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# New Database Middleware Management System for the Report of Aeroallergens

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## ABSTRACT

In Puerto Rico, respiratory diseases affect a significant percentage of the population and it is possible that environmental factors may influence the behavior of airborne biological particulate that could distress susceptible individuals. As most studies describe fungal spores in template environments, we wanted to address their concentrations in a tropical setting, indicant results that fungal particulate is present throughout the year at high or very high concentrations. In the field of allergy, knowledge of the behavior of airborne allergens is essential for an etiological diagnosis. The increasing need for the daily report of aeroallergens and in an effort to bring computer engineering technology into aerobiology, this project focuses on integrating computer engineering solutions with aerobiology to streamline and facilitate easy storage, manipulation and retrieval of data related to aeroallergens studies by developing an intuitive and easy to use computer application. Currently in Puerto Rico, we are in charge of two NAB accredited stations in San Juan and Caguas, to report the daily fungal spores and pollen counts to the American Academy of Allergy Asthma & Immunology (AAAAI). Currently, these stations rely on manual laboratory counters to make accurate spore counts and maintain this data in Excel format with very limited functionality. In this project, we developed a database and its related software application (SporeCount) to replace this tedious manual process with a reliable and feature packed software. The preliminary tests of SporeCount are being made in the Enclosure of Medical Sciences of the University of Puerto Rico. The present process of count and reports of spores lasts approximated of 6 hours and has 4 years of use. The times obtained with SporeCount during the first week of tests reflect a time average of 2,5 hours; one hopes that with greater time of use of the tool the users acquire better skills and the time can even be diminished.

**Keywords:** Aerobiology, middleware, spores.

## 1. INTRODUCTION

Contrary to temperate zones, in which numerous studies have been carried out and where spore and pollen calendars already exist, the concentration of spores and pollen in the atmosphere of the tropics has not been totally described (Tan et al. 1992). It has been found that the dynamism of spores and pollen changes, according to multiple factors, such as geographic position of the country in which the study is performed, atmospheric contamination, the climate, and numerous other intrinsic factors (Horner et al 1995; Levetin and Horner 2002; D'Amato and Spieksma, 1995). In temperate regions, summer and fall are the seasons with the highest concentration of spores in the atmosphere due to the presence of high amounts of organic substrates, important for decomposing organisms such as fungi (Levetin and Van der Water 2001). In contrast in tropical region that fungal

particulate is present throughout the year at high or very high concentrations. For this issue is required the use of tools to process data faster.

Aerobiology is a branch of biology that studies organic particles, such as bacteria, fungal spores, very small insects and pollen, which are passively transported by the air (Comtois et al., 1999).One of the main fields of aerobiology has traditionally been to measure and report quantities of airborne pollen and fungal spores as a service to allergy sufferers (Sterling et al., 1999). A problem has been identified in the process of recording and reporting daily spore counts, as such that is stated as follows: in the day to day management of pollen and fungal spores counts from aerobiological samples of national networks, only a small portion (usually from 12 to 15%) of the daily microscope slide is read. It is generally believed that, otherwise, too much time will be spent reading slides for a minimal increase in precision (Larson, 1993). The previous statement is based on an average. And this problem is further worsened by the fact that a study conducted states that while the twelve transverse traverse method gave slightly better approximations of the spore concentration, the increase in accuracy may not justify the extra effort required to analyze with this method (Spieksma, 1991). These problems give rise to the need for a faster method of reading and storing these counts such as to have more accurate and easier readings.

The aim is to enhance and facilitate the recording and reporting of fungal spores and pollens by means of useful and intelligent features such as: 1. Automated arrangement of spore counts into excel sheet tables by hour and by spore type, utilizing specific letter and number keys of a computer keyboard to identify different spore types. 2. Automated database acting simultaneously with Excel sheet creation. 3. Ability to retrieve, view and manipulate spore information utilizing any characteristic such as; spore size, type or count, date recorded and retrieves certain key database entries important for research. 4. Ability to generate different graphical representations of the data instantaneously. 5. Ability to store and reference images directly linked to each spore type with easy access to these entries later.

In Puerto Rico, respiratory conditions constitute an important public health problem by affecting 33.3% of the children attending school, and from this percentage 51.3% receive treatment (Perez Perdomo et al. 2003; Lara et al 2003). Recognition of the influence of environmental factors in the concentration and dispersal of biological particulates, the use of appropriate air sampler to quantify the density and diversity of the bioallergens in the atmosphere and the use of prototypes computationally for process fast of information aerobiological constitute effective means to design preventive programs, that in the short or long term, will aid in the prevention or control of respiratory conditions caused by the aeroallergens in the air (Ivey et al 2003).

## 2. METHODS

The air sampler (Burkard ® Air Sampler) and equipment measuring weather factors (Precision Weather Station®) were located on the roof of the main building (30 meters above ground level) of the Medical Sciences Campus of the University of Puerto Rico, in San Juan.

To collect spores and pollen, every morning a microscope slide covered with silicone grease was placed in the Burkard and replaced every 24 hours. After a day of sampling, the slide had 12 traces (one impact taken every 2 hours during a 24 hour period) that were stained with calcofluor Fungi Fluor TM kit (Polysciences, Inc). The stained slide was analyzed with the NIKON ECLIPSE 80 fluorescence microscope under 60X (C-FL UV-2 E/C DAPI TE 2000 fluorescence filter cube) to quantify total fungal spores and pollens and differentiate them into their corresponding group or genera. Each day the weather conditions were monitored for the following factors: rain, wind direction and speed, wind gusts, dew point, temperature and the percentage of relative humidity.

SporeCount is a tool for counting spores from the air. Built under the concept of relational data bases, the design used for Microsoft Access 2007 (Cary et al 2003). Entity Model - Relationship of the database to take into account attributes such as date and time of the count, spore type, size and quantity (Baron et al 2008). Other factors such as temperature, relative humidity, wind speed, precipitation and dew point are part of the database and analyzed to determine the effect of environmental conditions on the concentration or dispersal of fungal particles in the atmosphere.

The end-user application was made in Visual Basic 2008 (VB) for the counting of spores, shooting (automatic creation of metadata), search parameterized images of spores, and creation of statistical reports in Excel sheets that allow laboratory personnel to create additional reports as needed (Green et al 2007; Guy 2005).

The software's first function is to take a string of keys generated by the user where each represented a spore type and automatically scan the string for keys and assign the values to a table which is stored in excel.xls format. The second function is to be able to allow access through the program to access these tables and to modify them as needed although alternately it is possible to manually change the values by accessing the tables from the operating system and simply changing them. The third function is to be able to generate charts; this is to be done by storing key values in an access database and then later retrieving these and graphing them with visual basic. The fourth and final function is to store images and retrieve them later through the program.

The program is relatively new and was started in February 2008 so it is still in its prototype beta version and customized to work with the current system that is used in Puerto Rico and is not a generalized system as it is still in its infancy. But I have seen the need in not only Puerto Rico but in other places as well for a system like this and decided to demonstrate the progress as of now to create awareness of the software that is to come.

Software provides us with many key features such as: providing feedback instantaneously without wasting time manually having to insert certain values to generate a graph in a separate application, minimizing human errors (partially because we cannot avoid an error in spore identification among other things) by placing the values automatically in the correct table spaces, minimizing time and effort of manually placing values from hardware counters into computer tables among other things. Software is also cost effective and can be easily upgraded to fit certain needs.

## 3. STRUCTURE OF SPORECOUNT TOOL

Figure 1 shows the actual process of spore counting.(a) Burkand equipment special collector of air samples, inside this equipment there is installed a crystal laminate which is impregnated with silicon where it will remain for 24 hours and is impacted with the twelve 2 hour impacts.(b) impacted crystal laminate(c) preparation of the laminate with co flour, list to mount in the microscope;(d)spore viewed through a 100 magnification lens(e)count process of each spore, that are temporarily registered in a temporary mechanical device called a piano;(f) transfer of the registered data from the piano to the computer in an excel sheet;(g) spore images are taken according to specific criteria by an expert, that is observing through the microscope; up to this point the process is repeated twice(h) report generation, using Minitab and lastly results are published in the AAAAI.

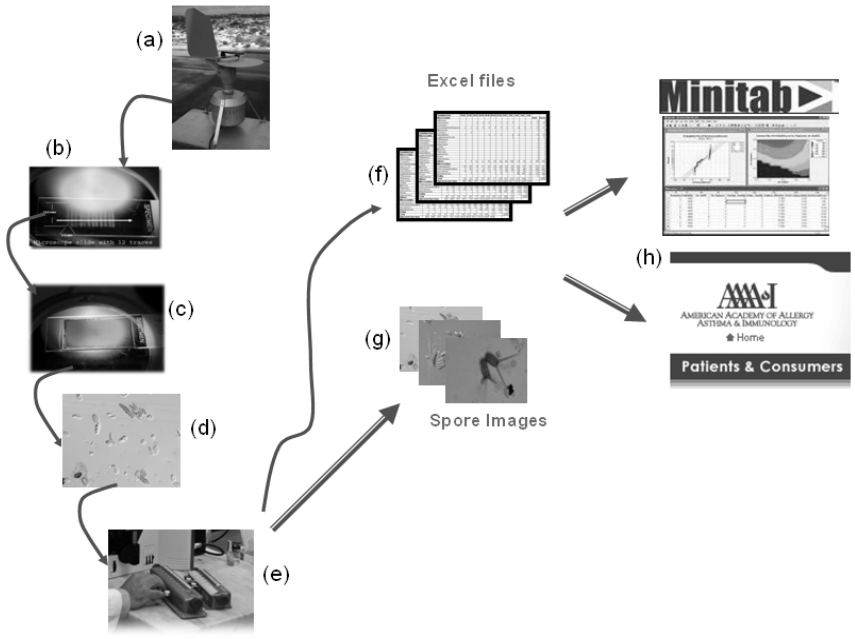


**Figure 1: Present process to count spores**

This process has duration of approximately 6 hours with a high rate of errors during the transfer of data. A solution to this problem is SporeCount.

The figure 2 shows the new automatic process to count spores. The procedure that is followed from (a) to(d) showed in figure 1 are the same.(e)process of counting each of the spores, are registered directly to a database of spores, utilizing the own computer keyboard;(f) are the databases that register the information of the spores and the images that the expert wants to take according to their own criteria, these images are directly related to the day, hour, form and type;(g)distinct reports can be generated, from the database .

SporeCount is a tool that contemplates in its design rules of usability such as the norms of HCI – Human Computer Interface, that make this an easily installable tools and easy to use. SporeCount is a toll created to count organism, understanding to be organisms anything susceptible to be counted such as: spores in the air, blood cells, people, trees, etc. The test with SporeCount tool was made with spores of air.

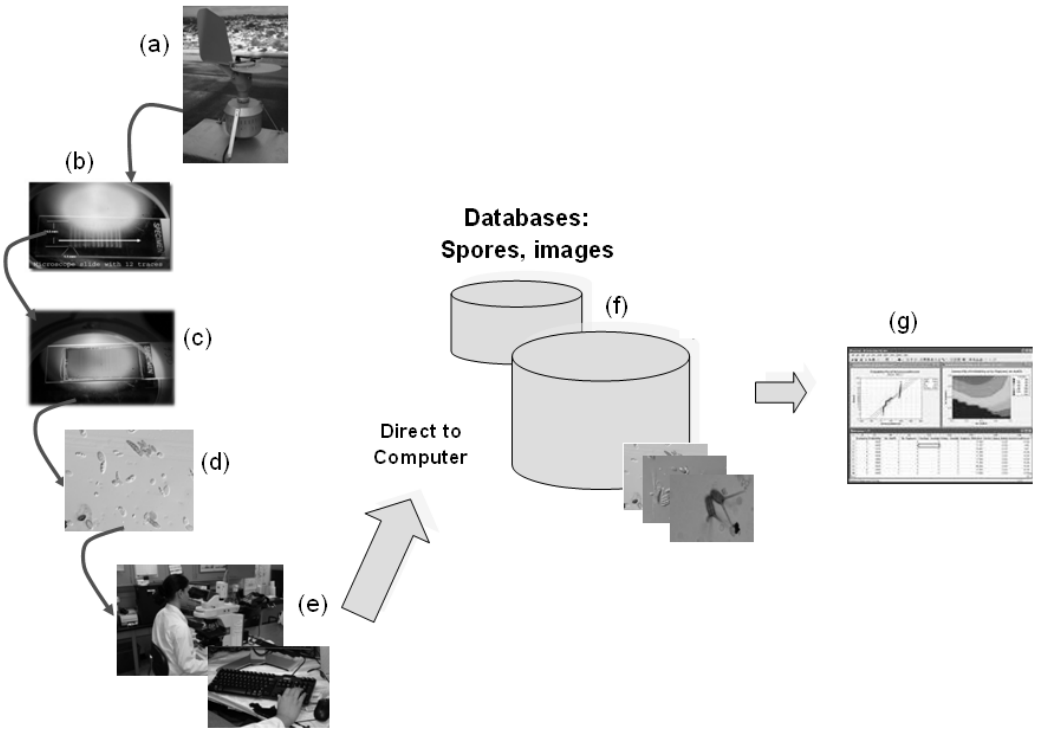


**Figure 2: Automated process to count spores of air**

The figure 3 shows with more detail the steps from (e) to (g) previous. It's important to outline here that the database of images is created utilizing the metadata of each image taken; these are organized in forms automatically by SporeCount, permitting easy and fast access afterwards.

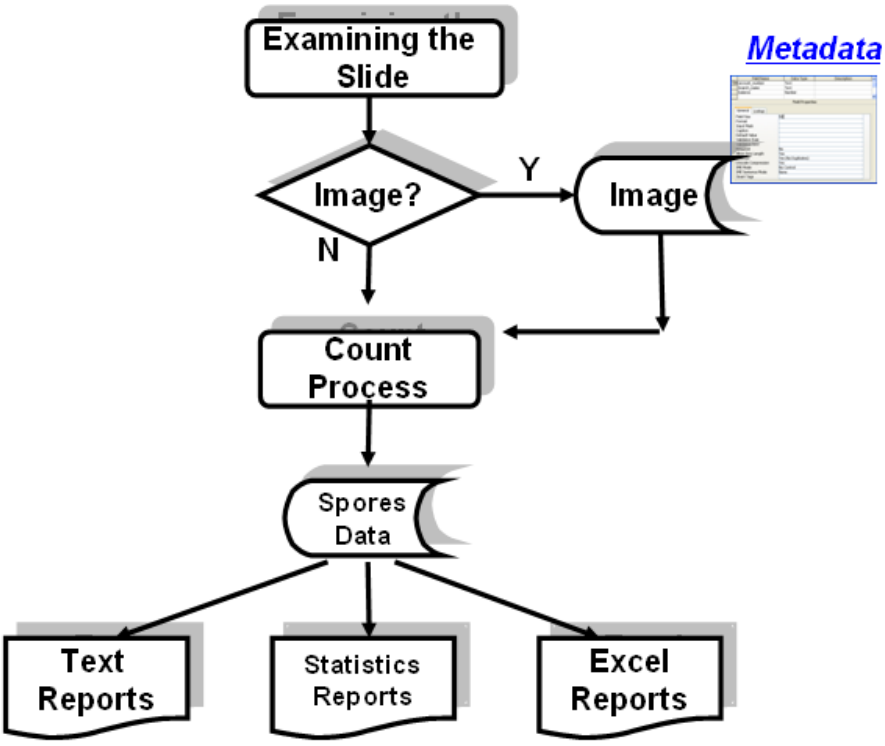


**Figure 3: Scheme logical-general of SporeCount**

SporeCount is designed in Visual Basic as a main programming language and the database are created and manipulated with Microsoft Access (Seyed et al 2006). In the following we make a description of each of the screen contained in the software: This first window (figure 4) permits the entry to the application. As can be seen it allows the creation of a user account to login to the software. After the user successfully creates the user account and logs in we move in to the main application window.

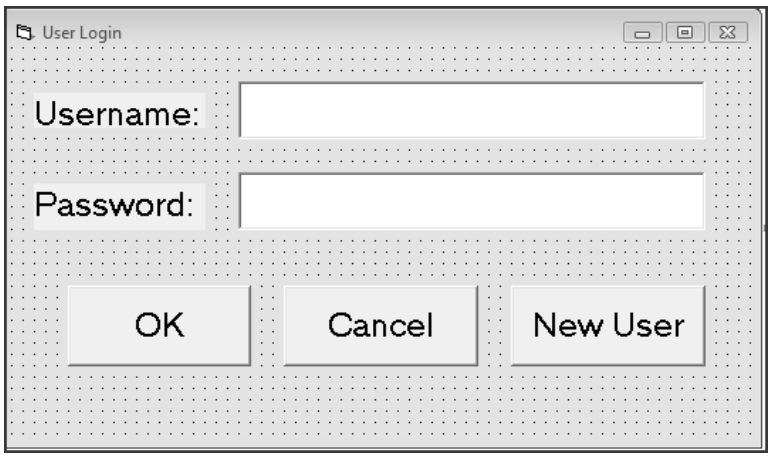


**Figure 4: Window of access to the application**

The figure 5 shows the main menu of the application, it contains five options: data input, data retrieval, graphic viewing, image finder and exit.

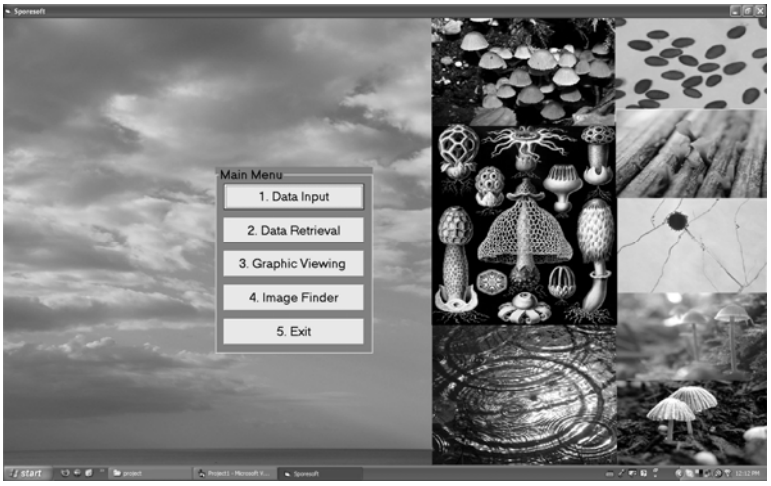


**Figure 5: Main screen of SporeCount**

Figure 6 shows how the data entry is performed; the lists at each side are the names of the spores, with their respective corresponding keys, the date is placed in the right upper hand box, the time of reading and we proceed to count; each time a trace is finished the information is transmitted to the database and the application automatically sets the following hour and proceeds to the following trace. The laminate has a total of twelve traces that's made by the Burkand instrument every 2 hours.


**Figure 6: Screen of Data Entry (Spores)**

The figure 7 is the second option of menu and allows to the users the graphical representation of the data of the spores. It can be done by size, forms, date and type of spores; besides to show the graph, the application shows in the right inferior part in the picture of "DATA" the information corresponding to the selections done by the user.

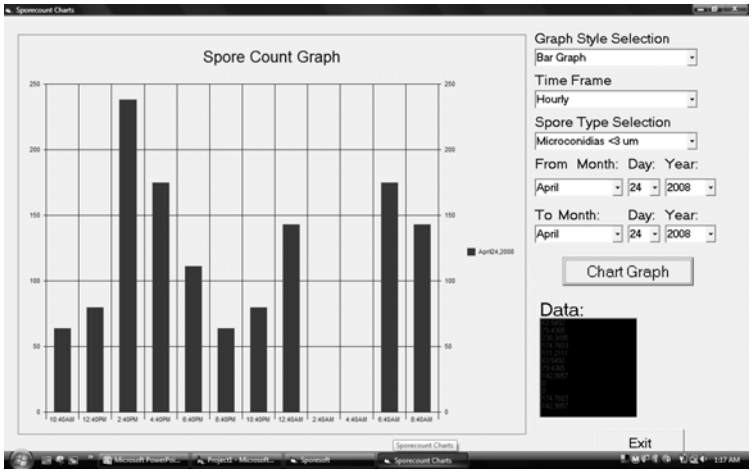


**Figure 7: Graphical representation of the data of spores**

The figure 8 is the third option of menu, this allows to load an image of spores according to the necessities of the users, just as in the previous case, these can be visualized entering the name of cases out that it contains the wished image.

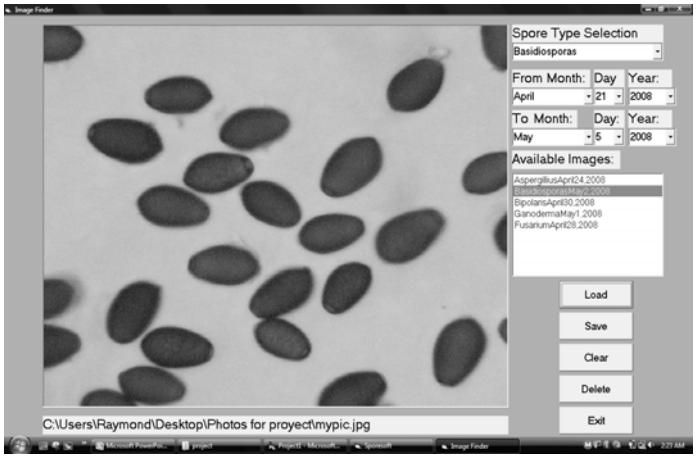


**Figure 8: Image Loading Form**

The figure 9 is option four of menu and allows to make searches of images by size, forms, date and type of spores, this option can return one or more images than are shown one by one the users.

**Figure 9: Search of images in the data base**

## 5. COMPARISON - RESULTS

The current technologies used in the present day to count spores are extremely costly and somewhat outdated. Feature wise the only process they do is to keep count of how many times each key was pressed. The software will accomplish this same task but the availability of more keys since the software will use the computer keyboard it can have a possible 255 corresponding keys. Also the software will have the enhanced functionality of automatically tabulating the data in excel format under the current date as the title, easy retrieval of key data critical for research, graphing spore counts as desired, and storing and accessing images.

The preliminary tests of SporeCount are being made in the Enclosure of Medical Sciences of the University of Puerto Rico. The present process of count and reports of spores lasts approximated of 6 hours and has 4 years of use. The times obtained with SporeCount during the first week of tests reflect a time average of 2,5 hours; one hopes that with greater time of use of the tool the users acquire better skills and the time can even be diminished.

## 5. FUTURE WORK

SporeCount es una herramienta versátil y se espera en un futuro implementar lo siguiente:

- To make a version of SporeCount in Java
- To create a version of SporeCount that can be installed in portable equipment that allows to make this type of work of field in-situ.

## 6. CONCLUSIONS

Reduction of the time of count in preliminary tests in more of a 50%, additionally the trustworthiness degree is greater with respect to the present process since the information goes directly to the data bases, avoiding this way the double transcription of the information.

SporeCount, is not only useful in the count of spores of air made in mycology laboratories, if not in another type of works or laboratories such as clinical laboratories, alive specimen studies, inventories, taxonomy studies, between many others.

The software is the optimal solution to facilitating the research process involving spore and pollen counting. It will speed up and enhance feedback from this process and allow for more profound research to be done in much less time and will improve visual viewing by charts.

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