Computer-assisted Cognition: Using Wireless Sensor Networks to Assist the Monitoring of Agricultural Fields

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***Abstract*— We use a *decision-support system for agriculture* based on a wireless sensor network, in order to understand how scientists solve a typical problem that requires environmental data (such as soil moisture, temperature, etc.). Subjects use an existing interface to solve simple problems, and a qualitative study of the users' interactions with the system is performed to better understand their requirements. The study is performed from the point-of-view of distributed cognition, the goal being to understand how a new tool fits in the mental model that agriculture scientists have of their own field of work, and how it may influence or enhance their mental representations and work-processes.**

I. Introduction

This paper is investigating the impact that new techniques of environmental monitoring will have on the job of agronomists and other agriculture scientists (such as plant physiologists) in the near future. Faced with the task of designing and implementing an agriculture-monitoring application using a wireless sensor network, we needed professional advice, in order to know how to design a well-adapted user interface. Such an interface needs to take into account the work processes and habits of its users' community.

At the same time, the use of a technology that allows a real-time sampling of the environment, both spatially and temporally, is likely to have an impact on the way agriculture scientists observe and instrument the rural environment. In that regard, the technological artifact becomes a world-shaping tool that participates directly to the scientist's cognition. In the distributive cognition theoretical framework, this is known as a *Cognitive Tool*. Computers have long been recognized as cognitive tools [1]. It may participate in the individual's cognition at several levels, from being a mere *servant*, which allows to perform tasks automatically and more rapidly, to acting as an *expert*, whose role is to complement the individual's knowledge, to teach him or to provide him with recommendations [2].

In this paper, we describe a qualitative study that we conducted in order to optimize the design of a computer user interface that assists agronomists in their work with wireless sensor networks. The main goal is to assess what in the new cognitive field is the domain of the computer, and what is the domain of the human actor. A secondary goal is to assess the impact that such a tool has on the way scientists envision their own work. Is the tool well understood? Is it perceived as useful? How does it reshape the mental model[1] of the scientists?

Our research question can be summarized as : "**What are the expectations of an agronomist toward the computer-based user interface of an application that gives him or her a precise knowledge of the conditions in the field over time and space?**"

The answer to these question depends of course on the socioeconomic context and the type of agriculture practiced. The context we chose is extensive agriculture in the semi-arid regions of developing countries, for 2 reasons:

1) A precise knowledge of the local environment is crucial for a successful practice of agriculture
2) This knowledge is today sorely lacking, since most of the studies on precision agriculture are focusing on intensive agriculture in industrialized countries

This paper is organized as follows: In section 2, we define precisely the context, first describing the role of environmental monitoring in agriculture, before giving a short introduction on what wireless sensor networks are, then describing a concrete project, on which we leverage in this study. In section 3, we precise our research question, explain and justify our methodology, and describe the details of the experiment. In section 4, we present the results of the experiment, which we discuss extensively in section 5, before drawing a conclusion and guidelines for future work.

II. Context

A. Monitoring the environment in agriculture

Among all the parameters that are crucial for agronomists to look at in order to monitor the field conditions, one of the most important is the water available to the plant in its root zone. Traditionally, this parameter is assessed indirectly, using characteristics such as precipitation, solar radiation and soil physics. This method yields an approximation at best, since the water content of the soil is a parameter constantly evolving over time and space.

Similarly, due to technological limitations, scientists have been forced so far to rely on scarce environmental data.

[1]A mental model [3] is the internal symbol or representation an individual has of external reality. One can see it as the explanation in someone's thought process for how something works in the real world. Mental models can be shared among individuals. Computer users construct mental models (structural relationships between application's components) of the systems they are using.[4]

Typically, measurement points are few, and used one-time in order to build a mathematical model. Often, the only "real-time" parameter used is precipitation.

B. *Wireless Sensor Networks*

A wireless sensor is a self-powered computing unit usually containing a processing unit, a transceiver and both analog and digital interfaces, to which a wealth of sensing units (typically sampling physical data, such as temperature, humidity etc.) can be adapted (see Fig. 1 as an example). These sensors automatically organize themselves into an ad-hoc network, which means they do not need any preexisting infrastructure, such as a GSM network. For this reason, we refer to such a network as a Ad-Hoc Wireless Sensor Network, which we denote WSN in the remaining of this document.

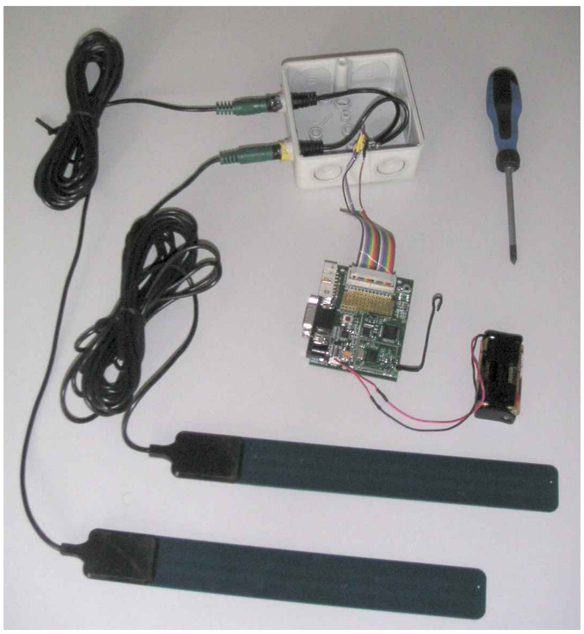

Fig. 1. Wireless sensor with 2 alkaline batteries, a connector to 2 soil moisture probes, and its casing

The sensor nodes communicate with each other in order to exchange and process the information collected by their sensing units. In some cases, nodes can use other wireless sensors as relays, in which case the network is said to be multi-hop. If nodes communicate only directly with each other or with a base station, the network is single-hop.

In a *data-collection model* (Fig. 2), sensors communicate with one or several base stations connected to a database and an application server, that stores the data and performs extra data-processing . The result is typically available via a web-based interface.

Recently, Wireless Sensor Networks have raised considerable interest in the computing and communication systems' research community. They have decisive advantages, compared to the technologies previously used to monitor environments via the collection of physical data. Whenever physical conditions change rapidly over space and time, WSNs allow real-time processing at a minimal cost. Their capacity to organize spontaneously in a network makes them easy to deploy, expand and maintain, as well as resilient to the failure of individual measurement points. Although they remain expensive at the moment because they are yet to evolve from laboratory prototypes to off-the-shelf products, most analysts rely on Moore's law to predict a price per unit of a few US dollars within 5 to 10 years.

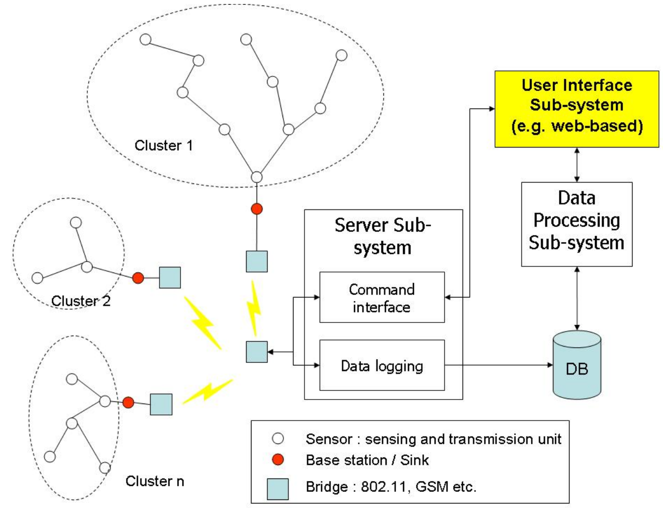

Fig. 2. An example of data collection system

As typical applications of WSNs envisioned today, one can mention home automation, forest fire prevention, monitoring of industrial processes or patients monitoring in hospitals. These are often targeted and tailored to industrialized countries. But researchers have also tried to apply WSNs to issues regarding typically the developing countries.

C. *COMMON-Sense Net*

Because farmers often lost the benefit of traditional farming knowledge when moving from subsistence agriculture to market production during the green revolution, a better knowledge of the field environment is needed to design more sustainable agricultural practices.

The COMMON-Sense Net project [5] aims at designing and developing an integrated WSN for agricultural management in the semi-arid rural areas of developing countries. The first user targets for this system are the agronomists who develop the models that are used to define farming strategies well adapted to local conditions. Using a WSN will help them to identify the best crops and optimized farming strategies in terms of water and fertilizer management, and to assess relevant water conservation measures. However, direct use of the sensors by the local farmers for real-time farming management will also be studied.

COMMON-Sense Net consists of a wireless network of ground-sensors that record periodically the temperature, humidity, light intensity and soil moisture in the field environment. Sensors record data on a periodic basis and send them in a multi-hop fashion to a base station connected to a centralized server through an 802.11 bridge.

III. EXPERIMENT

A. Goal

This experiment will focus on the use of the system by agriculture scientists. We want to test the usability and utility of the COMMON-Sense Net system among the community of agronomists who seek to understand better the cropping environment.

Our research question can be summarized as : "**What are the expectations of an agronomist toward the computer-based user interface of an application that gives him or her a precise knowledge of the conditions in the field over time and space?**"

In order to answer this generic question, we divided it into 5 themes:

1) Aggregation: Is an analytical view of the data preferable to a synthetic one?
2) Spatial view: are details about the location of every data useful?
3) Temporal view: is the evolution of a parameter over time useful?
4) Modality: Are graphs preferable to tables of numbers?
5) Correlation: Is the relationship between different types of data useful?

B. Methodology

The overall methodology is a qualitative study revolving around the use of the user-interface along predefined scenarios.

The goal of the experiment was to present the subjects with the interface described in the next section, and to ask them to solve 3 simple problems based on scenarios typical of issues facing farmers in semi-arid areas. In order to make the analysis of their interaction with the system clearer, they were asked to think aloud when performing actions.

In a second phase, a semi-structured interview was conducted through a form with open questions, in order to reflect on the use of the system. Questions can be found in Appendix D.

C. Detailed Description

We contacted 7 agriculture scientists, five of them residing in India and familiar with the problems faced by farmers of semi-arid areas, and 2 coming from Swiss institutions. The area of expertise of the participants varies from plant physiology to agronomy to soil physics. In all cases, however, the subjects are familiar with environmental monitoring in relation with agriculture.

In a pre-experiment briefing, they were exposed to the general context, as well as to the scenarios they were supposed to resolve. Interviews were conducted both in India and in Switzerland. In the former case, the experimenters were connected to the subjects through a VoIP link. Since the bandwidth of the internet connection was insufficient for acceptable image quality, no web-conference tool could be used. In order to mitigate the inconvenience of this obstacle, a web-cam was used so that the remote experimenters could follow approximately the actions of the participants. All the session was recorded on a DVD that was visioned after the experiment.

This DVD was used to check and complement the written observations that the experimenters compiled during the experiment. The activity of the participants was observed and segmented into atomic actions. We regrouped similar atomic actions and removed what we considered as noise before placing them on a mind-map. More details on this mapping is provided in section IV-B.

The subjects were always assisted locally by an experimenter, whose job was to describe the experiment's context, scenarios, and to introduce the interface used.

The meetings followed a standard procedure in three points, each of them monitored in time:

1) **10 minutes:** The participants are introduced to the simple interface developed to present the sensors' data (see Appendix B)
2) **20 minutes:** Using the interface, the participants are asked to solve simple problems (see Appendix C).
3) **15 minutes:** A semi structured interview is used to ask the participants to criticize the interface. They are asked questions to analyze their use of the interface (see Appendix D)

The whole interview is monitored to last 45 minutes.

D. Scope and limits of the study

The size of the sampling was too small to infer general results about the way cognition is distributed between a scientist and the tools he or she uses, and how the nature of these tools influences the cognitive processes of the individuals. Similarly, timing is an issue. In order to assess the effect of a new tool on the mental model of a subject, prolonged interaction is necessary, which was not possible in the context of this study.

The analysis of the video footage from the individual sessions was done non-systematically. As in all human activities, the main problem was to identify what actions were noise, and what actions were meaningful considered the space of analysis. We define more precisely what we mean by noise and what was considered meaningful to us in the next section. Accordingly, we strove to record all meaningful points in the course of the user-system interaction. However, such a qualitative analysis leaves a lot to the experimenter's subjectivity. Because of time-constraints, we could not perform the cross-analysis that would have allowed to remove this limitation.

This experiment should be considered as a preliminary study, whose results will be used to design a more conclusive experience on the distribution of cognitive processes. Such an experiment could then be used to optimize the design of an application used in the context of agricultural sciences.

IV. DATA ANALYSIS

The participants were divided in two groups based on the geographic location, since one hypothesis is that the cultural background can have an influence on the way people conduct business in that field. The participants were thus classified as *Indian* and *Swiss*.

Then the experiment was segmented in 3 for the formal analysis:

1) **Pre-experimental briefing:** The phase where we explained to the participants the context of the experiment
2) **Experiment with the interface:** The phase where participants actually interacted with the application
3) **Post-experimental feedback:** The phase where the participants gave their feedback on the experiment via a web-based form

A. *Pre-experimental briefing*

The first surprise came during the preparation of the interview in India. We designed the scenarios, which we exposed to the subjects at this stage, so that they highlight some features of wireless sensor networks: the ability to monitor parameters over time and space. However, when presented with the scenarios, the Indian subjects thought immediately of a solution in a prescriptive mode, which does not take into account the probability of climatic events such as rain over time and space, or the influence of soil physics in the interpretation of the data.

This immediately led us to envisage a simple alternative. Either the time and space variability are aspects that are irrelevant to the field of agricultural science, or agricultural scientists are not used to take this aspect into account because the tools they have been using so far (crop models, soil physics model and at best precipitation over time) participated in the elaboration of the mental model they have of their own field.

B. *Experiment with the interface*

We positioned the actions of the participants on a two-dimensional mind-map, whose axes are *Descriptive vs. Interpretative* and *Problem vs. Solution*. We claim that these two axes are orthogonal, one axis being relative to the outcome of the action (problem/solution) and the other pertaining to its semantics (descriptive/interpretative).

We considered a descriptive action as being one, where the user tried to explore the application without seeking to understand the meaning of the features he/she was using (such as nodes, graphs etc.). On the other side, an interpretative action contains a reflection on what is behind the screen representation (a node is a sensor recording soil moisture or temperature, the graphs represent the evolution of a parameter over time etc.). Problems are situations where users did not manage to accomplish a task that was meant to be done int he framework of the experiment (such as selecting a node to display the readings of its probes over time). In the opposite, solutions were successful resolutions of a challenge.

As shown in figure 3, this mind-map partitions the experimental space into four quadrants. The location of an action in one of the 4 quadrants can be interpreted as follows:

- **Quadrant 1 (Q1):** The participant was blocked at one point in the navigation of the interface
- **Quadrant 2 (Q2):** The participant successfully discovered a feature... or a bug.
- **Quadrant 3 (Q3):** The participant failed to interpret adequately a concept

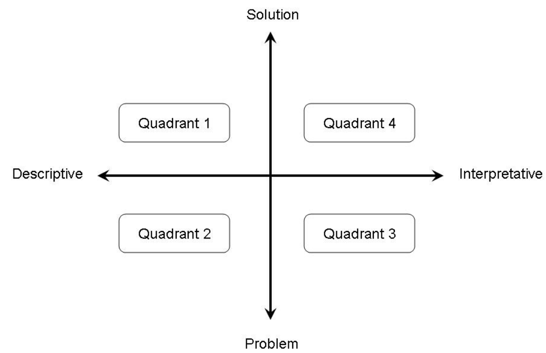

Fig. 3. Mind-map for users' actions

- **Quadrant 4 (Q4):** The participant successfully interpreted a concept, or reached a pertinent conclusion on the situation in the field through the interface.

Due to the qualitative nature of the study, we did not try to position the actions on a continuous scale in the graph, but rather to find a single quadrant where they belonged. Accordingly, we limited our analysis to this level of granularity.

In half of the cases, users performed actions that span totally the 4 quadrants. In all cases, they cover at least 3 of the quadrants. Overall, the actions are distributed quite evenly. Numbers indicate that users wasted most of their time being blocked by a navigational problem (29 occurrences), but also spent a significant time solving interpretive issues (20 occurrences). The successful resolution of navigational problems was less frequent (15 occurrences), while the interpretive problems were the rarest (12 occurrences). This tends to indicate that while the interface was difficult to use, the application allowed the users to address intellectual challenges related to their domain of activity.

The difference in results based on the origin of the participants is interesting. The two Swiss scientists spent much of their time in the "Solution" half of the graph (24 solutions/10 problems), while the Indian scientists found it more difficult to cope with the problems (31 problems/11 solutions), especially problems associated with the web interface itself. On the other hand, they were quite successful when addressing interpretation issues (they found a solution in at least half of the cases). Even so, there seems to be a strong cultural aspect in the difficulties encountered with the application, which represents a design challenge for the application designers.

This hypothesis still holds if we take the quadrants individually. In the Indian case, there is a strong weight coming from operative problems. Here, the participants spent more than twice as much time dealing with the interface than doing anything else. The situation is more balancing for the Swiss participants, who spent as much time solving operative and interpretative problems (12 occurrences in each case). Nevertheless, they were not immune to navigational hurdles (7 occurrences).

The detailed numerical results can be found in appendix

C. Post-experimental feedback

The form that the participants had to fill-up can be found in Appendix . In the case of the Indian participants, this form was submitted on-line (see Appendix). For the Swiss participants, the questions were asked orally directly at the end of the experimental session. Since we chose to ask only open questions, we analyzed the answers globally, because several similar issues were addressed in different answers by one participant or another.

In general, all users emphasized the need to simplify the application, which is not a surprise given the number of problems most users had in understanding and using the interface. This concern was especially strong with the Indian users.

The possibilities offered by the real-time analysis of the data were acknowledged by 3 users, most notably by the two Swiss scientists. One of them noticed: "If the irrigation water is limited, it is important to know what is the water available to the plant at any stage of its development, since the plant copes differently with water scarcity at its different growth stages." In the Indian participant's words: "It is indeed a fantastic option to monitor weather parameters in real time."

Three users (2 Swiss, 1 Indian) stressed the usefulness of having a spatial view of the data. For instance, User 3 (Indian) mentioned: "The data on soil temperature should have been in different depths. Similarly, data on soil moisture across a given plot (at same depth) should have been presented." This user did not manage to display the graphs, but recognized the importance of having such a representation to analyze field-data.

The overall importance of having soil moisture data available was highlighted by all users in one way or another. One Swiss participant said: "The available water content in the soil is the most direct measure for the growth capacity of a plant at a moment in time." An Indian participant went even further: "Soil moisture data is the most important one for agriculture."

V. Discussion

Obtaining a single coherent picture from qualitative results gathered on a population of 7 subjects may seem artificial. However, the results obtained are valuable in three ways for the organization of a larger experiment on the same subject.

Firstly, the application presented to the users was a prototype. Clearly, it came short of satisfying the minimal requirements for running such an experiment smoothly. The analysis of the participants' interaction with the application provided extensive information on immediate improvements of features.

Secondly, we realized the problems caused by the conceptual gap between the designers and the users of the application. Such a gap had already been mentioned by Heeks [6]. In our case, computer scientists designed the interface, making assumptions on "intuitive actions" such as double-clicking to select a node, that were not understood by the users. Conversely, computer scientists did not question the probes' output, since it did not mean anything to them. Agriculture scientists pointed out at inconsistencies that were not detected until then. The question of units displayed also puzzled them at times. We had put an emphasis in avoiding this hurdle by organizing participatory meetings with potential users at the beginning of the project [7]. However, this experiment shows that a tighter co-designing process needs to be put in place for the application to be usable by its target users.

Thirdly, the cultural differences are also to be emphasized. One clear issue is computer literacy. It was clear from the analysis of the video footage that most of them work seldom with a computer, while it is a daily tool for the Swiss scientists who participated to the survey. This cultural difference is also perceptible in the manner participants envisage the usage of wireless sensor networks in their work. Swiss participants, who have used sensors previously recognize immediately the potential of monitoring the soil moisture at several points across time and space, while Indian scientists seem to see them as merely a way of saving time and human labor. With that regard, it is interesting to note that the only Indian user who mentioned the "real-time capability" of this tool was the only one who had been presented with this technology previously. There seem to be a conceptual disruption associated with this artifact that would be interesting to explore in a subsequent study.

VI. Conclusion and Future Work

In this study, we explored the impact a new *cognitive tool* - a wireless sensor network with a web-based interface - may have on the way agriculture scientists envision their domain of activity. We found evidence that such a tool represents a disruption in the way they look at the monitoring of the environment, and that further investigation needs to be conducted to avoid this new technology to be dismissed because its real-time and geographical capabilities are not well understood.

Conversely, we realized that there is work to be done in improving the interface itself, in order to make it more intuitive. The concept-gap between designers (software engineers) and users (agriculture scientists) is a possible explanation for the operative difficulties encountered by the participants throughout the experiment.Cultural differences seem also to appear as a factor in the easiness with which users can use the application and interpreting the specific capabilities of wireless sensor networks.

Due to the small number of participants, we consider the experiment described above as a preliminary study. In the future, we plan to verify the cultural hypothesis with a larger sample of participants, and to test an improved interface to see if this can help mitigating the cultural gap that we identified.

References

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APPENDIX

The Pavagada region is a part of the large semi-arid tract of Southern India. It is centered on $14\,^{\circ}$N and $77\,^{\circ}$E and is situated in the Eastern part of Karnataka state. The central part of the region is a plateau with an elevation of about 600 to 700m, and several chains of rocky hills found in the landscape form series of watersheds.

The upper catchment areas of the watersheds are utilized for rain-fed groundnut cultivation. Hills and rocky outcrops constitute the grazing lands for the livestock. In the lower reaches of the watershed, manmade tanks storing runoff for irrigation were constructed several centuries ago. In addition, large open wells, as well as tube wells, support small patches of irrigated farms. For economical reasons, however, about 85 percent of the total cultivated area depends exclusively on rainfall for the growing of groundnut during the rainy season (June-November).

Indeed, water for irrigation is too costly for the resource-poor farmers. Their farms are usually located on the upper reaches of the local watershed, and thus cannot benefit from the water stored in traditional surface storage reservoirs in the valleys below. Since the drilling of bore wells is costly and has a history of high failure rate, the risk is too high for them to take.

The major climatic feature of the Pavagada region is the low amount of rainfall and its high variability. The annual average is 561mm, with a standard deviation as high as 190mm. The distribution of the rainfall within the year is bimodal. The maximum rainfall occurs in the second half of September. The second mode is between the last week of May and the first week of June.

Another major characteristic of the climate of the region is the frequent occurrence of long dry spells. Consequently, the crop is highly prone to moisture stress, a risk enhanced by the low moisture retention capacity of the shallow sandy loam soils. As a result, for 60% of the harvests the cost of cultivation is not recovered.

The interface presented to the participants is structured as follows:

Cluster selection page: From this page (see Fig. 4), a user can select from a list the sensor network he or she is interested in. We refer to a single network as a cluster, since it represent the largest logical entity on which actions are performed (typically, a cluster corresponds to one field, or to an ensemble of adjacent fields, where wireless sensors were deployed).

Cluster page: On this page the cluster is presented as a map, where the individual sensors are located (see Fig. 5). Basic information on the sensors can be viewed by rolling over each one with the mouse. One or several sensors can be selected to display more precisely their data, in particular their evolution over time.

Sensor data page: Data of sensors can be displayed, either individually, or jointly, with simple statistics (such as mean) (see Fig. 6). The display format can be either a graph, or a table of numbers, which can also be downloaded in order to be used as an input for other programs (MS Excel, MatLab etc.)

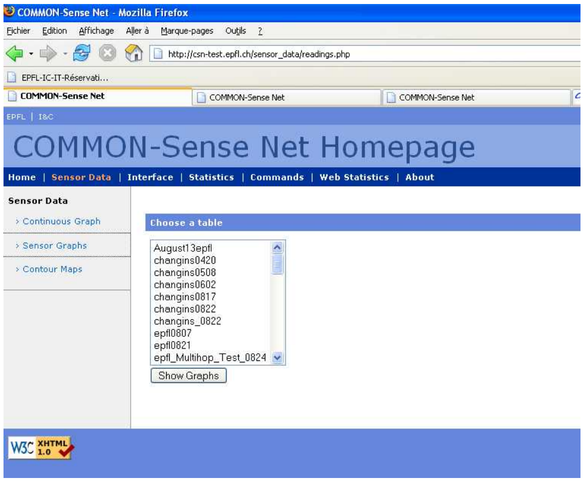

Fig. 4. Cluster selection page

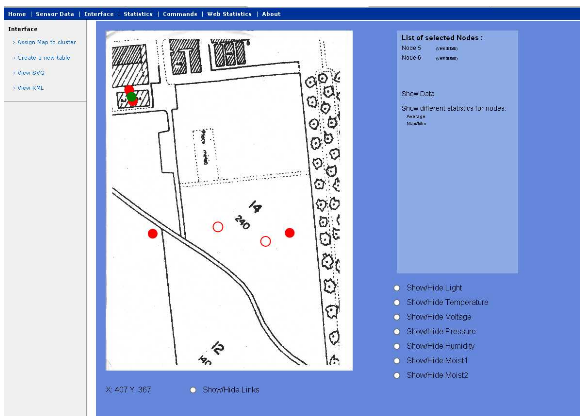

Fig. 5. Cluster page

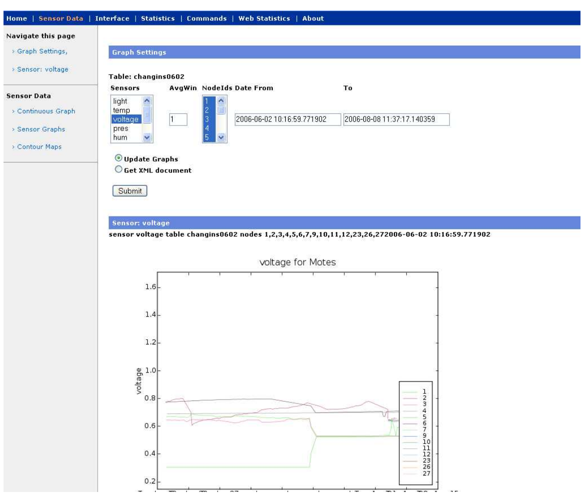

Fig. 6. Sensor data page

1) Decision on planting time. What is the amount of soil moisture that can be regarded as sufficient or safe to sow, considering that there is 40 % probability of of a dry spell (period without rain) lasting 25 days or more.
2) Gypsum application is done at 30-45 days after planting, but there should be sufficient soil moisture to absorb the nutrient and also ensure good yield. Only then is gypsum application profitable. What amount of soil moisture is considered sufficient to meet these conditions?
3) Other crops like pigeon pea, castor and minor millet are promising either as intercrops or alternative crops to groundnut in this region. Soil moisture availability during the crop season in the soil profile, especially at the root zone of these crops is an important factor to decide their yield. To measure such moisture availability, what soil moisture data in terms of depth, frequency, accuracy needed etc. are needed?

The subjects are asked to think aloud while solving the problems. This is used in the analysis of the experiment's results.

The questions of interest in this study about interface design are the following.

1) Aggregation: Is an analytical view of the data preferable to a synthetic one?
2) Spatial view: are details about the location of every data useful?
3) Temporal view: is the evolution of a parameter over time useful?
4) Modality: Are graphs preferable to tables of numbers?
5) Correlation: Is the relationship between different types of data useful?

In order to avoid influencing the subjects of the experiment, open questions are preferable to the list of choices above.

1) How did you solve the problem?
2) What type of data were relevant to the problem you had to solve?
3) Were any data missing? If yes, which ones?
4) How did you select the sensors you looked at?
5) How did you make sense of the data? What transformations were necessary?
6) How did you connect a type of data to another?
7) What is your general opinion on the usability of the interface?
8) What are your suggestions for the improvement of the interface?

	Q1	Q2	Q3	Q4	Q1 + Q2	Q3
User1	1	2	1	4	3	
User2	0	4	2	3	4	
User3	0	7	3	1	7	
User4	2	9	3	0	11	
User5	3	4	3	4	7	
User6	9	3	0	8	12	
India	3	22	9	8	25	
Switzerland	12	7	3	12	19	
Total	15	29	12	20	44	

Fig. 7. Numerical results

	User 1	User 2	Us
How did you solve the problem?	Besides reading the command prompts, I also saught the help from Jaques and Andreas.	By using the data provided and the leads given by the interacting scientists.	What probl referred to? face probler interacting understandi
What type of data were relevant to the problem you had to solve?	Soil moisture data, temperature and light intesities are always of great interest to me.	The different parameters as recorded by the probes.	Given that I presented w problem, I c that I was th soil moistur temperature expected to understandi growth & it relationship cliamtic / so parameters
Were any data missing? If yes, which ones?	Not really. But I could see some large variability in soil moisture data when one compares the values of sensors deployed 10 cm and 30 cm deep.	Yes. All those data points that were shown as -1.	The data on temperature havebeen in depths. Sim on soil mois a given plot depth) shou been presen

How did you select the sensors you looked at?	I followed the command prompt on the left side. I was also guided to use the software.	By pressing on the Red circles.	the be famil
How did you make sense of the data? What transformations were necessary?	Soil moisture data is the most important one for agriculture. Graphical representation is fine.	The numbers were indicative of the situation prevalent at the spot which were reflected by the probes. This made sense. However, cirtain probes did not record. More clarity in terms of the units would be necessary.	The d onle v in gra three in mo the pr as rou
How did you connect a type of data to another?	I was trying look why soil moisture at 30 cm depth suddebly has a peak between 10 and 17th October? I was trying to look at the temp data to see if it was very low? Guess: low temp may have reduced evaporation. But there seems to be some mistake i	The relevance between temperature and moisture is meaningful. Likewise, those variables which could be related were connected.	By se paran

What is your general opinion on the usability of the interface?	It is indeed a fantastic option to monetor weather parameters in real time. But we need to standardise a number of things before extending this facility to the field.	Usable but for the ground level workers, further details in a simplified way would help.	The interfac usable in its condition by scientists. It presumed th scicentists h equivalent k proficiency computer
What are your suggestions for the improvement of the interface?	As I said, it is a serious issue and let me take time to think about it.	More clarity from the point of view of the subject per-se. For example: moisture to be related to canopy or crop stand, wind speed, sunshine hours, and rainfall.	Improve it t more user fr Improve the presentation combine the meaningfull Negative so Y- axis labe misleading In one graph parameters s displayed