
Tamil Market: A Spoken Dialog System for Rural India

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Abstract

In this paper, we describe the design process, results, and observations from a pilot user study for Tamil Market, a speech-driven agricultural query system, conducted in community centers in rural India. The primary users were rural villagers of varying degrees of literacy from three districts of Tamil Nadu. Preliminary findings from a Wizard-of-Oz field study show that rural villagers are able to navigate through a dialog system using their voice, regardless of literacy level and previous experience with technology. Traditional user study techniques, however, favor literate users and are ill-suited to research in developing regions.

Keywords

Literacy, IT, India, user interface, speech.

ACM Classification Keywords

H.5.2 [Information interfaces and presentation]: User Interfaces---user-centered design

Introduction

Cost and current methods of input (i.e., mouse, keyboard, stylus, mobile phone keypads), create a barrier to information technology (IT) for the majority of people on this planet [3]. Speech-based user interfaces (UI) are often suggested as a means to overcome current barriers of cost and literacy: Speech-based UIs are cheaper than display-based UI solutions and more accessible to illiterate or semi-literate users than text-based UI solutions [12].

However, successful speech-based UIs in developing regions are scarce due to the unique challenges and constraints from data collection to deployment, including scarcity of training data, multilingualism, dialectal and cultural diversity, and lack of resources [4]. In addition, power, connectivity, and limited infrastructure are all significant obstacles in developing regions. Finally, UI design requires a familiarity with the cultural and economic context of the user. As a whole, people who have never learned to read or write are poorly understood by researchers and developers of technology.

IT access in rural Tamil Nadu

In Tamil Nadu, southeast India, news, weather, employment opportunities, governmental notices, and free health and education services are primarily disseminated by newspaper or by word of mouth [16, 19]. A substantial body of evidence indicates that access to written information (i.e. literacy) increases farmer productivity and earning potential [6, 11], and positively affects children's health and nutrition [2]. In rural Tamil Nadu, where 50% of men and over 60% of women are illiterate, there is a need for affordable and appropriate access to information [17, 18, 20].

MS Swaminathan Research Foundation (MSSRF), a non-governmental organization (NGO) dedicated to the economic and social development of the rural poor of Tamil Nadu, operates a network of community centers to address economic and educational inequities. Each morning, MSSRF volunteers travel to nearby markets throughout the state to record the current market prices of agricultural goods. Market prices along with educational materials are shared across MSSRF community centers. Rural villagers that live near a center can learn current prices for goods in all markets in the state by checking posted notices, or if they cannot read, by relying on a volunteer to interpret written text.

A spoken dialog system (SDS) operated over the phone by voice would increase access to rural villagers regardless of their proximity to a village center and their literacy level [1]. Due to our inability to communicate directly with rural villagers of Tamil Nadu, our initial needs assessment and subsequent design were based on MSSRF volunteer reports and extensive reviews of IT case studies in developing regions.

Previous UI designs for illiterate users

UI studies that target illiteracy in developing regions focus on teaching or reinforcing literacy skills [10], require extensive training during which users memorize a set of icons or command words [7, 8], or assume some degree of literacy [13]. Previous efforts, along with cognitive studies [5, 14], suggest that successful UI solutions for illiterate users will rely on command words that are meaningful and relevant to everyday language use. In addition, interaction in the local language gives users a sense of familiarity and ownership.

Tamil Market

Tamil Market is a simple SDS that provides weather, market prices for ten crops, and rainwater collection techniques to users who navigate by uttering one of thirty Tamil words (fig. 1). The command words of an SDS will vary with the needs and dialects of each village, which are difficult to anticipate in advance. In addition, automatic speech recognition, even for a small vocabulary of isolated Tamil words, requires the development of phonetic dictionaries and acoustic models, which are currently unavailable for rural dialects of Tamil and must be built from scratch for the SDS. We did not attempt to anticipate the exact content and command vocabulary for a useful application in advance. Instead, we designed Tamil Market as a template to determine whether an SDS can be powered by limited resource speech recognition and to initiate involvement by rural villagers in the development of an application that suits their social and economic realities.

Although an application-independent command vocabulary (i.e. “back,” “next,” “repeat”) might mitigate variations in application content, it would require users to memorize an arbitrary set of command words. Tamil Market is primarily operated with the Tamil words for “yes” (*aamaam*) and “no” (*illai*), which are likely to retain their meaning and function across different dialects. In addition, a parallel study on limited resource speech recognition found that reducing recognition complexity to a binary distinction between *aamaam* and *illai* results in a recognizer that is highly robust to both dialectal and environmental variations [15].

Each specialized dialog is accessed according to a different type of interaction. To quickly access rainwater collection techniques, a user must say *aamaam* at the appropriate moment. Access to a particular crop price requires two or more user turns, however. First the option for crop prices is offered, then the user is prompted for a particular crop name. The quickest access to weather also requires two turns, including a prompt for the user’s zip code, a sequence of 6 numbers.

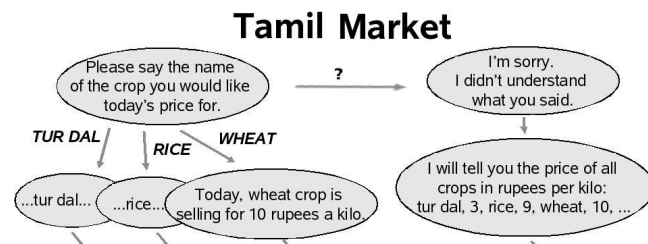


figure 1. English translation of a selection of the Tamil Market dialog system. '?' indicates a recognition error.

Explicit prompts for input options and a redundant structure ensure that users have access to all available information, albeit not in the most direct way, even when their input is mis-recognized or missing altogether (fig. 1). In this way, Tamil

Market can accommodate first-time users and users unfamiliar with technology with no need for a separate training session.

User Study

Participants

Seven men and six women from the rural, agricultural villages of Kizhur, Embalam, Kallitheerthealkuppam, Ettimadai, Sivaranthayam, Sempatti, and Kodangipatti were recruited by word of mouth as participants in our study. The age of participants ranged from 28 to 60 years old (average: 43 years). Due to the challenges of recruiting illiterate participants [4], including location, apprehension, inflexible occupations, and limited access to infrastructure, only 3 out of 13 participants were illiterate. Participants in this study reported an average of 10.6 years of formal education.

Experimental Setup

Tamil Market ran on a PC laptop connected to a computer microphone and speaker embedded in a phone handset (fig. 2). The phone microphone avoided the need to fasten equipment to participants' clothing and was easily used by all users, including those who had never used a phone before.

Procedure

With the help of an interpreter, we first introduced users to Tamil Market, explained the purpose of the user study, and asked for verbal consent to participate. We administered a background questionnaire, gathering demographic data, including education and literacy skills, and current means of accessing agricultural information, daily news, and weather.



figure 2. User study of Tamil Market dialog system.

While the participant observed, one researcher used Tamil Market to access the price for wheat. The participant was then offered the phone and assigned three tasks in balanced order:

- access the current market price for rice (2 turns)
- locate the local weather forecast (2 turns)
- listen to rainwater collection methods (1 turn)

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Using the Wizard-of-Oz technique [9], one researcher played the role of the recognizer, typing user responses on the keyboard and injecting 2% recognition errors to simulate automatic speech recognition error rates for small vocabulary recognition built on limited linguistic resources [15]. Another researcher noted critical incidents and out-of-vocabulary responses. Participants could direct questions to the interpreter, but neither researcher assisted during interactions with Tamil Market. Finally, we assessed participants feelings

towards Tamil Market using Likert scale and open-ended questions.

Results

Task completion

Participants were overall adept at operating Tamil Market with no training and little familiarity with phones or computers. Users completed 35 out of 38 tasks, averaging 70 seconds to access a task and 162 seconds to exit the system (fig. 3). Many users, however, had difficulty understanding the nature of a “task” and instead explored the system out of interest or correctly completed unassigned tasks.

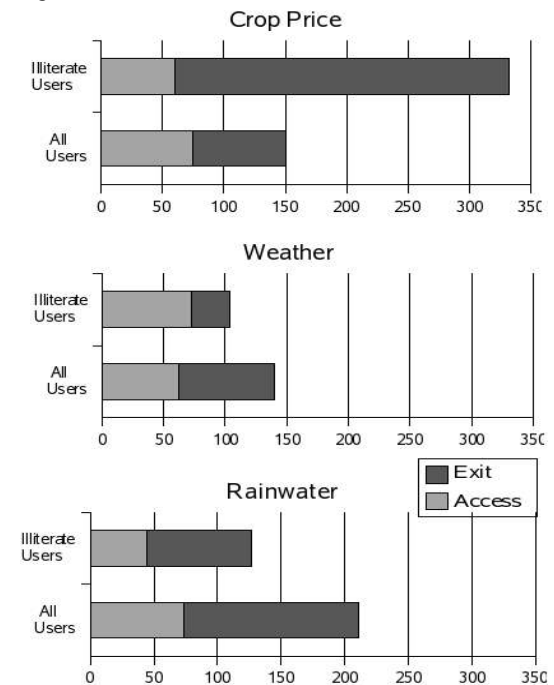


figure 3. Times (in seconds) to access and exit each task. Averages for all users and for the three illiterate users are shown.

Errors

We found 34 dialog interaction errors in total (average: 2.8 per user), where an error is any input that Tamil Market is unable to recognize, whether it is a failure on the part of the system or the user. Errors usually occurred at the beginning of the interaction or with questions that prompted users for a response other than the Tamil words for “yes” and “no.” Errors consisted mostly of no input, complete sentences, or unexpected input (fig. 4). All errors in the weather dialog were caused by the prompt for a zip code: Users generally did not know their zip code. Users recovered from 7 out of 8 injected errors.

Literacy

Three participants were unable to read a newspaper; One had never been to school and could not read or write her name. Villagers with little or no education were reluctant to participate in the study, often only completing one task and politely refusing the lengthy questionnaire. The dialog interactions of the three illiterate participants averaged 1.75 errors per task as compared to 0.971, the average for all users. In two of the three tasks, illiterate participants were faster than average at accessing and exiting Tamil Market (fig. 3). Due to the limited participation of illiterate villagers in this study, we cannot draw any conclusions about literacy level based on our data.

User Assessment

Participants valued accuracy of information and time of interaction, which averaged about three minutes. Participants expressed pride and excitement at hearing a computer speak Tamil. They were forgiving of system limitations and able to recover from recognition errors. Participants wanted information on different varieties and grades of crops and different markets. They instructed us to use district names to determine location instead of zip codes.

Interest in Tamil Market correlated to the distance of the village from the nearest marketplace. Participants who lived far from a market reported that if the information was accurate, they would be willing to pay the price of a phone call (1 rupee, equivalent to \$0.02) to use such a system. In villages near a major market, however, at least one individual visits the market each day and reports the prices for that market to other members of that village.

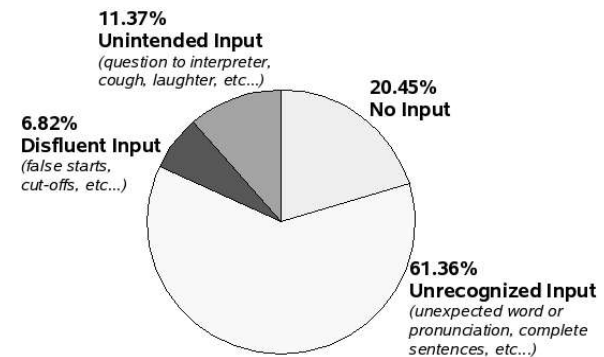


figure 4. Types of Errors.

Conclusion

Our initial results reveal the potential for speech-based UI solutions in increasing IT access to include non-technical users in developing regions, as well as some of the challenges. We plan to spend six weeks this spring working alongside volunteers in an MSSRF village center to customize a modifiable kiosk version of Tamil Market.

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