Environmental Communication in Biodiversity Information Systems

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Abstract

"Without pollination there would be no life". This quotation might indicate that the survival of the species of pollinators is of crucial ecological and economical relevance. Furthermore, it reveals to be a global task which enforces the worldwide usage and exchange of biodiversity information of pollinators with the support of information and communication technology. We present the communication structure and technology employed for the automated surveillance of pollinator species within a global network of centres of competence.

1. Biological Diversity and Biodiversity Informatics

The Convention on Biological Diversity, commonly referred to as the Biodiversity Treaty, was one of two major treaties opened to signatories at the *United Nations Conference on Environment and Development* (UNCED) in Rio, in December 1992. The treaty defines biodiversity as "the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." Parties to the Biodiversity Treaty "affirm sovereign rights over the biological resources found within their countries, while accepting responsibility for conserving biological diversity and using biological resources in a sustainable manner," according to an International Union for the Conservation of Nature (IUCN) assessment of the treaty. The Federal Republic of Germany signed the treaty along with more than 170 other countries.

If we are to take our responsibilities as signatories of Biodiversity Treaty seriously, it becomes obvious that the conservation and sustainable utilization of biodiversity necessitates the mapping and assessment of the current status and of the risk of loss of biodiversity as well as the continual monitoring of biodiversity. These demands in turn require the gathering, storage, analysis, visualization and exchange of enormous amounts of data which is essentially impossible without using modern computer and communication technology as well as innovative computer science techniques.

To meet these specific demands for the mapping and monitoring of biodiversity, a new field in computer science has been established which is now termed Biodiversity Informatics. It is an innovative and interdisciplinary research field in computer science which employs modern information and communication technology for world-wide access interdisciplinary integration of biological and geographical data and knowledge.

2. Ecological and Economical Value of Pollination

In 1999 the *Workshop on the Conservation and Sustainable Use of Pollinators in Agriculture with Emphasis on Bees* took place in Sao Paulo, Brazil. The workshop report stated that about one-third of the world's crops demand pollination to set seeds and fruits and the great majority of them are pollinated by many of the estimated 25,000 species of bees. *The annual value of this service in the U.S. is calculated at US -8 billion and the estimate worldwide is US -70 billion.*

Many of the bee species are currently threatened with extinction. Efforts to preserve and protect the species are currently severely hampered by

- the difficult taxonomy, i.e. the classification into groups (genera and species),
- the lack of entomological (insect) specialists who can identify bee specimens.

3. The Automated Bee Identification System ABIS

Generally speaking, the efficient gathering of data is important for the construction and maintenance of every information system. In biodiversity research, a central part of the data gathering is the identification of the observed species. Due to the urgency of the need for diversity mapping and monitoring (engendered, for example, by the imminent, dramatic, extinction of species) on the one hand and the huge amounts of data, the difficulties in taxonomy and the worldwide lack of experts on the other hand, the task of species identification becomes, in practice, the key role for usage of an biodiversity information system suited to support efficiently the survival of the pollinator species.

In the project ABIS, an interdisciplinary team of zoologists and computer scientists from the University of Bonn are working to develop an **A**utomated **B**ee **I**dentification **S**ystem ABIS for the automated gathering and identification of bee species based on image analysis of their forewings. Furthermore the identification system ABIS is integrated within the German **E**ntomological **D**ata **I**nformation **S**ystem EDIS.

Figure 1: ABIS in the field

Figure 2 : Fixed bee

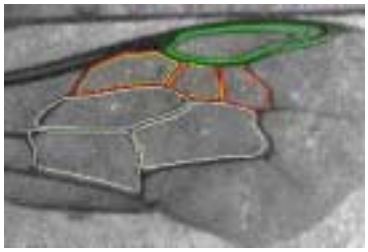

Figure 3: Image analysis

4. Communication in the International ABIS-Network

The spreading of plant and bee diseases as well as the migration of bee species and races across countries and even continents (remember the invasion of the Africanized honey bees - also called "Africanized bees" or "killer bees" - into the wild in South and North America) reveals that the global exchange of information about the pollinator biodiversity and also the global sharing of state of the art methods to survey and manage bee species, races and populations is necessary.

We are currently building up an international network (s. figure). The currently planned network will connect five centres of competence in Recife (Brazil), Logan (Utha, U.S.), Pretoria (South Africa), Amsterdam (The Netherlands) and Bonn (Germany).

Within this network ABIS is offered as an identification service via internet using a client-server architecture and employing a secure java-based implementation. The benefits of this network are:

- international gathering and exchange of biodiversity information of pollinating bee species
- comparable surveillance and evaluation results
- a growing international database

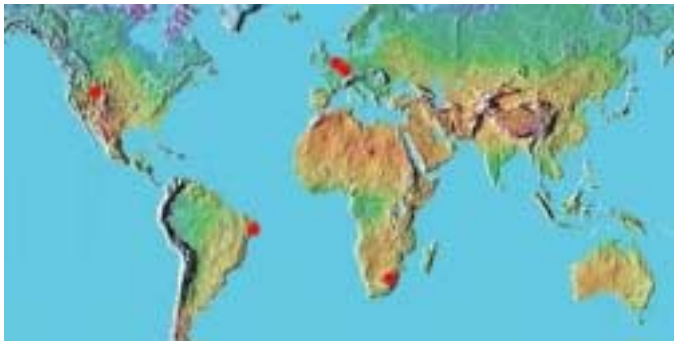

Fig. 4: Centres of Competence in the ABIS Network

5. Technical Implementation

Due to reasons of security and work load balance the bee identification is implemented as a distributed application via a client-server architecture. The user (client) will communicate directly with communication server, whereas the identification process if done by the hidden identification server which holds sufficient processing and storage capacity.The processing of a request for bee identification from a client is sketched in figure 5.

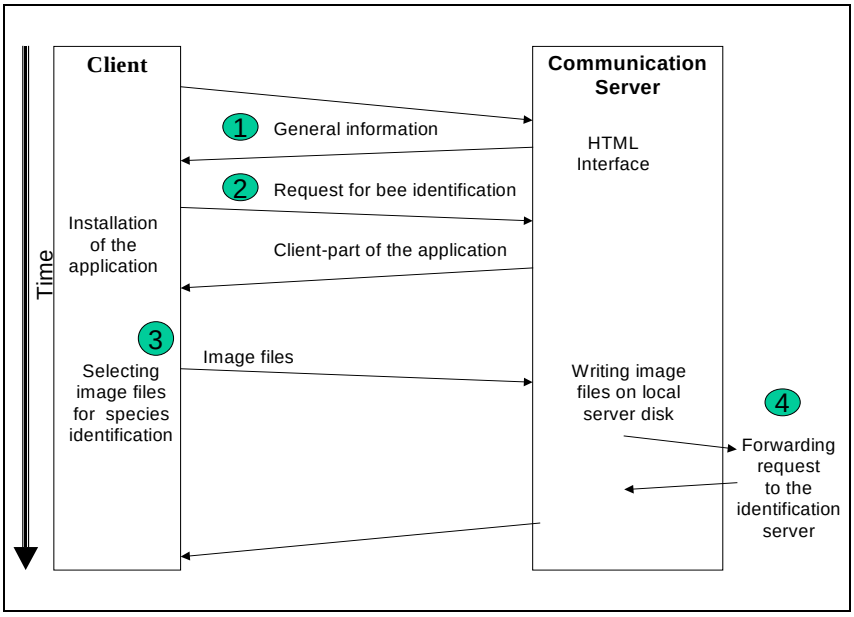

Fig. 5: Communication between Client and Communication Server

1) **ABIS portal:** The **communication server** presents general project information about bee identification including an entry page for identification requests.
2) **Installation of Client Components:** When the user (client) loads the entry page, he can click on an icon to start bee identification. Thus, the server will send the client the client component of the application for installation on her machine.

3) **ABIS Communication:** The client starts the application by selecting images of bee forewings for image analysis and species identification. The image files will be send to the communication server, where they are stored on the local file system.
4) **ABIS Identification:** The image files will then be processed by the identification server. The client will receive all in-between-information (like the status of the identification process) from the communication server.

Figure 6 details the interaction between client and communication server. Each box refers to the existence of an instance of the according class or its process, respectively.

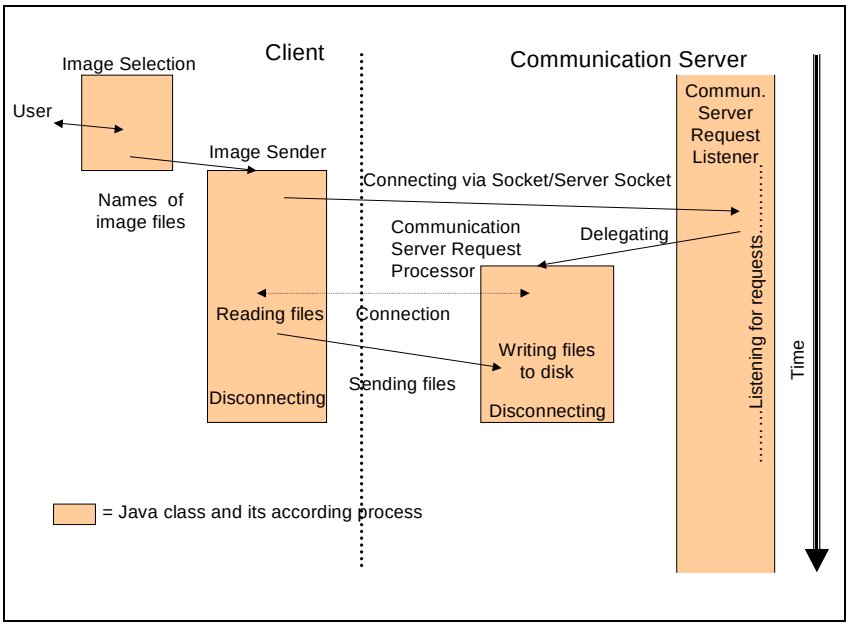

Figure 6: Implementation of Communication

6. Conclusion

Global environmental topics like biodiversity reveal an extraordinary need on communication to support scientific and practical exchange of knowledge, methods and tools. The ABIS network is a typical example of an innovative information system whose value is enhanced significantly by integration into a human and technological communication network.

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