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Automation of Agriculture Support Systems using Wisekar: Case study of a crop-disease advisory service

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ABSTRACT

In the recent years, there has been a major thrust in the use of Information and Communication Technologies (ICTs) to boost agricultural production. These efforts include setting up of agricultural advisory systems for farmers to address crop-related problems. We present a framework developed by us to rapidly expand the range of services offered by one such agricultural advisory system (that uses a call-centre approach) located at IITM's RTBI, Chennai, in the state of Tamil Nadu. The framework has been developed around an Internet-of-Things repository, Wisekar (http://wisekar.iitd.ac.in), located at IIT Delhi, which supports machine-to-machine communication between heterogeneous systems. We use Wisekar to propose and implement a distributed Automated Crop-disease Advisory Service (ACAS) in which Wisekar acts as a communication bridge between the advisory system and the software for crop-disease recognition. The response-time performance of ACAS for different placement configurations of its component systems is evaluated to support its strategic deployment for different situations.

1. Introduction

Agriculture plays a major role in India's economic growth. Due to the large spread of agriculture, sustainable services developed for it must be scalable. Computing and communication resources available with farmers and experts helping the farmers can differ widely due to their different socio-economic backgrounds. It is non-trivial to develop an Information and Communication Technology (ICT) system which seamlessly interconnects the farmers, experts, and the related assistive technologies required by both. Also, any system that tries to address the problem by replacing or introducing drastic changes to the system used by the stakeholder (farmer or expert) will find little acceptance.

To increase the role of ICT in agriculture, an agricultural advisory system to mitigate crop-diseases has been proposed and implemented by IITM's RTBI (Hannuna et al., 2011; Jhunjhunwala et al., 2013). The system involves the establishment of a specialised call centre in the state of Tamil Nadu, which has now been implemented, to issue agriculture-advisory where the farmers can dial-in using their phones to instantly get the most relevant information from experts. The call-centre has a user interface called the *dashboard* intended to be used by semi-trained experts at the call centre to issue advisory to the farmers. Wisekar (Sarangi and Kar, 2013) is a web-based repository for archival of sensor-derived events. Due to its novel design as a generic centralised Internet-of-Things (IoTs) repository for sensor networks, the structure of Wisekar is flexible enough to be useful for a variety of applications.

Diseases affecting crops are a major hindrance in the net increase of agricultural output and also affect the crop-quality. Farmers often resort to their experience and knowledge about similar seasonal diseases to decide a course of action in disease detection. They also seek the help of local or remotely located experts who try to improve the diagnosis of the problem. Experts usually service requests from multiple farmers. Information Technology and the feature rich smart/mobile phones available today can support rich interaction between the farmers and experts in terms of the nature and content of communication. Thus, automating the recognition of disease in crops is an important step in providing tools to increase the efficiency of the semi-trained expert at the call-centre and to help the agricultural expert in improving diagnosis. To address this, we configure Wisekar to act as a key component of RTBI's system (Jhunjhunwala et al., 2013) which could use this as an additional tool for diagnosis and issue necessary advisory to farmers.

Disease detection can be classified into direct techniques such as serological and molecular methods (Sankaran et al., 2010) and

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indirect techniques such as biomarker- and plant stress-based methods. Stress-based detection includes the non-destructive imaging and spectroscopic methods. Recently, disease detection from crop-images has attracted considerable attention due to rapid progress in machine-vision and image-processing. Sannakki et al. (2011) perform image-processing (segmentation) on leaf images to identify diseased regions. Fuzzy Logic is used to create a scoring scale to find the percent-infection of disease. In Surendrababu et al. (2014), fractals are used to identify rice-leaf disease in images. A method to standardise the capture of crop-images to simplify disease recognition has also been proposed (Hannuna et al., 2011). We illustrate how one or more of such disease recognition methods can be offered as a service to the advisory system through Wisekar.

2. Background

Glendenning et al. (2010) list the information-related challenges faced by farmers especially when 81% of them do not have more than 2 hectares of cultivable area. They review the agriculture extension programs from 1980s (started after the Green Revolution) till 2010, and note the shortcomings of these programs in meeting those challenges. Although a lot of importance has been attached to Information and Communication Technologies (ICTs) in the policy framework laid out by the Ministry of Agriculture in 2000, the authors note that ICT initiatives for the purpose of delivering last-mile agricultural advisories are still in an experimental stage. Examples of popular ICT implementations for agricultural advisories include AGMARKNET (Anandaraja et al., 2009) in 2000, establishment of Kisan Call Centre (2004) (Glendenning et al., 2010), the Agritech web portal (2009) of Tamil Nadu Agricultural University, India (TNAU) (Anandaraja et al., 2013).

India has a State Agriculture Marketing Board in each state. AGMARKNET (Marketing Information Network) (Anandaraja et al., 2009) was one of the first major ICT initiatives attempted to link the market produce of different states and the Agriculture Marketing Boards together. The objective was collection and dissemination of price, produce and related information of the country through a single connected system to help farmers make more informed decisions. Kisan Call Centres (Glendenning et al., 2010) are specialised call centres that take the extension efforts further by providing information on demand (in the local language) to farmers. The farmer calls a toll-free number for enquiry which is fielded by level-I agricultural experts. If the answers to queries are deemed insufficient, they are escalated to officers at levels II and III. In addition to these efforts, specialised initiatives have been taken at the state level. TNAU is a key intermediary for any transfer of technology to the farmers in Tamil Nadu. In Anandaraja et al. (2013), authors point out the limitations of existing services and note that the growth of rural population is much higher than the staff required to handle their grievances. This motivated the development of the farm technology portal—Agritech—to allow quick decisions to be taken at the field level in Tamil Nadu, India. It is envisioned that RTBI's call centre (Jhunjhunwala et al., 2013) will eventually be merged with the systems developed at TNAU.

3. Development of the Wisekar-based Automated Crop-disease Advisory Service (ACAS)

When a farmer wishes to learn about the disease affecting his crops, he uses his mobile phone to capture a few images of the crops and sends them to the RTBI call-centre (Jhunjhunwala et al., 2013). He also calls up the call-centre to learn more about managing or mitigating the disease. We note that to enable farmers understand the advisory system, a planning workshop was held in the villages chosen for the pilot study and participating farmers were briefed about the objective of the pilot as well as the tools that were being used in the advisory system. After the workshop, interested farmers were registered into the system and those who have been calling into the system to seek advisories, have been doing so voluntarily.

The semi-trained experts at the call-centre use the information available at the dashboard to advise farmers. It is envisaged that, the call-centre staff could take the help of agricultural experts who are brought in through conference calls directly with the farmers. The call-centre maintains a database of farms, registered farmers, all the call records and the history of advisory issued. The call-centre, thus, also becomes an information-rich interface for providing other support services to farmers. However, this does not remove the possibility of human errors in diagnosis which may arise from misreading, miscommunication or misinterpretation of the condition by the farmer or the expert. Technological intervention can be used to dramatically reduce, if not eliminate, the possibility of such (human) errors at various stages. Further, it can be used to introduce features that significantly improve the quality of service available to both the farmer and the expert.

In order to empower the agricultural advisory personnel at RTBI's call centre and increase their efficiency in diagnosing pest-disease infestations, we have designed and implemented an Automated Crop-disease Advisory Service (ACAS) framework using Wisekar for the dashboard. ACAS is a part of our efforts to provide more such services to the dashboard which help the personnel take faster decisions on their own. Fig. 1 shows how multiple heterogeneous services can be integrated with the advisory system. Wisekar provides a number of application libraries (Fig. 2) to support integrated development and testing of services on different software platforms. While the heterogeneous services choose the appropriate library to interact with Wisekar, a single homogeneous interface is provided to the advisory system to consume the services. For clarity, we use a single service called the *crop-monitor* to propose a Wisekar-based disease advisory service framework for the dashboard. Crop-monitor can be extended to include

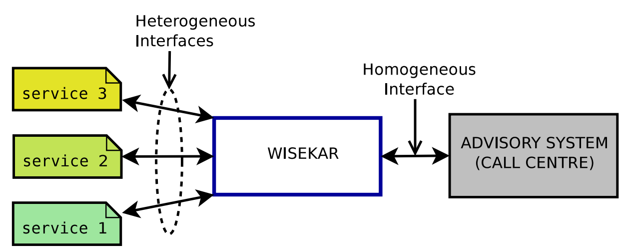

Fig. 1. Interfacing heterogeneous services to the advisory system through Wisekar.

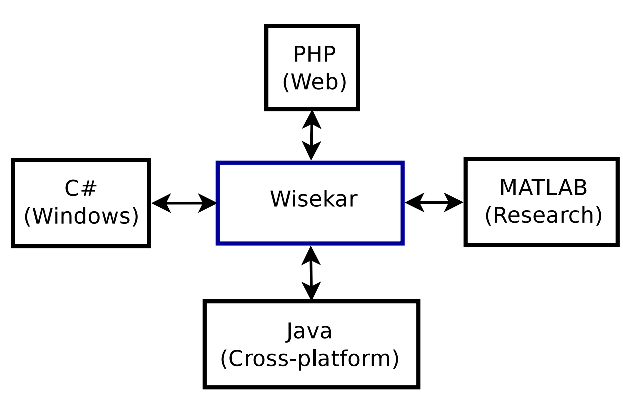

Fig. 2. Libraries available with Wisekar to develop third-party services.