Emerging Technologies for Irrigation District Management and Rehabilitation Planning

Yanbo Huang, David Flahive, Guy Fipps
Biological and Agricultural Engineering Department, Texas A&M University, College Station, TX 77843-2117

Improved Prototype of Irrigation Distribution Network Model (IDNM)

The original prototype model (Huang and Fipps, 2003) has been further improved in order to better support district management, rehabilitation planning and decision making in irrigation districts.

The new prototype model has following features:

• Modular and recursive algorithms C++ coded with object-oriented programming

• Simulate flows (discharge and depth) along irrigation distribution networks by automatically following the topology of networks

• Handle different types of irrigation network together such as lined/unlined canals, reservoirs and resacas, and pipelines and siphons along mains, laterals and farm takeouts

• Consider water losses in seepage and evaporation

• Able to "plug in" in-line structures, such as gates, weirs, flumes, etc.

• GIS compatibility

Figure 1 shows the flow chart of the calculation structure of the new prototype model. Currently the model mainly handles subcritical flows, so the calculation direction is from downstream to upstream.

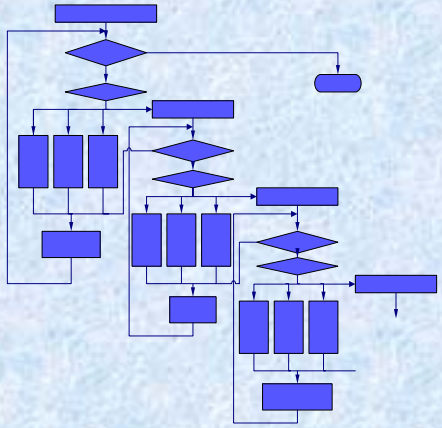

Figure 1.

Model Verification

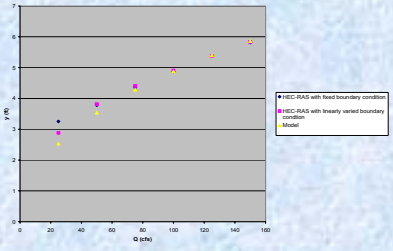

Figure 2.

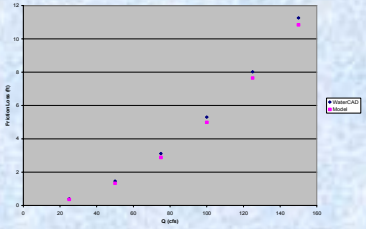

Figure 3.

The IDNM was used for the analysis in the Municipal Water Supply Network (MSN) of fourteen (14) districts in the LRGV. The model accurately calculated the water volumes over the network with seepage and evaporative losses.

The IDNM was also used to model the MSN of HCID #16. The results were compared to HEC-RAS (for open channel) and WaterCAD (for pipeline).

In figure 2 good agreement is seen between the IDNM and HEC-RAS for open-channel calculations. The slight differences shown are due to how the downstream boundary condition is handled in HEC-RAS, while the IDNM better handles such issues.

Figure 3 shows good agreement between IDNM and WaterCAD for the pipeline friction loss calculations.

The new IDNM is able to automatically handle different network topology and irrigation networks and simulate water flow in irrigation distribution networks accurately in practice and compared with commercially available software, the model has the advantage of solving problems in irrigation networks.

The IDNM is being further refined in order to answer questions in district management, rehabilitation planning and decision making. A GIS interface will be developed to allow users to schematize the system, organize the data, run the model and visualize the results.

Remote Sensing for Detection of Canal Leaks

Traditional field survey methods for detection of water leaks in irrigation systems are costly and time consuming. Airborne remote sensing has shown great promise as a quick and cost-effective remote sensing method of determining location of leaks in open channel and underground pipelines. Last year thermal imaging remote sensing was studied (Huang el al., 2003). A color image processing scheme was developed to help visualize the ground surface temperature difference on the basis of conventional grey-scale thermal images. With image analysis and field verification on a portion of the main canal of United Irrigation District, airborne thermal imagery was found to be able to identify leaks with a 91% success. This technology would have widespread application.

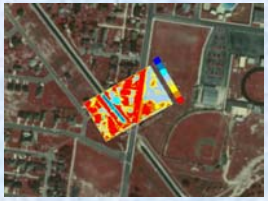

Figure 4.

Figure 5.

Figures 4 and 5 show a typical example of match between thermal image analysis and leak location. Now this technology is extending to multibands: thermal, near-infrared (NIR), and red. With the multiband sensor system the vegetation can be quantified and the shadow and the trees can be differentiated, which can significantly improve the detection.

A hyperspectral sensor is another consideration to enhance spectral analysis for canal leak detection.

Model Database System

With a few exceptions, the database systems in place at most of the irrigation district offices are long past needing replacement. The majority of these databases are file-based database systems which are not compatible with modern software.

These system limitations greatly effect the districts' ability to utilize the historic records that are contained in the databases. These historic records contain account information which will prove to very useful for future planning efforts as well as current management.

Proposed Solution

Upgrading the existing database systems to a modern database platform will allow the districts to utilize the historic information with modern software packages. The use of the database records through a GIS software could prove very valuable for real-time management and future planning.

Several database platforms have been considered and evaluated. Some of the issues which were addressed during the database evaluation are:

- What jobs is the database required to handle?
- What software does the database have to be compatible with?
- How easy is the database to manage? Can it be managed in-house?
- What operating system should database run on?
- How difficult will system upgrades be?

Recommendations are currently being made based on the best possible solution.

Future Considerations

Several software packages are in development currently based on the above mentioned recommendations. These package will most consist of GIS system plug-in type applications. However, a special water ordering system is in development as well as several web applications.

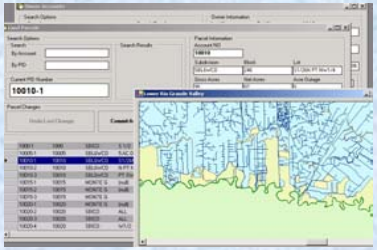

Figure 6.

Figure 6. is a screenshot of management application in development.

References

Y. Huang and G. Fipps. 2003. Modeling flows in irrigation distribution networks – model description and prototype. Paper No. 032146. ASAE, St. Joseph, MI.

Y. Huang, G. Fipps, and E. Leigh. 2003. Airborne thermal imaging remote sensing for leak detection of irrigation distribution networks. Biological and Agricultural Engineering Department, Texas A&M University