest specie based on a probability score. The result and relevant solutions are returned to the user within seconds. Images are also queued for expert labeling through another application for pest experts. Upon expert validation, the machine automatically retrains the classifier and improves its identification accuracy. Machine learning coupled with crowdsourcing enables communal building of a valuable and elusive pest dataset, which expands and improves over time.

Farmers get necessary information easily and instantaneously, increasing their reaction time to pest problems. **Pest experts** share and learn from other experts by digitising their knowledge and can focus on critical cases. **Agencies and NGOs** can keep track of real time pest problems to better plan programs and work with government to formulate policies or development plans to help the community.

This architecture is highly versatile and deployable to other domains, such as healthcare and education, by adapting the relevant processing system based on data input type and involving the corresponding domain experts.

Categories and Subject Descriptors

H.3.5 [Information Storage And Retrieval]: Online Information Services—*data sharing*

General Terms

Human Factors, Documentation

Keywords

Agriculture, rural communities, crowd-sourced experts, machine learning, image recognition, analytics

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