Context Based Content Aggregation for Social Life Networks

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Abstract: It is extremely useful to have right information at the right time. Social Life Networks (SLN) extend the capabilities of current social networks by combining them with the technological advances now found in Smartphones that include myriad of sensors and multimedia input and output capabilities to provide essential information to support livelihood activities. The challenge is to provide this information within the required context. For this we need to model the context by acquiring the physical data to provide meaningful abstractions with respect to the application domain and the needs of the users. We have developed a physical context model based on user profile, location, time and activity and a mapping to match the logical context of various data sources from which we can get the required information. Based on this model we have developed a SLN for farmers in Sri Lanka to provide agricultural information in the context of farming life cycle stages, location of their farm land, cultivation season and other economic parameters. In the field trails there was unanimous agreement among farmers that this application is very useful for them because they were able to get the required information in context.

1 INTRODUCTION

Due to lack of access to current information, often farmers tend to grow the same crop within a region, and this is causing potential over supply of crops (Hettiarachchi, 2011). Farmers come to know, or realize, there is an oversupply only when they bring their harvest to the market, and the oversupply reduces market price for the crop, disadvantaging the farmers. This is a frequent scenario happening in developing countries (Hettiarachchi, 2011). Neither the farmers nor government agencies are able to make necessary adjustments for lack of timely information on what farmers plan to cultivate, or have cultivated. The yield could also be affected by various factors including availability of water, weather, and pests.

(De Silva et al., 2012) have shown that farmers can make an informed decision on what crop to grow if they have access to a mobile phone based information system to inquire what others in that region are growing. The information system can provide this information only if most farmers use this system and indicate what crop they plan to grow. Aggregating the information provided by the farmers the information system can also inform the government agencies monitoring and managing agriculture sector in a country, fertilizer and pesticide suppliers and potential buyers what has already been grown for better management of the overall crop production.

Mobile phone usage in the world has grown rapidly including among people in developing countries. At present, 90% of the world population is covered by a mobile signal, 128% of the world population has a mobile subscription and in developing countries the subscription rate is 89% (ict, 2013). Further Smartphone prices are rapidly decreasing and now are comparable to a cost of a basic mobile phone few years ago. A Smartphone can be considered as a sensor in the hands of a human capable of capturing user input as text, voice or gestures and other environmental parameters using build in sensors such as GPS, camera etc. It is also capable of communicating with the user using range of media types; text, images, video, and audio.

An International Collaborative research project was started to develop a Social Life Network (SLN) (ict, 2013) ; a mobile based information system to support livelihood activities of people in developing countries. Social Life Networks (SLN) tries to extend the capabilities of current social networks by combining them with the technological advances now found in Smartphones that include myriad of sensors

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and multimedia input and output capabilities (Jain and Sonnen, 2011). An essential component of the SLN architecture is a module that provides information to users in context. In order to get a deeper insight into research challenges and to investigate possible solutions we selected a specific real world problem to work on. The first SLN was developed for farmers in Sri Lanka to address the over production problem mentioned above.

2 BACKGROUND

2.1 Components for SLN

(Jain and Sonnen, 2011; Ginige; et al., 2012) proposed that there are a few basic components for realizing the vision of social life networks. Data coming from multiple users and heterogeneous devices needs to be wrapped into a common format and made accessible to the system. Logically the data needs to be translated from localized sensor/human input to higher level situational abstractions. There is also an encompassing issue of user engagement. Both intrinsic and extrinsic factors matter, but enhanced feedback and user motivation are key aspects of it.

The biggest catalyst for the adoption of the traditional Web was the presence of search engines which routed users to their desired resources (static web pages). A situation analysis performs a similar role in the dynamic social life networks i.e. routing the users to the appropriate resources based on situation detected. In this paper we propose that to carry out the situation analysis, it is vital to identify the context and using the contextual information will result in a more personalized set of results for the user.

2.2 Context

During the past two decades, researchers have developed techniques that enable systems to adapt to their users in many different ways (Seher et al., 2007). One of the major research directions for humancomputer interaction (HCI) and Information Retrieval (IR) has been exploring the novel forms of interaction that can be achieved by integrating computer technology with the everyday physical world in which we live and work. Ubiquitous or pervasive computing represents a powerful shift in computation, where people live, work and play in a seamless computer-enabled environment and people are surrounded by computing devices and a computing infrastructure that supports us in everything we do (Poslad, 2011; **?**; **?**). Ability to accurately represent user context is very important to make optimum use of these smart environments. For this we need to model the context by acquiring the physical data to provide meaningful abstractions with respect to the application domain and the needs of the users interacting with the application.

A qualified definition of context is given by (Dey, 2001). In this work the term context is defined as follows:

Context as any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.

After defining context, context modelling is used to handle context information for the different entities of the application.

2.2.1 Need for Context

Human communications are quite successful and seem to be very easy. This is mainly due to the richness of the language used, and the common understanding humans have about how the world works (Dey, 2001). Human communication is more successful when there is an implicit understanding of the everyday situations of others who take part in the communication.

For example, in a conversation between two friends, the question How was the game? might not require any further elaboration. This question is incomplete, as it does not explicitly describe the game. Still, the respondent can understand the question. This is possible if the humans involved in the communication have a shared context which includes knowing the everyday situations of each others lives. Moreover, the type of the answer expected is not mentioned in the question. However, it is understood that the answer is not only about who won the game, but also should include descriptions of the game, such as the scores.

For an automated system to have the ability of bringing this contextual information in the interaction between the human and the computer is challenging. By improving the computers access to the context, the richness of communication in humancomputer interaction can be increased, giving more useful computational services. Furthermore, personalized information services help to improve the conversational bandwidth in a humancomputer interaction.

2.2.2 Context-specific information for Agriculture

Information must be relevant and meaningful to farmers, in addition to being packaged and delivered in a way preferred by them (Diekmann et al., 2009) cited in (Babu et al., 2012). Context-specific information could have a greater impact on the adoption of technologies and increase farm productivity for marginal and small agricultural landholders (Samaddar, 2006) cited in (Babu et al., 2012). However, making information context-specific is more resource intensive. It requires information at the farm level, which could vary spatially and temporally, and with different degrees of specificity (Garforth et al., 2003) cited in (Babu et al., 2012). Despite the additional cost and time associated with generating localized content, this content could be more relevant and useful in meeting farmers information needs (Cecchini and Scott, 2003) cited in (Babu et al., 2012).

(Babu et al., 2012) discuss clearly the importance of contextualized information and knowledge for the farmers in India. They further explain how effective this knowledge can improve their productivity and income since this information is more relevant to their farm enterprises and better reflects needs of the farmers. They therefore recommend that the existence of context-specific and relevant information should be considered when developing approaches for farmers.

In this paper, we describe context specific to the farmers in Sri Lanka and the approach we developed to design the context expansion module to provide context-specific information and knowledge to farmers. It further discusses the design and implementation of the first version of a mobile application for framers. The remainder of the paper is organized as follows. Section 3 presents the methodology for modelling context. Section 4 describes the high level architecture and implementation of the mobile application. Finally, section 6 concludes the paper.

3 MODELING CONTEXT

Every activity that a user can perform can be subdivided into sub tasks or phases. User needs specific information based on each phase.

In farming domain, (De Silva et al., 2012) has identified that farmers in Sri-Lanka need specific information rather than generic information. For instance, farmers need agricultural information relevant to their situation such as the location of their farm land, their economic condition, their interest and belief, need and available equipments etc.

(De Silva et al., 2012) carried out a causal analysis to determine the factors that influence farmers decision making at various stages of the farming lifecycle and in that process they identified what specific information is required in each stage. The causal analysis was carried out through a series of surveys. In this process, they also looked at the various information sources currently available for farmers following which (De Silva et al., 2012) determined how the information needs to flow to the farmers. (De Silva et al., 2012) postulated that the information should be made available to farmers in context to make meaningful use of the information and that the information needs of farmers change with each stage of the farming cycle.

Deeper information need analysis revealed that the farmers need two types of information for each stage; dynamic information such as current extent of crop cultivation, market prices etc. and more stable static information such as crop types, cultivars, suitable pesticides, fertilizer, previous market prices etc (De Silva et al., 2012; Walisadeera et al., 2013). The agriculture domain knowledge obtained from (Walisadeera et al., 2013), also suggests that farm environment, types of farmers, farmers preferences and farming stages are the important factors that needs to be considered for filtering relevant information.

3.1 Physical and Logical Context

When developing context aware applications we need to consider two types of contexts. The physical context attributes are the raw environmental parameters which are captured in real time using sensors or pre stored in the system while the logical context attributes are concepts associated to physical data, which provide meaningful abstractions with respect to the application domain and the needs of the users interacting with the application.

Each user of the application will have different physical values according to their settings. Every application would have its own logical interpretation of the stored physical data. The system needs to derive the logical application context from the physical data to get information in context.

3.2 Modelling Context in Farming Domain

To develop a context model for the farming domain we had to first identify the relevant physical context, the logical context and the mapping between the two. For example one of the attribute of the physical context that is stored by the system is the geo coordinates. The geo-coordinates can be interpreted in many possible ways like agro ecological zones or administrative districts. If the goal of the application is to determine the environmental attributes of the region then the application can map the geo-coordinates into agro ecological zones otherwise if the goal is to obtain the market price of the region, then the application needs to determine under which administrative district the given geo-coordinates belong and then query the appropriate information source to get the relevant data.

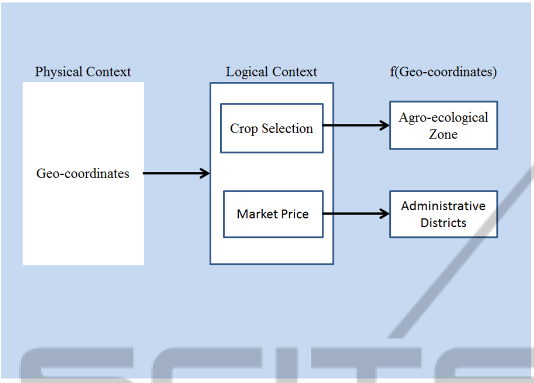

Figure 1: Physical to Logical Context Mapping.

Thus, it can be seen that the same physical context attribute can be mapped into different logical context attribute according to the information requirements of each of the application. So, one of the important capabilities of the context expanding application would be to facilitate this conversion of raw physical data to match the required logical context. Different application can have space- time- user related information and activities represented different ways which would allow different application to identify and querying different databases static or dynamic, based on the requirements.

3.3 Designing the Generic Model for Physical Context

Physical context can be modelled using user profile, space, time and activity as major sub categories. Each sub category will consist of further sub categories and attributes.

Profile Modelling: This consists of the user context, such as the users profile and preferences. Some of these are general or domain-independent to a user. Examples include the users personal characteristics such as profession, age and gender. Some other user preferences are specific to the domain or application in consideration. These could be the users level of knowledge of particular topics, and the users level of interest in particular topics. Starting from the identity of a user, it is possible to obtain individual context information. This can be achieved by having a registration system which manages the basic user profile.

Spatial Information: This context type describes aspects relating to the spatial extent of the user context. It can contain attributes like location, direction and speed. One of the most common contexts used is the location of the user. Location-awareness is the most important part of context-awareness for mobile computing systems. The spatial region of interest defines the physical boundaries and may be of any shape. Spatial context is represented as regions, spatial relationships and geometric coordinates. In a regional representation, a boundary is specified as regions, such as Australia, Sydney or Parramatta. These representations can be hierarchically organized. Spatial relationships can be direction relationships (above, below, or north_of, southwest_of), topological relationships (near, far, around, within, adjacent, inside), and metric relationships (distance). The geometric coordinates specify points or areas in a metric space that represent the latitude, longitude and elevation above sea level.

A users location can be sensed using Active Badges, radar, video cameras or GPS (Global Positioning System) units. GPS sensors have become available in very small package sizes, enabling their integration in mobile devices. The level of precision required by the GPS module will depend on the information requirement of the application. For some application there could be instances where multiple geo-coordinates may be made associated with an individual user profile.

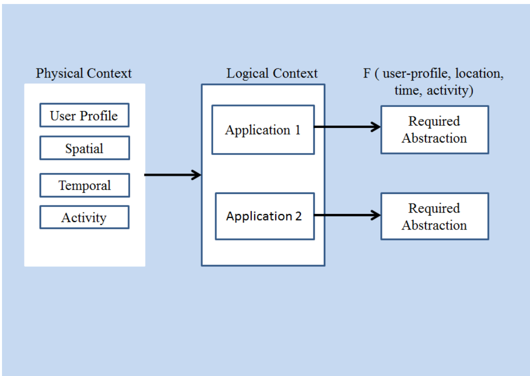

Figure 2: Generic Model for Physical Context.

Temporal Information: This context type describes aspects relating to time. Time is a fundamental variable, since the context is dynamic and changes with time. A temporal context can be represented as time instants or absolute time references, time intervals, periodic descriptors, and temporal relationship. A time instant or absolute time reference is an instant of time that is an absolute moment of time. It can be different in time units such as 9.00 a.m. and 11/10/2005. A time interval is based on calendar units such as year, today, morning. It is the time interval between two absolute time references.

Activity Information: The task context can be described with explicit goals, tasks, actions, activities, or events. The task context could be specific to the domain in which those tasks are performed. It can be decomposed into sub-tasks.

4 SOCIAL LIFE NETWORK APPLICATION FOR FARMERS

(Ginige and Ginige, 2011) states that connectivity and empowerment as the two important characteristics that needs to be addressed when developing an application for farmers. Now let us look at an exemplary scenario to show how an application can work in an agriculture domain.

Example: A good example to describe the advantage of using a context aware application would be a situation in which the farmer decide what crop to grow?. The system identifies that the farmer is in the first stage of farming and thus only needs to concern itself with the subset of information that the farmer might need at this stage. This sub set of information needs has already been identified through the analysis of the domain (Lokanathan and Kapugama, 2012) as shown in table 1.

Table 1: Information needs of Farmers.

Information needs of Farmers in Crop Selection Stage.
Current market prices for a specific crop(s) in the specific market that I sell at
Current market prices for a specific crop(s) in the specific market that I sell at
Current market prices for a specific crop(s) in market(s) other than what I sell at
Expected future market prices for a specific crop(s) around the time when your crops will be ready for harvesting
Information on finance (formal and informal sources, the cost involved etc)
Information on govt. schemes (including subsidies and minimum support prices) and policies on agriculture (current as well as changes)
Information on higher yield crops
Information on best farming practices including how to grow a particular crop
Information on crop diseases and how to solve them
Information on input availability and associated costs
Information on labour availability and associated costs
Information on land availability and associated costs
Information on farming machinery/equipment and associated costs
Information on electricity timings
Information on water availability
Information on weather

The system then provides a list of crops suitable to the farm of the farmer based on the fact that the farm is located in a particular agro ecological zone of Sri-Lanka and therefore a matching can be done to produce a list of crops that could be grown in that ecological zone. This list is further limited by the season in which the farmer intends to grow the crop. This list of crop can then be ranked according to the current production level if that dynamic information is available to the system. To empower the farmers each crop would be associated with vital information, which would then assist the farmers in their decision making process.

In this particular scenario, the system is able to filter, rank and provide information about different crops by identifying the context of the farmer. The context of the farmer is dictated by the ecological zone in which the farm is located, the farming stage, the season in which the farmer intends to grow the crop, and the personal preferences of the farmer.

4.1 Components of SLN4Farmers

An appropriate infrastructure for social life networks should support most of the tasks required to identify the context. The context expansion model needs to focus on a scalable context management while a data manger should be responsible for reasoning and concept representation. For example if the farming stage is crop selection then the context expansion module creates the query what crop to grow?.

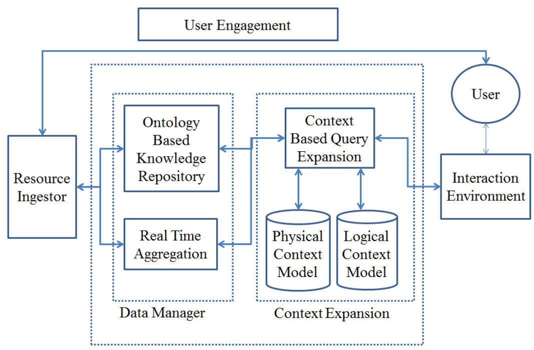

Figure 3: High Level Architecture for SLN.

Conceptually the data manager can be grouped into two, ontology based knowledge repository for static information and real time aggregation module for dynamic information. (Walisadeera et al., 2013) has shown how ontology can be used to find a response to queries within a specified context in the domain of agriculture. This structured view is essential to facilitate knowledge sharing, knowledge aggregation, information retrieval, and question answering while the real time aggregation module ingests and manages the sensory and dynamic data, based on the attribute values available at run time.

The focus of this paper, the context expansion module has the application data that is specific to the application domains characteristics which is used to carry out the logical interpretations and a physical context model that is responsible for keeping the context state updated for each individual user of the application. The context characterizing properties that change with spatial and temporal attributes is captured by the physical context model.

The context expansion module provide the following functionality :

- The definition and structure of context model that is used to represent the task being carried out by the specific application.
- The acquisition of data at run time that is used by the context model to provide personalized information in context.

4.2 Context Expansion

The context expansion module identifies information need of the sub task of the activity performed by the user. This information along with the logical interpretation of the application of the stored physical context of the user is used to filter and provide the required information.

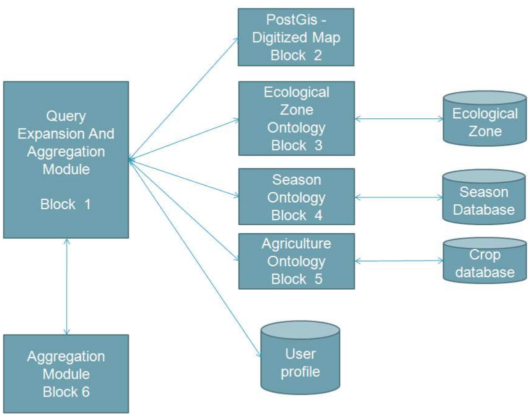

Figure 4: Conceptual Model for Context Expansion.

Let us look at one of the working example of the application. The farmer logs into the system, the system asks the farmer to register his farm. This is governed by the basic application domain knowledge that a farmer might have multiple farms associated with him. The context model allows us to capture this information through the user profile. The current stage of farming is also captured in the user profile and having the relationship that each farmer has multiple farms allows us to capture the farming stage of each farm associated with the farmer. The GPS system of the mobile is used to capture the geo-coordinates for each farm.

	Input	Output
Post GIS Module (Block 2)	Geo-coordinates (ex: 79.63,7.53)	Ecological zone (ex: DL1)
Ecological Zone Ontology (Block 3)	Ecological zone (ex: DL1)	Rainfall – (Dry, Intermediate, Wet) Elevation – (Low, Mid, Up) Temperature Soil type Identification – (Low country, Dry Zone)
Season Ontology (Block 4)	Expected time	Season - (Yala, Maha)
Agriculture Ontology (Block 5)	What crop to grow in Yala with values zone=DL1, Low country, Dry zone; Rainfall = 100, Elevation = Low	List of vegetables
Aggregation Module (Block 6)	Individual vegetable	Production Level of individual vegetable
Query Expansion and Aggregation Module (Block 1)	What crop to grow ? (Meta-data : User data, Geo-coordinates, Expected time)	List of vegetables with current production level

Figure 5: Input Output Table for Context.

Once the farmer selects a farm the information specific to that farm will be made available by the system. If the farmer selects crop planning the context expansion module checks the farming stage of that particular farm and then provide information relevant to that farm for that particular farming stage by creating a corresponding query.

For example if the farming stage is crop selection then the context expansion module creates the query what crop to grow?.

This query is further expanded by different blocks of context expansion module as shown in the figure 3. Thus the query createTd by the context expansion module is expanded from What crop to grow? into What crop to grow in Yala with values agro ecological zone=DL1, Low country, Dry zone; Rainfall = 100, Elevation = Low. This query is then passed on to the data manager where agriculture ontology is used to obtain a list of crops. For each of the individual crop, a query is generated and sent to the aggregation module, to obtain the current production level of each vegetable.

4.3 Implementation

To test the concept an end to end prototype was developed. Focus was on user interface, usability and acceptance of the system by the end-users. The design process was based on the research done by (De Silva et al., 2012) and took into account several factors such as users level of literacy, familiarity in using the device, users cultural background, and language beliefs.

Scenarios based on (Di Giovanni et al., 2012) studies were used to identify a list of non-functional requirements. The above architecture was implemented as a mobile up for Android phoned connected to a back-end server through web services.

The application model specifies the following information:

- The user is a farmer and that he can have multiple farms and multiple mobiles.
- Each farm has geo-coordinates, season and the farming stage associated with it.
- There is a set of information required for each farming stage.

Figure 6: Login and Farm Selection.

Figure 7: Crop selection and List of crops.

Figure 6 shows the login screen. It has been designed to handle the situation of farmers having multiple mobiles and also for the authentication process. The application domain dictates the fact that a farmer might have multiple farms and since each farm has its own unique characteristics, the farmer is asked to select a unique farm at the start of the application.

Figure 7 represents the higher level of grouping of information needs in the agriculture domain, which

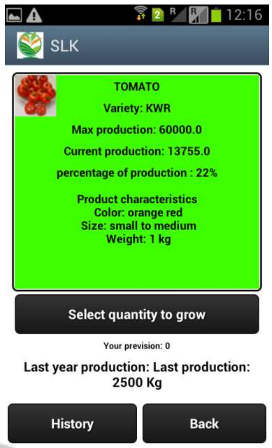

Figure 8: Crop Characteristics.

caters to the different information needs at different stages of farming. In the first version, the crop planning stage was implemented, so when the farmer selects this button, the system provides the user with a list of suitable crops as shown in figure 8. The farmer can find more information about a particular crop by selecting the individual crop. The farmer can on this screen indicate which crop he plans to grow and in what quantity. This information is stored as part of the user profile and is associated with the farm of the farmer.

5 RESULT

The usability field test with 32 farmers in Sri Lanka was done to prove the effectiveness of the initial solution and positive response was obtained.

There was universal agreement among the farmers participated in the field trial to varying degree (strongly agree, agree, moderately agree) to the question All information for the crop choosing stage is provided. This information was provided to the farmers using farmer context via low cost Smart phones running Android operating system.

6 CONCLUSIONS

To understand the research challenges and to derive possible solutions to provide context based information in Social Life Networks, we have taken a concrete example in the form of an application for farmers that could meet the information needs within the farmers context. To represent information in context, we have developed an approach to model users physical context and carried out the mapping to obtain the logical context required by various data managers based on the current attribute values of the physical context. The context expanding module of the application was responsible for facilitating the conversion of raw physical data to match the required logical context of the application.

The solution described in this paper have been tested by creating a mobile application which has allowed us to prove that the solution is feasible and meets the information needs of farmers in Sri Lanka. In the future we plan to improve the context expansion module by inferring the intent of the users from their interactions with the system (Deufemia et al., 2013). The current application is a specific instance of the SLN project and we plan to create a generalized architecture that would be useful in creating many application for SLN.

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