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Mapping and Management of Sewerage System

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ABSTRACT: The Sewerage system is an essential part of living in a city or urban area, as it reduces sanitary water by carrying it away. The sanitary water makes its way through sewerage systems, into rivers and into the sewer treatment plans. In areas with houses, shops and roads we need to create alternative ways for this water to drain away into open sewer close sewer lines. For this reason, local municipal corporations provide drainage system that safely carries storm water and sewer away from built-up. Sewerage system is an important utility of urban area and in traditional way municipal corporations keeps information about them in a database like spreadsheets, hardcopy records like map. However, tabular data refers to an address is insufficient to find network lines. These type of data is hard to maintain and hard to update. So this paper gives different ways to organize asset using GIS, Google API, Tools and sensors.

KEYWORDS: sewerage system;GIS;RFID; GPS; GPR; CAD; 3D.

I. INTRODUCTION

Sewerage system is a necessary urban infrastructure; playing an important role in the urban areas [1].It includes wastewater collection and its pass through the sewage network to the wastewater treatment Plant [2].Most management on underground drainage is manual therefore it is not efficient to have clean and working underground system. Also it is hard to locate them as corporations have insufficient data about them. There are different foreign countries which uses better method to keep data of drainage system. In this process of data management the hard part is collecting data of underground network. This is not sufficient for managing data only. It should be used for monitoring the drainage system for better public services.

II. LITERATURE SURVEY

1. Detection Methods:

Underground manholes have threefold characteristic: **Hidden**: Manhole cover is hidden under the road surface of the underground environment. Therefore some kind of scientific tools are required to search for the exact location. **Metallic**: Manholes are usually outfitted with or produced by metal materials. **Identification**: It is necessary to identify and locate position of desired manhole without mistake.

Based on the characteristics of underground manholes, there are some feasible ways to identify and locate these manholes for its Maintenance [3].Various kinds of methods can be applied to search manholes. There are different methods are used to search for the manholes hidden underground:

- Metal detection
- RFID authentication
- GPS location
- GPR

- **Metal Detector Approach:**

Metal detectors are used by people to discover buried treasures in past. Now days, metal detectors are used by security agencies to identify a person wearing any type of metal.

If the manhole cover is made of metal material, then it can be easily identified by metal detectors. A schematic diagram for metal detector is given in figure 1.

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Metal detectors work on the principle of electromagnetic induction. Metal detector contains coil which generate electromagnetic field around it. When metal detector moves over the metal objects then metal has induce current. This current is called Eddy current. Due to the formation of Eddy current metal generates its own magnetic field. Generated field is received by metal detector and using buzzer or LED [4].

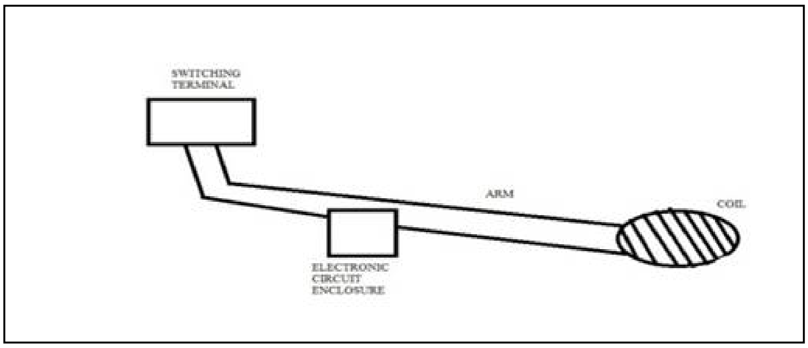

Figure 1: Handheld Metal Detector

Thus, Metal detector scan be used to search for the location of manholes, with two limitations: (1) Metal detector can only detect the metal object with very short range. (2)Metal Detector cannot recognize details of metal.

- **RFID Positioning Approach:**

The main application of RFID (Radio Frequency Identification) is the identity identification. RFID tags develop to replace barcode. But the advantages of RFID i.e. wireless identification make it useful in different field like vehicle identification, managing inventory, theft detection in malls. RFID is popular technology because no line of sight needed to detect and one more thing passive tag. Passive tags does not have power source and also store information other than tag.

A basic RFID system consists of three components:

- An antenna or coil
- A transceiver
- A transponder

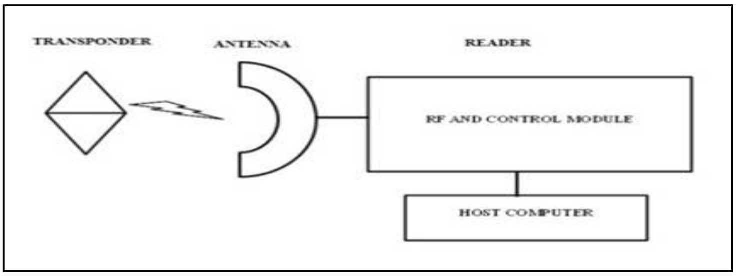

Figure 2: Working Of RFID

The working of RFID is explained in figure 2 [5].

A transponder consists of microchip and antenna. Transponder is passive which means does not have power source. It works on principle of induction when reader (transceiver) emits radio waves which are received by antenna of tag to power it. Passive tags work in low range.

When transponder comes in range of radio frequency it start transmitting tag information [6].

- **GPS Positioning Approach:**

The Global Positioning System consists of 29 satellites that circle the globe once every 12 hours, to provide worldwide position, time and velocity information. The principle of GPS positioning is to receive more than three GPS satellite signals together along with the computation of triangulation to derive the coordinates of the GPS receivers. GPS can collect both the location and the data [7].

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Global positioning system uses 3 satellites to triangulate the position on earth. For the measure of height from earth surface, it uses 1 more satellite.

The GPS positioning is achieved by measuring time taken by signal to reach device. This time is considered as radius and the location of device anywhere on the sphere form by the radius. It's not easy to determine location using single satellite so to reduce search area 2nd satellite is used which gives less area form by 1st and 2nd satellite. Still position cannot be specified then 3rd satellite forms a sphere intersecting sphere formed by other 2 satellite which is the approximately correct location on earth. GPS divided in 3 segments (1) Space segment (2) User segment (3) Control segment. GPS tags helps to map the location of each manhole [8], [9].

Manholes are searched by metal detector and RFID and then map their location using GPS device. This will help to form the information system of manhole on mapGPS has its own limitations (1) GPS accuracy up to 15m (2) It can be affected by natural phenomenon.

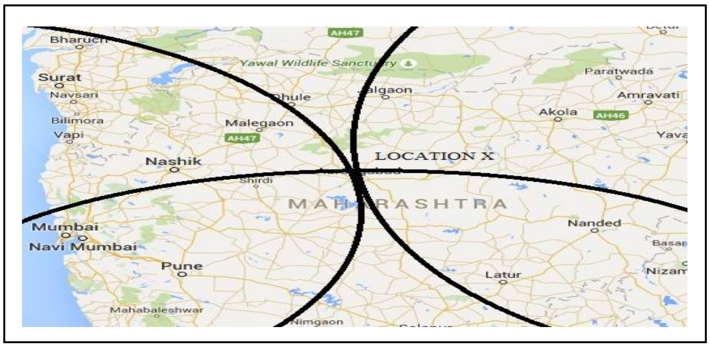

Figure 3: Trilateration Works In Three-Dimensions To Locate A Fixed Position On The Earth, For Height Determination A Fourth Satellite (Not Shown In The Figure) Will Be Needed

- **GPR Approach**

Figure 4 shows the basic working principle of an impulse GPR system. Like any other radar device, the transmitter generates a very short pulse that is emitted by a ground-coupled antenna; energy backscattered by any target, such as metal, pipe, is then captured by a receive antenna, that is joined to the transmitting antenna so that they move along the with surface together. The receiver processes the data collected by the equipment and displays the results on acolor monitor. The 2-D image is composed by representing side-by-side all the traces collected with a certain spatial step. The X axis shows the path along the direction of scanning, whereas the Y axis represents the "time-of-flight" of the radar signal. As GPR antenna has a wide beam in the ground, a target is illuminated even if the antenna is not exactly above it. That means an echo is produced also when the antenna is approaching and leaving the target's zenith; resulting, a typical hyperbolic pattern is produced in the radargram [10].

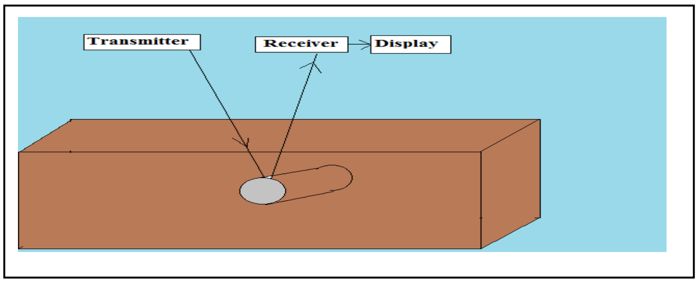

Figure 4: Working of GPR

2. **Visualization Methods:**

- **New methods for mobile GIS offered by VIDENTE**

The figure 5 gives the schematic diagram of handheld augmented reality device by Vidente.

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It can be seen from the Figure, that it has four components, viz. GPS, Antenna, Camera, Joystick and Ultra mobile PC (UMPC).Handheld augmented reality extends traditional 2D or 3D visualizations by overlaying registered visualizations over video footages [11].

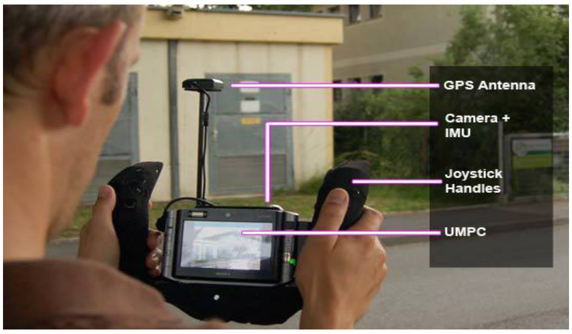

Figure 5: Vidente: handheld augmented reality device.

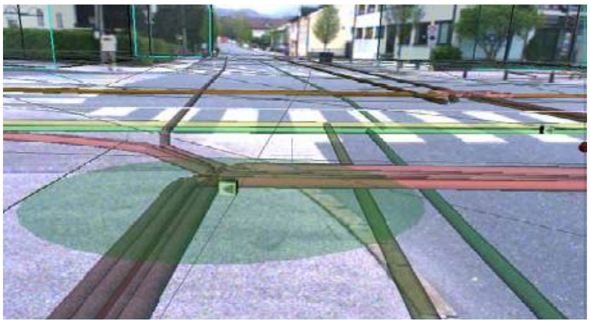

Figure 6: Vidente: presentation of the subsurface infrastructure information at the client device (screenshot) (data courtesy of Salzburg AG).

For example, reference surface features are occluded by winter snow. AR thus has the potential to remove the need for a mental transformation from map to reality. Figure 7(left) shows a digital 2D plan showing underground infrastructure printed on paper. This is what field workers often take to the field for inspection tasks. Figure 7(right) shows the GIS feature, while standing at the position indicated by the red arrow shown. The mobile AR user is oriented toward the direction of the arrow. The AR visualization using a trench along the pipes can convey depth and 3D information better than on a 2D map only [12].

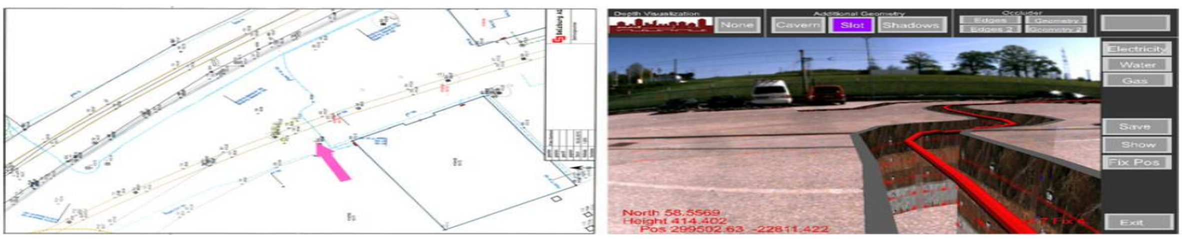

Figure 7:2D GIS versus 3D AR visualization of the same location. Left 2D map showing IS features. User is located where the arrow in the center of the screen is pointing. Right 3D AR visualization shows subsurface features.

- **Design methods provided by GEMS V8i Software**

The SewerGEMS V8i software is efficient for sanitary sewer network design. SewerGEMS V8i takes minimum time to create the drawings. It is also used for labeling the system parts, updating data automatically for layout and longitudinal

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profile with the modifications we make along the designing process, calculating the pipe diameters automatically, using the features for creating the plotting drawings. This process is easy and simple for the design of sewerage networks.A map containing pipe details, velocity, elevations and flow can be directly obtained from SewerGEMS V8i. SewerGEMS V8i will maintain the minimum and maximum velocity condition.

Modes in GEMS V8i software

- **Micro-station Mode**
  Micro-station mode lets user create and model your network directly within primary drafting environment. This gives access to all of Micro-stations drafting and presentation tools, while still enabling you to perform Bentley SewerGEMS V8i modeling tasks like editing, solving, and data management. This relationship between Bentley SewerGEMS V8i and Micro-station enables extremely detailed and accurate mapping of model features, and provides the full array of output and presentation features available in Micro-station. This facility provides the most flexibility and the highest degree of compatibility with other CAD-based applications and drawing data maintained at any organization.
- **ArcGIS Mode**
  ArcGIS mode lets user create and model network directly in ArcMap.
- **Auto CAD Mode**
  AutoCAD mode lets user create and model network directly within primary drafting environment. This gives access to all of AutoCAD‘s drafting and presentation tools, while still enabling you to perform Bentley SewerGEMS V8i modeling tasks like editing, solving, and data management[13].

- **Mapping using high end GNSS system and GIS software**

The design and implementation of a GIS order to efficiently manage utility distribution systems and replace the existing system based on Paper Maps Etc. The Municipal departments have relied on Paper data for years.Sewerage Utility Management Centre (SUMC) in Municipal Corporation of Greater Mumbai (MCGM) was using High EndGNSS and Digitized Base map with GIS Software in sewer network design and analysis processes. In addition how GPS and GIS provides user-friendly working environment and powerful tools for mapping and display of results. Efficient integration of utility asset data with geographical information system is the key to successful water supply and sewerage system. Location is the most important information in water supply and sewerage network. With GIS integration we can better visualize our data and can keep check on the performance of utility data [14].

The MCGM is using Mumbai Base Map Digitized by NIC with ArcGIS system to manage their utilities .MCGM departments realized that this Map has to be updated time to time using the Real Time System i.e. GNSS. MCGM started researching ways to update their data and efficiency within the departments and wanted a centralized system that could be accessed across all departments in the city. The figure 7 and 8 shows an example of a sewer CAD drawing and sewer mapping. The CAD Drawing shows the Manholes and the Flow analysis. The GIS Map shows the exact location with the Route analysis [15].

Figure 7:CAD Drawing

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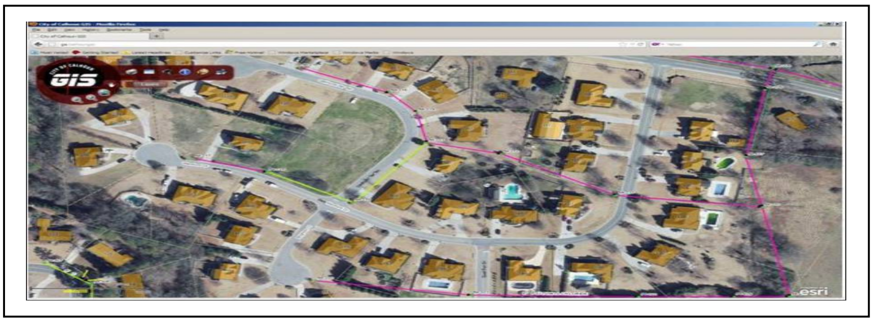

Figure 8: Sewer Mapping

- **Geovisualization of Sub-surface Pipelines: A 3D Approach**
  Proper visualization of pipelines such as oil and gasoline pipelines, water supply, sewage, power supply, heat supply, industrial pipelines etc. is a top-level challenge for the geospatial industry. Due to the essential functions performed by the pipelines that transport these essential utilities, most governments are committed to ensuring their safety. Similarly, most governments are keen on ensuring that they are properly managed because of the important functions performed by these pipelines an integral part of a pipeline management system is the availability of documents (maps) that offer related graphic information about existing pipelines. These maps serve as visualization tools needed to monitor the underground infrastructures. However, the visualization of utility networks has usually been on two dimensional (2D) maps, and also the information therein is often misinterpreted particularly when made available to third parties like unskilled labourers, or non-professionals Such misinterpretations have led to severe accidents which consist of blind-cutting off of water, gas, heat supply and so on . To be able to resolve these perennial problems,three-dimensional (3D) visualization of utilities is most important.Using the preliminary datasets available, the pipelines can actually be viewed underneath the building lots, in 3D form as shown in figure 9. It can be seen that the 3D view is definitely clearer and better than the 2D format shown in figure 10[16].

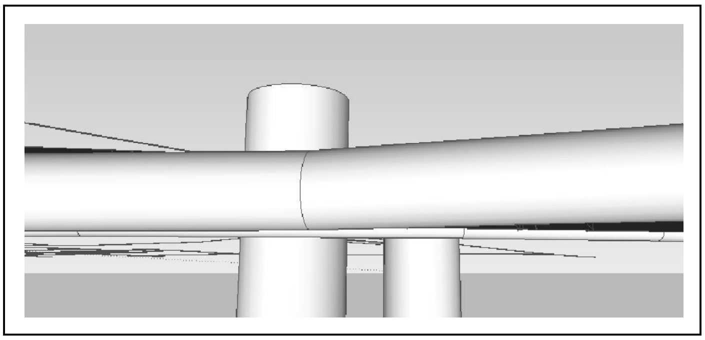

Figure 9: The pipes in 3D format

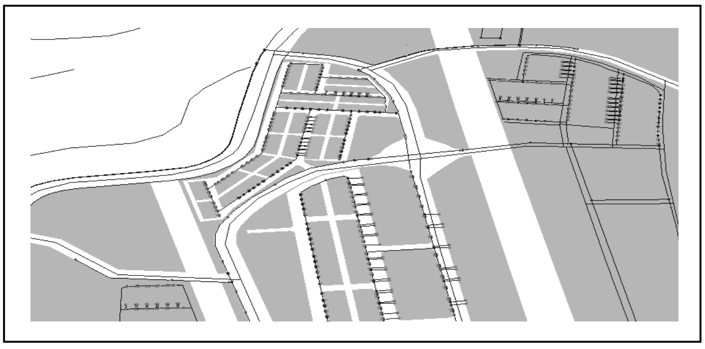

Figure 10: The pipes in 2D format

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- **Design And Mapping Of Underground Sewerage Network In GIS, A Case Study Of Islampur Town**
  Islampur is a town in Sangli dist.; Maharashtra, India. They design a system for sewerage network using GIS. They consider 35 years of data to design and predict population. They consider following factors to the case study population, rate of water supply, slope/gradient, peak factor, velocity, pipe size, depth of cover, manholes.

  ➢ **Mapping of sewerage network**

  Each point was taken at 30 m interval on straight path and at every change in connection point. GIS was used to generate a map [17].

3. **Monitoring:**

Monitoring large scale urban infrastructure such as water supply and sewer networks for detecting leaks, changes in water quality and preventing water contamination caused by sewer overflows.There is a variety of telemetry solutions which the water utilities are using and frequently these solutions are integrated into SCADA (Supervisory Control and Data Acquisition) systems. The schematic of a typical SCADA system is shown in Figure 11, and it has four major components that are interconnected via a network: (i) remote telemetry and automation devices, such as outstations, data-loggers and PLCs (Programmable Logic Controller); (ii) data gatherers which acquire and manage the telemetry data; (iii) data server providing telemetry data for users and other applications; and, (iv) workstations which provide a user interface.The outstations are connected to the data gatherers via a range of different media including telephone lines, leased lines, radio,private networks, fieldbuses and satellite. The workstations communicate with the data gatherers via local and wide area networks. Communications interfaces between workstations, data gatherers and corporate systems are provided through Industry Standard Protocols such as TCP/IP or OSI standards. The data gatherers (DGs) provide the data collection service at the heart of the system by scheduling and executing telemetry polling, managing and distributing the real time database, and serving the workstations. The outstations are grouped into sets and then each set is interfaced to two DGs: a primary and a secondary, to minimize the risk of failure. During normal operation, the primary DG polls the set's outstations and collects the corresponding data. This data is forwarded to the secondary DG where a further copy of the set's database is maintained [18].

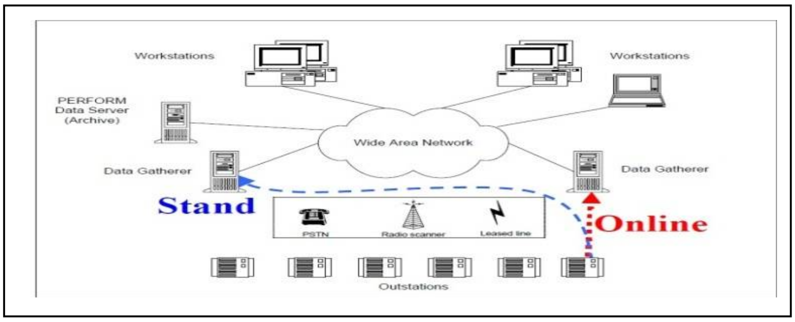

Figure 11: Schematic of a SCADA system

- **Sensor and Communication Medium for Monitoring Sewage Pipeline**
  The objectives are as follow:

➢ To identify sensor which could be placed inside the sewage pipeline which can measure the level, velocity and temperature of sewage material?
➢ To identify communication medium and send the data collected by sensor to the central server.
➢ The data could be used for monitoring the sewage pipeline and can be represented on GIS so that operator can easily identify the location of the blockage.

I. **Identification Of Sensor**

Liquid-level measurement methods are classified into two types:

1. Contact
2. Contactless

Contact-type liquid-level measurement methods include those for float-type mechanical, electrical (capacitive and resistive), and pressure sensing. Liquid level is measured with these methods directly by using a sensor that gets into contact with the liquid. Although Contactless methods are more complicated than contact methods, they are necessary for specific applications, such as measuring hazardous solutions and medical instruments.

II. Identification Of Communication Medium

There are number of technologies for wireless communication, like Wi-Fi, ZigBee, and Bluetooth etc.

- **WI-FI technology**

Wi-Fi widely is becoming the ideal mode of internet connection. To access connection of this type, one must have a wireless adapter on their computer. Radio waves are used to transfer information across a network. Wi-Fi offers wireless connectivity by producing frequencies between 2.4GHz to 5GHz based on the load of data on the network.

- **ZigBee technology**

ZigBee device operate under the 802.15.4. The ZigBee is a group of companies that produce trustworthy, cost-effective, and have less power requirements, version of a personal wireless communication devices. The significance of these devices is that it has very less power consumption, which extends their battery life noticeably. There is a 100 meters transmission distances which is provided by ZigBee devices if nothing is obstructing the signal. ZigBee uses low RF signal, which does not harm humans [19].

III. CONCLUSION

The sewerage system is one of main asset of city. It helps to draw out sanitary water out of the city towards sewer treatment plants. As all we know our sewerage systems were developed with the development of city. Most of the municipal corporations don't have proper way to keep data of assets like sewerage network. This paper gives different ways that will helps different corporations to modernize, organize and monitor sewerage system. Even there was new or old network of sewer lines in city.

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