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Data fusion of drought and disease effect on crops

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Abstract
The process of integration of multiple data and knowledge representing the same real-world object into a consistent, accurate, and useful representation is known as data fusion. In a world where drought and disease has being a major setback in the agricultural sector both in mechanized and non-mechanized farming, it is necessary to have a method of detecting the degree of the adverse effect these will have on crop yield, as it will help in the quality of decision that will be made to aid production. The data fusion software is an application that can gather and collate information from multiple platforms delivering a more comprehensive view of intelligence than from a single source. The purpose of this research is to enable users' input detailed analyses of infested and drought affected crop for comprehensive report which can be used for decision making. This work was designed to be robust as it has the ability to show information about each crop being observed, display pictures of good and affected crop, botanical names of each crop, the effect of drought and disease on each of the crop and show the fusion of the effect of drought and disease on the crop.

1. Introduction

With more and more information sources available via inexpensive network connections, either over the Internet or in company intranets, the desire to access all these sources through a consistent interface has been the driving force behind much research in the field of information integration. During the last three decades many systems that try to accomplish this goal have been developed, with varying degrees of success. One of the advantages of information integration systems is that the user of such a system obtains a complete yet concise overview of all existing data without needing to access all data sources separately: complete because no object is forgotten in the result; concise because no object is represented twice and the data presented to the user is without contradiction. The latter is difficult because information about entities is stored in more than one source.

After major technical problems of connecting different data sources on different machines are solved, the biggest challenge remains: overcoming the effect of the same information being stored in different ways. The main problems are the detection of equivalent schema elements in different sources (schema matching) and the detection of equivalent object descriptions (duplicate detection) in different sources to integrate data into one single and consistent representation.

However, the problem of actually integrating or fusing, the data and coping with the existing data inconsistencies is often ignored. With this survey, data fusion was introduced to integrate data (information) gotten from various sources to produce a complete and concise data.

Data fusion processes are often categorized as low, intermediate, or high, depending on the processing stage at which fusion takes place. Low level data fusion combines several sources of raw data to produce new raw data. The expectation is that fused data is more informative than synthetic than the original inputs. Techniques to combine or fuse data are drawn from a diverse set of more traditional disciplines including: digital signal processing, statistical estimation, control theory, artificial intelligence, and classic numerical methods.

In principle, fusion of multisensory data provides significant advantages over single source data. In addition to the statistical advantage gained by combining same-source data (e.g., obtaining an improved estimate of a physical phenomenon via redundant observations), the use of multiple types of sensors may increase the accuracy with which a quantity can be observed and characterized. The most fundamental characterization of data fusion involves a hierarchical transformation between observed energy or parameters (provided by multiple sources as input) and a decision or inference (produced by fusion estimation and/or inference processes) regarding the location, characteristics, and identity of an entity, and an interpretation of the observed entity in the context of a surrounding environment and relationships to other entities.

Qualitative advantages of data fusion have been cited by numerous authors. Waltz, for example, cites the following benefits for tactical military systems; robust operational performance, extended spatial coverage, extended temporal coverage, increased confidence (i.e., of target location and identity), reduced ambiguity, improved target detection, enhanced spatial resolution, improved system reliability, and increased dimensionality. Waltz performed Monte Carlo numerical studies to show the quantitative utility of data fusion for improved non cooperative target recognition, leading to advantages in tactical air-to-air engagements. In fusing data from different sources into one consistent representation, we distinguish between and apply different high-level strategies. Bleiholder and Neumann [2006] describe and classify such strategies which would be extensively discussed later in chapter two. The different classes of this classification can be seen as defining different data fusion semantics. Conflict-ignoring strategies do not make a decision as to what to do with conflicting data and sometimes are not even aware of data conflicts.

2. Brief History of Data Fusion

Data fusion is a technique that combines data from multiple sensors and related information from associated databases, in order to achieve improved accuracy and to make better inferences than could be achieved by the use of a single sensor or dataset alone. Therefore, the emergence of new sensors advanced processing techniques and hardware would make fusion more effective. While the coverage of methodological areas of data fusion systems includes artificial intelligence, pattern recognition, and statistical inference, application areas of data fusion are wide spread.

One of the historical barriers to technology transfer in data fusion has been the lack of a unifying terminology, which crosses application-specific boundaries. Even within military applications, related but different applications such as IFF systems, battlefield surveillance, and automatic target recognition, have used different definitions for fundamental terms such as correlation and data fusion. In order to improve communications among military researchers and system developers, the Joint Directors of Laboratories (JDL) Data Fusion Working Group, established in 1986, began an effort to codify the terminology related to data fusion. The result of that effort was the creation of a process model for data fusion, and a Data Fusion Lexicon (DFL). The JDL process model is a functionally oriented model of data fusion and is intended to be very general and useful across multiple applications areas. Data fusion technology has rapidly advanced from a loose collection of related techniques, to an emerging true engineering discipline with standardized terminology, collections of robust mathematical techniques, and established system design principles. Software in the area of data fusion applications is becoming available in the commercial marketplace.

3. Need for Data Fusion

Correct analysis and interpretation of data has woven itself into the integral part of decision making. The outcome of a large percentage of decisions made based on wrong information is not always instrumental to the problems being addressed. This is as a result of the defective system being employed when it comes to data analyses, interpretation, comparison and even presentation.

4. Understanding and Defining Drought

Drought is a normal, recurrent feature of climate, although many people enormously consider it as a rare and random event. It comes in virtually all-climatic zones, but its characteristic varies significantly from one region to another. Drought is a temporary aberration: it differs from aridity which is restricted to low rainfall regions and is a permanent feature of climate.

Drought should not be viewed as marching a physical phenomenon or natural event. Its impacts on society result from the interplay between natural event (less precipitation than expected resulting from natural climatic variability and the demand people place on water supply). Human beings often exacerbate the impact of drought. Recent drought in both developing and developed countries and the resulting environmental impacts and personal hardships have underscored the vulnerability of all societies to this ‘natural hazard’.

Thornwaithe (1947) considered drought as a period of dryness i.e., want of rain or water especially such dryness of water as affecting the earth and preventing the growth of plants. Based on the water budget approach, drought is defined as a condition when the amount of water needed for transpiration and direct evaporation exceeds the amount available in the soil.

Drought under farming situation can be classified into

- Early season drought associated with late commencement of sowing rains.
- Mid-season drought associated with the failure of rains during the growing season.
- Late season drought due to early cessation of rainy season.
- Permanent drought as a result of mismatches of the rainfall and water availability to the crops.

Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficit, reduced ground water off reservoir levels and so forth. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, and its state of growth and the physical and biological properties of the soil. A good definition of agricultural drought should be able to account for the variable susceptibility of crops during different stages of crop development, from emergence to maturity. Deficient top soil moisture at planting may hinder germination, leading to low plant populations per hectare and a reduction of final yield.

4.1. Effect of Drought

Drought can have serious health, social, economic and political impacts with far-reaching consequences. Water is one of the most essential commodities for human survival, second to breathable air. So when there is a drought, which by definition means having too little water to meet current demands, conditions can become difficult or dangerous very quickly.

The consequences of drought may include:

Hunger and famine: Drought conditions often provide too little water to support food crops, through either natural precipitation or irrigation using reserve water supplies. The same problem affects grass and grain used to feed livestock and poultry. When drought undermines or destroys food sources, people go hungry. When the drought is sever and continues over a long period, famine may occur.

Thirst: All living things must have water to survive. People can live for weeks without food, but only a few days without water.

Wildfire: The low moisture and precipitation that often characterize droughts can quickly create hazardous conditions in forests and across range lands, setting the stage for wildfires that may cause injuries or deaths as well as extensive damage to property and already shrinking food supplies.

5. Understanding and Defining Disease

Disease is a normal part of nature and is one of many ecological factors that help keep the hundreds of living plants and animals in balance with one another. When the plant is suffering i.e., not developing and functioning in the manner it is expected, it is called diseased. However, this does not mean define the term ‘disease’. Often, the symptom produced by a disease, the cause of disease and the injuries caused to the plant have been considered synonymous. However, they signify only the condition of the plant due to disease or the cause of the disease.

In 1858, Julius Kuhn, in German had defined plant disease as abnormal changes in physiological processes which disturbs the normal activity of crop organs. H.M. Ward in 1896 defines disease as a condition in which the functions of the organism are improperly discharged or in other words, it is a state which is physiological abnormal and threatens the life of the being or organ.

The malfunctioning processes due to inroads of a foreign factor or due to some other biotic cause should make the plant abnormal in the sense that it is losing its economic value. If there is some malfunctioning or abnormality, even if caused by some biotic or abiotic factor which does not cause loss of economic value or enhance the beauty or value of the plant it should be called disease.

5.1. History of Crop Disease

The late blight of potato, a disease caused by the fungus *physophtora infestans* a famous example of what a plant disease can do to change the course of history. In 1845, this disease destroyed the potato crop of Ireland where potato constituted the staple diet of the majority in rural areas. When the late blight epidemic destroyed the potato crop in 1845 there was famine in Ireland. The demographic data are highly variable (of Hampson, 1992 but it was reported that in1840 the population of Ireland was 8million which was reduced to 4million). As a result investigation was taken up, the cause of disease was identified, and concept for crop disease control came into existence. The late blight epidemic not only brought the science of plant pathology to limelight, it caused many social and political changes in the affected countries.

In addition to direct loss in yields and monetary returns to the farmer, the plant disease affects the society in many other ways. Crop disease management requires use of toxic chemicals excessive use of such chemicals may lead to environmental pollution affecting human health.

5.2. Causes of Crop Disease

A pathogen is always associated with a disease. The word 'pathogen' can be broadly defined as any agent or factor that incites 'paths' or disease in an organism. Thus, in strict sense the pathogens do not necessarily belong to living or animate groups. They may be non-living (inanimate) or in between the living and non-living (such as viruses and viroid). The plant pathogens are thus, grouped under the following categories;

- Abiotic factors: These include mainly the deficiencies or excesses of nutrients, light moisture, aeration, abnormalities in soil conditions, atmospheric impurities, etc. Example of disease caused by abiotic factors are mango tip rot, or fruit necrosis, 'kharia' disease of rice hollow and black heart of potato, nutrient deficiency symptoms in various crops.
- Mesobiotic factors: these are diseases incidents' which are neither living nor non-living. They are considered to be threshold of life.

1 Viroids are naked infectious strands of nucleic acid, spindle tuber of potato, citrus exocortic and tomato bunchy top are some of the example.

2 Viruses are infectious made up of one type of nucleic acid (RNA or DNA) enclosed in a protein coat. Examples of virus disease of plants are leaf roll of potato, leaf curl of tomato and chilli, mosaic disease of numerous crops.

- Biotic causes: this category includes diseases caused by animate or living or cellular organisms.

6. Data Analysis and Results

6.1. Data Analysis of Cassava

The effect of cassava green mites(CGM) on young plant with little accumulated biomass, only moderate growth rates during the dry season was difficult to separate from drought stress. An interaction between CGM and planting date was evident in the amount of biomass lost.

6.2. Data Analysis of Maize

Drought is one of the most important factors limiting maize production in Africa. It can severely reduce maize yield in the guinea savannah or drier Sudan savannah, drought can lead to the loss of the entire crop. Eldana saccharina walker, a post flowing pest of maize occurs in all countries of sub-saharan African. Eldana is the dominal stem borer at the time of maize harvest. Yield is reduced through direct damage to the ears and through the reduction in the translocation of nutrients, in addition the stalk is weakened and becomes more susceptible to lodging. Test was carried out by scientist to determine the degree of damage drought can cause to the maize crop.

Table 1. *Data Analysis of the Effect of Disease and Drought on Cassava*

Tolerance Rating against Planting date		
	Tolerance rating	
Date	Drought	Disease
April	26.5	29.3
July	47.1	50.3
Oct	23.1	46.4
April	23.6	16.6
July	30.8	46.6
Oct	11.4	48.9
	Drought and disease	
	Leaves	
Planting Date	End of Dry Season	100 days After Dry Season
April	26.5	29.3
July	47.1	50.3
Oct	23.1	46.4
	STEMS	
Planting Date	End of Dry Season	100 days After Dry Season
April	23.6	16.6
July	30.8	46.6
Oct	11.4	48.9
	TUBERS	
Planting Date	End of Dry Season	100 days After Dry Season
April	10.5	24.5
July	32.9	45.3
Oct	9.3	41.4

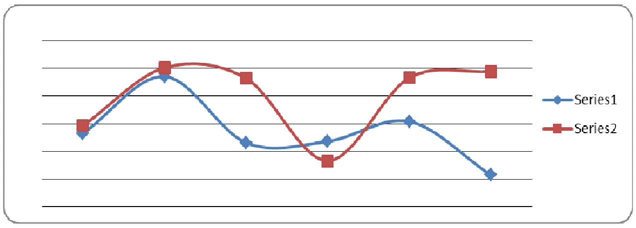

Figure 1. *(Graph of Analysis of the Effect of Diseases and Drought on Casava)*

Table 2. *Data Analysis of the Effect of Disease and Drought on Maize*

Maize		
Tolerance Rating against Variety		
	Tolerance rating	
Variety	**Drought**	**Disease**
KU 1414	1.7	2.6
9499	2.2	3.7
5012	2.1	2.9
5057	3.7	8.3
ANT-C-55	3.9	36.5
MC 2010	3.8	16.1

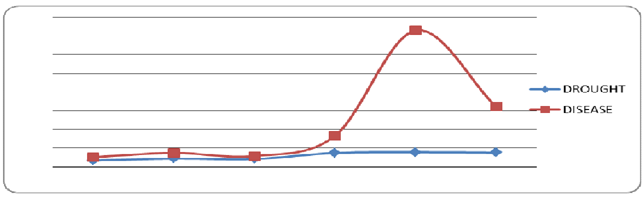

Figure 2. *(Graph of Analysis of the Effect of Diseases and Drought on Maize)*

7. Summary and Conclusion

It is clear that a lot of financial advantages are associated with the use of data fusion and these includes reduced cost driven by less duplication of efforts, future protection against costly integration project enabled through the incremental inclusion of system data sources with no requirement for coding etc.

In a new decade, with increased technology available to agricultural centre and a new perspective on how to implement data fusion application that would meet the requirements of Agricultural Society of Nigeria, it is appropriate to begin investigating how valuable tool like Data Fusion might be used to meet the demands of the next generation of agricultural research.

The purpose of data fusion with respect to this research is to get a holistic view of the fusion of two or more analyzed data type of infested crop so as to enhance quality decision making. Data fusion is to simplify the process of comparing different analyzed results by just entering the sets of data from the interface and the fused result is generated in form of a graph.

8. Recommendations

In a new millennium, with increased technology available to agricultural centre and a new perspective on how to implement data fusion that would meet the requirements of Agricultural Society of Nigeria. It is appropriate to begin investigating how a valuable tool like Data Fusion might be used to meet the demands of the next generation in agricultural research.

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