International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970)
Volume-4 Number-1 Issue-14 March-2014

A Sanitary Sewer Detection Simulation Model

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Abstract

This paper describes works performed to develop a simulation to support Sanitary Sewer Detection (SSD) studies. An SSD study aims at identifying infiltration and inflow (I/I) sources in a sanitary sewer system to plan and develop cost-effective system and maintenance activities. In order to operate this simulation, various algorithms have been included. When studying urban drainage systems using simulation techniques large amount of data are produced and are interpreted. Moreover when we build a computer simulation for a sewer system it is very difficult to eliminate data-errors.

Keywords

3D, ANDRIOD, DRAWING AREA, GIS, (I/I), SSD, VOLUME.

1. Introduction

GIS has been regarded and proven as an efficient and powerful tool in water distribution industry. This paper discusses the process for how the SSD evolved, not as a specific scope of service requirement, but as management decision toward making more effective design decisions.

Basically, this paper aims of identifying inflow and infiltration (I/I) which are two unwanted and potentially expensive visitors in any sewage system. Ground water infiltrates poorly constructed or aging pipes through pipe defects such as misangled joints, cracks, fractures and holes. [1] In wet weather, inflow enters pipes of all conditions through manhole covers, catch basins, and rain water connections. Once in the pipe, excess water must be transported to the plant, reducing the pipe's capacity to transport wastewater. However, this simulator is only a hypothetical approach of how Sanitary Sewer System will work in computer simulator.

Manuscript received March 12, 2014.
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If we will get any leakage in our pipes of computer simulated model it will be detected and holes will be highlighted in red colour. This highlighted red colour holes can be sent to the field crew member for maintenance work. This simulator offers a new potential to view sanitary sewer in an urban. The information produced as a part of SSD project will be provided to meet the objectives of the future GIS program.

2. SSD GIS Scope and Objective

SSD projects involve a large amount of data and an algorithm. Municipal officer can use this data to make decision related to sewer system maintenance. Effective visualization of the spatial characteristics of a sewer system is a key factor to provide municipal officer with more understanding and insight into such data. By embedding GIS in this SSD we can provide an idol to explore, analyse and visualize the characteristics of the sewer system. Potential of GIS to can support and improve decision-making process in SSD projects is very well recognize.

The software was implemented on the SSD field testing and inspection results of the sewer systems in the study area. The software was developed to provide a set of generic tools and functions that could support other SSD projects as well. The main objective of the SSD GIS can be summarized as follows:-

1. Capability to interactively and graphically access.
2. Capability to provide to print SSD report.

It should be noted that this project is an engineering analysis undertaken to address sewer system design issues, not specifically a 3D GIS project. [1] This project is a software simulation developed in java language. It must be mentioned that Sanitary Sewer Detection Using Android based 3D GIS was more theory than fact a time this project was initialized. At the outset of this software simulation, there was no stated objective to create a GIS and developing a GIS was not included in the original scope of the project. Initial goal of this paper was limited to the development of a software simulator to enable the

management of the SSD. It is also recognize that GIS would provide speed and accuracy for preparation of graphical displays of the SSD data.

3. Brief Literature Survey

This computer simulator model is basically made for Bilaspur district which is located in north-western part of Chhattisgarh state and fall within latitude 21º37" to 23º7" North and longitude 81º12" to 83º40" East, covering approximately 6377 sq. km. The district occupies upper basin of the Mahanadi and includes a large track of hilly country to the north. Bilaspur town is Headquarter of the district. Bilaspur district is situated on the banks of Arpa River which originates from the high hills of Maikal Range of central India.

Bilaspur city is experiencing growth with corresponding increase in economic and commercial activities. The already inadequate infrastructure is unable to bear the pressure of increased institutional and commercial activities. The population growth of Bilaspur district is strongly adding more pressure to the already grossly inadequate sewerage system. If no action is taken, this is likely to result in contamination of existing surface and underground source of water supply of Bilaspur district. For these reasons, it is imperative that an efficient and effective sewage collection, treatment and disposal system complimented by a good storm water drainage system be quickly installed to allow Bilaspur to meet the health and sanitation needs of the population and to prevent the lack of infrastructure from hampering economic growth. [2]

The main advantage of sewage system is to carry peak residential, commercial and industrial flow, including infiltration, where such condition exists. The computation of design flow is governed by rate of water supply in the project area. The norm for provision of water supply facilities in urban areas is given in table below:-

Table 1: Urban Water Supply Norm

S. No.	Classification of Towns/Cities	Recommended maximum water supply levels(LPC)
1	Town provided with piped water supply but without sewerage system	70
2	Cities provided with piped water supply where sewerage system is existing or contemplated	135
3	Mega cities provided with piped water supply where sewerage system is existing or contemplated	150

4. Problem Formulation

Copy Apart from the advantage of sewage system there is a lot of disadvantages also. [3] One of the major disadvantages is the overflow of sewerage system. Due to overflow of sewage in the sewerage system causes leakage in a system which required huge maintenance work in a system. And of course, it is very hard to find out the leakage in sewerage system. The sewerage system for Bilaspur is planned with four categories of sewers, namely:-[2]

1. Lateral sewers
2. Collector sewers
3. Sub-trunk
4. Trunk/ interceptor sewers

Bilaspur district is covered with area of 6377 sq. km. which is very hard to monitor it for the maintenance work which is caused by leakage problem. Suppose if there is an overflow problem in a sewerage system which causes leakage in a system. So how the municipal officer will detect this leakage where it has occurred. If we can't identify the position of leakage in a system it will be very hard to maintain this system and eventually cost will increase to maintain it. If this leakage problem can't be identify due to overflow will exert physical, chemical and biological effects on the receiving environment. This may result in human health problem, environment problem, which can be both acute and cumulative. [3] To solve this problem I have proposed a system through which we can detect this overflow which cause leakage in a system. It can be detected by a new system called Sanitary Sewer detection using Android based 3D GIS. But at a fact of time when project was initialized it was just a theory concept. So we have created this SSD software simulation model which is similar like a EPANET which is a computer program that perform extended period simulation of hydraulic and water quality behaviour within pressurized pipe networks. A network consists of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET is used for the hydraulic

analysis for water pipe [4]. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, and the concentration of a chemical species throughout the network during a simulation period comprised of multiple time steps. In addition to chemical species, water age and source tracing can also be simulated.

EPANET is designed to be a research tool for improving our understanding of the movement and fate of drinking water constituents within distribution systems. It can be used for many different kinds of applications in distribution systems analysis. Sampling program design, hydraulic model calibration, chlorine residual analysis,
And consumer exposure assessments are some examples. EPANET can help assess alternative management strategies for improving water quality throughout a system.

These can include:
-altering source utilization within multiple source systems,
-altering pumping and tank filling/emptying schedules,
-use of satellite treatment, such as re-chlorination at storage tanks [5].

But our SSD is just a hypothetical approach to enable to identifying the leakage problem in a sanitary system so that municipal officer can get the position of leakage area. And can do the maintenance work and can eventually decrease the cost of maintenance work of sanitary system. By using this SSD model one can analyse the reports also analyse the defects in the system in a way to prioritize those repairs that would have the most impact on reduction of leakage.

5. Flow-Chart of Working of Simulator

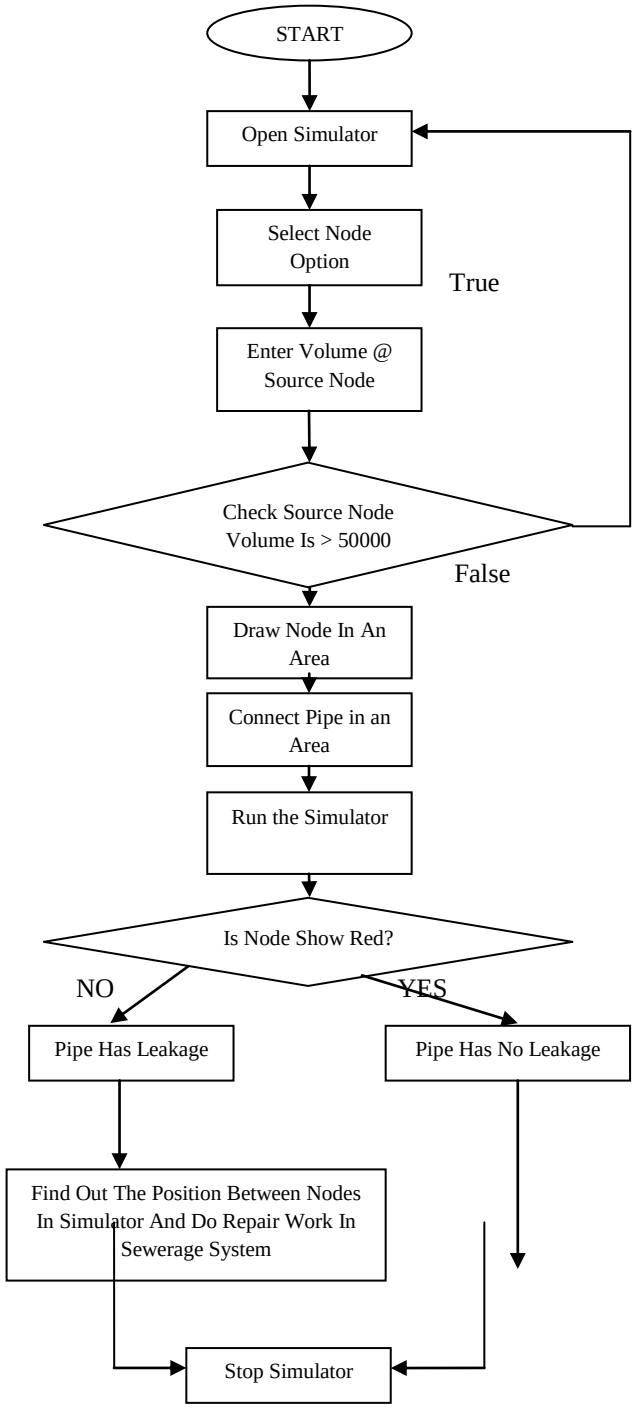

Figure 1: Flow Chart

6. Working of SSD Simulator

The name of simulation model is SSD (sanitary sewerage detection software simulation model). For this research work, several datasets are collected from Bilaspur Municipal Office which includes size of diameter of pipe, different types of sewers pipes. Actually what we have proposed in our research work is sanitary sewerage detection using android based 3d GIS and to demonstrate the working of my research work we have made a simulation model. The working of a simulation model is very complex one. In order to operate this simulation model we have included algorithm in our software simulation model which make working of this model very efficient. Below figure describes the model of simulator model.

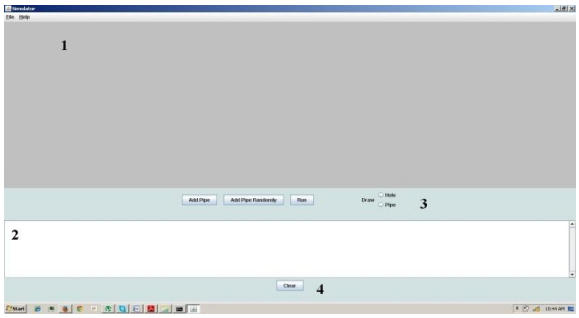

Figure 2: sanitary simulation model (SSD)

Our model is basically divided into 4 parts:

1. Drawing area
2. Result area
3. Control panel
4. Clear button

After opening the SSD simulation model we can describes working of model in various steps. And these steps are as follows:

Step 1: Select Hole option of control panel box.

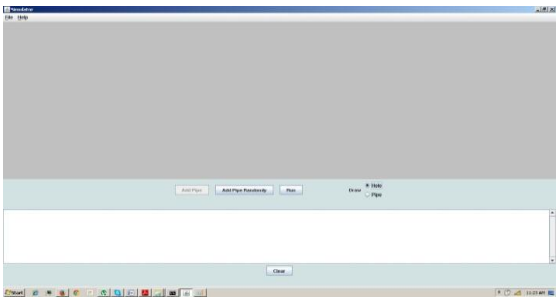

Figure 3: selecting hole in a control panel box

Step 2: After selecting hole option from control panel box draw the hole in drawing area of model. Just remember after putting the hole option in a drawing area, a dialogue box will appear for entering the value of volume in a source node. Remember that volume value should not exceed 5000, because pipe has maximum capacity of holding 5000 value. Initially we put 5000 in a source node point and the result will generate according to this given value.

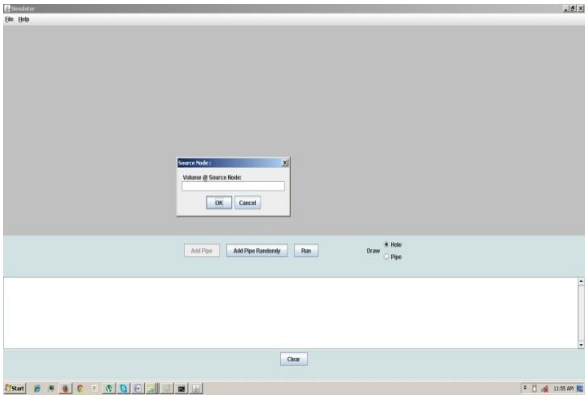

Figure 4: dialogue box of source node open for entering volume value in at source node.

Step 3: after entering the volume data in a source node dialogue box, put the mouse cursor in a drawing area. And draw the holes in a drawing area box of a model wherever you want.

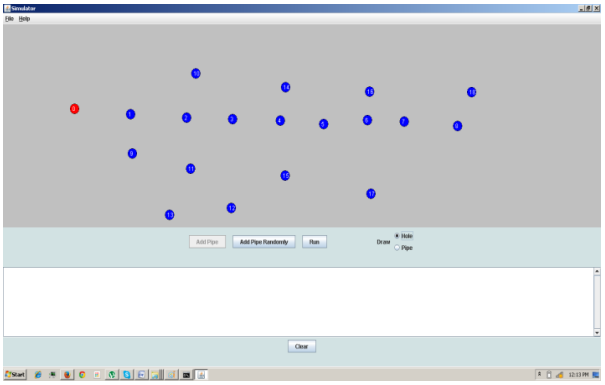

Figure 5: red circle describes the source node and blue circle describes the manholes

Step 4: after adding the holes in a drawing area, draw the pipes to connect all the holes. We have two options to connect all the holes, first is to connect with manual and second one is to connect with random order.

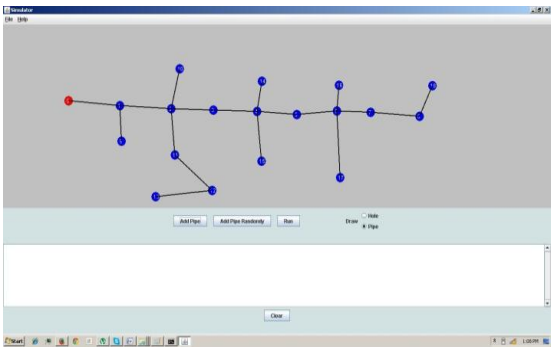

Figure 6: added pipes in a drawing area

Step 5: after adding the pipes to connect the holes in a drawing area, click the run button in control panel. After clicking the run button result will display in result area and a dialogue box will appear describing where the leakage has occurred. And the circle will highlight in red colour.

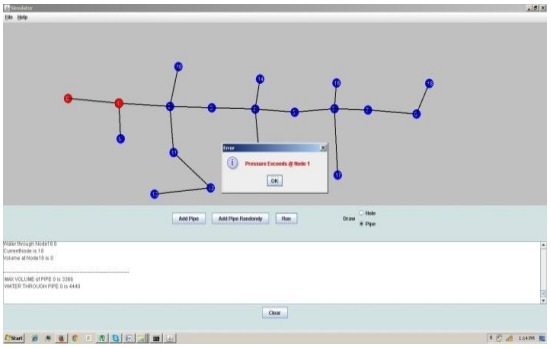

Figure 7: result of simulator model describing the leakage position (circle is highlighted in red color where the leakage has occurred)

Step 6: final result of the simulator model

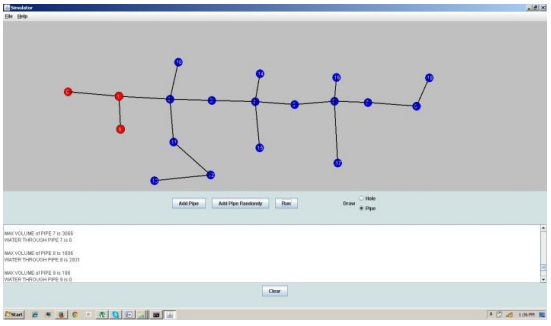

Figure 8: final result describing that where the error has occurred

Step 7: result will be displayed in result area.

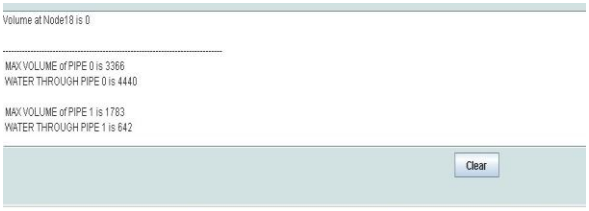

Figure 9: data generated in result area to analyse

7. Result

In the above figure 9, the PIPE 0 and PIPE 1is appearing which indicates that in PIPE 0 and PIIPE 1 has an error and leakage is occurred in this particular pipe. The maximum volume of pipe 0 is 3366 cu. Mt. but after the execution of simulator volume of water through pipe 0 is 4440 cu. Mt. which indicates that at pipe 0 overflows occur. Alternatively, in the drawing area pipe 0 will blink in red colour mark and this result can be given to the field crew member.

8. Conclusion

The SSD software simulation model is similar like EPANET software but this EPANET models the hydraulic and water quality behaviour of water distribution piping systems and SSD is to find out the leakage in sewerage system.[6] SSD has proved to be useful tool for detecting the leakage position in a sewerage system, retrieving and displaying SSD information. The development of the android based 3D GIS was targeted toward the goal of making more informed decisions by taking advantage of spatial and analysis of the field collected data. Prior to android based 3D GIS, manipulation of large amounts of varied but related data this was a long and tedious work. The physical management of paper and chance of error were management concerns. This SSD software simulation model can cause a dramatic improvement in the handling, and analysis of data. Where the leakage has occurred in sewerage system can now be produced and graphically displayed in a matter of seconds. When we build a computer simulation for a sewer system it is very difficult to eliminate data-errors.

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