



ROLE OF REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM IN CREATING FUTURE SMART CITIES

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Abstract : The rapid urbanization in India, due to fast paced population growth, has caused number of problems for the citizens of cities in terms of lack of drinking water, sanitation facilities, power, roads and infrastructure, etc. At present, no viable solution is seen that could address this demand and supply gap in the near future, except ‘Smart City Planning’. Smart city planning is crucial as it would help in balancing between the resources available and requirements of the citizens.



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In general, Smart means the one, who is well dressed, stylish, modish, clever, quick-witted, Energetic etc. Thus a smart city should also have such types of criteria for smartness. It means that it should be well dress in terms of infrastructure (physical, social), quick witted in terms of issues like social challenging, natural challenging, modish in terms of accepting new technology or new concept, to give a better life to common person, energetic in terms of development.

In order to have a sustainable development of a city, it is better to incorporate Remote Sensing and GIS based tools in the ‘Smart City Plan’. These tools may help in proper planning and the execution, as well, for the development of future smart cities and will act just like a human brain, which integrates all the sensors. A GIS decision support system (DSS) is a computer program application that integrates, analyzes and presents the complex data into relevant information which, in result, would help in creating, planning and developing smart cities.

KEY WORDS: GIS and Remote sensing, Smart City, NDVI, Land use change, sustainable mobility



1. Introduction

The cities are referred to as the “engines of economic growth” for India because they constitute around 31% of total population and contributes over 60% of GDP of India and further it must contribute around 75% of national GDP in next 15 year (ministry of human development).So India is at a point of transition where the pace of urbanization will speed up and lead to several social, economic and environmental problems for the citizens of cities in terms of lack of drinking water, sanitation facilities, power, roads and infrastructure, health problem etc. Due to these problems, we need to well planning for urban area and cannot wait any longer to do so. At present, no viable solution is seen that could address this demand and supply gap in the near future, except ‘Smart City Planning’. Smart city planning is crucial as it would help in balancing between the resources available and requirements of the citizens.

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K.K. Joadder also supported that smart city is one which provides for the wellbeing of the people through integration of urban planning systems, efficient service delivery, smart governance, energy management and conservation of resources with underlying use of technology and instrumentation leading to socio – economic and sustainable development.

According to government cite, the core characteristic of smart cities would be

- Assured electricity supply
- Adequate water supply
- Sanitation, including solid waste management
- Efficient urban mobility and public transport
- Affordable housing
- Robust IT connectivity and digitalization
- Good governance and citizen participation



- Sustainable environment
- Safety and security of citizen
- Health and education

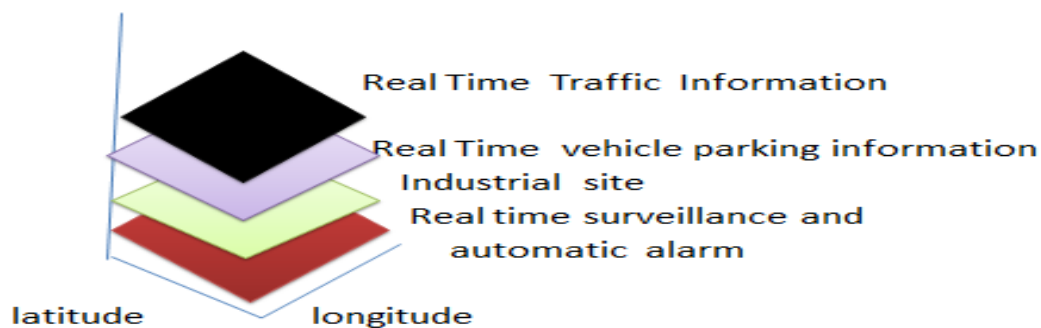
In this regard, traditional method of planning and managing cities do not work anymore in this environment. For this, new approaches are necessary like interactive design and planning computerized techniques. It is generally agreed that the context is a key element in the design of future new and the transformation of existing cities. Context must include societal, governmental, economic and technological component. This context must be transformed to and modelled in the digital domain. In this series, there are requires precise, reliable, actual and largely complete data for political, social and economic decision-making processes. For this Geomatics always has played a significant role when it comes to reality based data acquisition and processing Geomatics is the science of acquiring, modeling, analyzing and representing spatially-referenced data. It can serve many purpose regarding smart cities as for environment monitoring, planning of roads, buildings, location, mobile communication, energy, natural hazards, tourism, real estate, architecture, landscape engineering monument preservation, smart homes, car navigation, homeland security, police, traffic and crowd control. (Armin Gruen 2013).

In order to have a sustainable development of a city, we should have smart urbanization strategy in the right direction by taking advantage of the smart geospatial data with latest developments in technology like Remote Sensing and GIS based tools. Smart geospatial data is the base of creating future smart Cities. But the challenges with smart geospatial data is in bringing together smart data from multiple providers (static and real time data from sensors) and in the end provide an entry to several smart data sources((Raghavendran,2014)

In this context these tools will act as a human brain, which integrate all the sensors and provide the smart data in the form of many layers of different information on a single map, which is very important in proper planning and the execution, as well, for the development of future smart cities.



Armin Gruena also supported that, traditional and modern (ICT) communication infrastructure make a city as a smart through sustainable economic development, a high quality of life, wise management of natural resource through participatory governance. He is also said that all component like brain, hard and software which is important to manage a city efficiently with the goal to sustain high quality of life over a long period of time through information collection and processing, real time alert, forecasting, learning, collective intelligence and distributed problem solving In this regard GIS and remote sensing play important role, providing data acquisition, processing, analysis and representation.



GIS : Smart Data in the form of different layer

Fig.1.1

2. OBJECTIVE: : The purpose of this paper tries to show how useful and precise is the multi resolution satellite data for detecting any changes like land, environmentally etc. in that area or visualization of patterns helps in change analysis, planning, policy making, monitoring of social indicator, and make cities sustainable.

3. METHODOLOGY : Arc GIS and ERDAS software have been used for image processing and map making for this work. Firstly imagery of Jawaharlal Nehru university taken from google digital map and convert into vector form of different layers of



information through Arc GIS and make a map. Apart from that some maps like figure 4,5 and 6 as an example taken from ‘Urban sprawl and its effect on peri-urban villages’, where Landsat imagery have been used for showing changing land cover and vegetation cover pattern in Bangalore and Meerut city through supervised classification and NDVI method respectively.

4. GIS and smart city : Without any accurate and real time data, nobody could do good planning for a smart city and eventually, develop a Smart City. GIS and remote sensing are that tool which provide us real time data related to the different layers of information like settlement, road, infrastructure, different type of resources availability in that area through map visualization of complex patterns of real world. This visualization of patterns helps in change analysis, planning, policy making, monitoring of social indicator. This in turn result in improving needs assessment of any city or area.

In this regard, digital as well as vector form of map for Jawaharlal Nehru university campus new delhi have been taken with the help of Arc GIS and remote sensing, as an example which can be helpful for detecting different layers of information like road, infrastructure etc. over there as well as changes which can be helpful for future smart planning in that area.

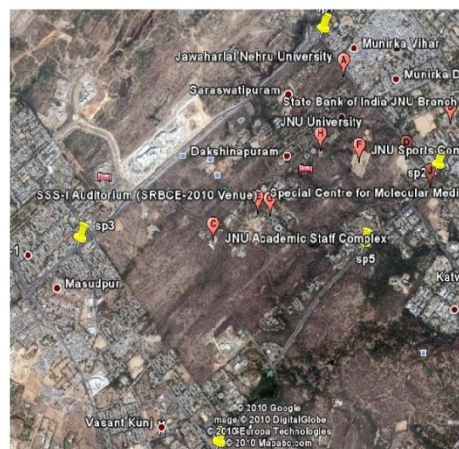


Fig. 1.2

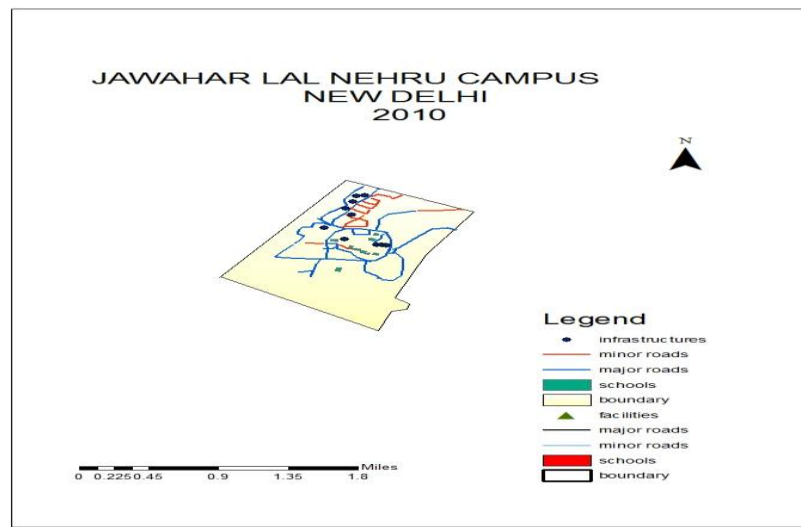


Fig.1.3

Apart from this, there are of example of importance of GIS in creating smart city like khed city. This city of Pune in Western India was developed by using GIS and Remote Sensing tools. This project was joint venture between the Kalyani Group, Bharat Forge and Maharashtra Industrial Development Corporation. Initially, the speed of work of this project was quite slow because of absence of important information and data integrity. In this context, the project developer implemented a web-based Geospatial information system. The system includes regional data derived from external sources including information on general location, connectivity and access to the area, topographic data based on the actual mapping of the terrain carried out using satellite imageries planning data derived from the master plan and other detailed plans created for internal and external features in the city including revised layout and subdivision of plots and various utility networks propose.

Thus, GIS and mapping software helped in improving the quality, productivity and the asset management of the project. The management as well as the stakeholders has near-real-time access to the progress of the particular site through the Web GIS application. They are able to view the layout maps with the updated status through satellite images, actual site photographs and attribute information.



According to DR. Khele, the project with this [the technology], is set to become an exemplar for enhanced infrastructure development, optimizing on resources, energy, and thus enabling the investor to make most out of it.

4.1 GIS and land use planning

Due to population pressure, economic growth, land is becoming a scarce resource due to. So optimal use is necessary for selection and management of that, which is fulfill the increasing demands for basic human needs and welfare. In this regarding, information related to land is essential. Through this information we can do also monitoring the dynamics of land use resulting out of changing demands of increasing population. In land use planning, the planners consider, understand and manage the following:

- What is the Change in land use pattern over the period?
- Land uses within zoning classifications (e.g. amount of green or open space per residential unit within residential zones)?
- How much decreases and increases the area under different category like say barren land over the space and what would be utilize of that?
- The amount of land needed for parking, given a particular land use

In this regard, GIS is an important tool for good land use strategy and transportation plan which should be analyzed at regular interval to ensure that there will be sufficient land to meet the anticipated population and economic growth, and provide a good living environment. Here in figure1 shows that how we can easily detect what is the changing in land use land cover in Bangalore city over the period, where the barren land which will be the use for what kinds of categories (parking, green space, industry) etc. with the help of GIS mapping.

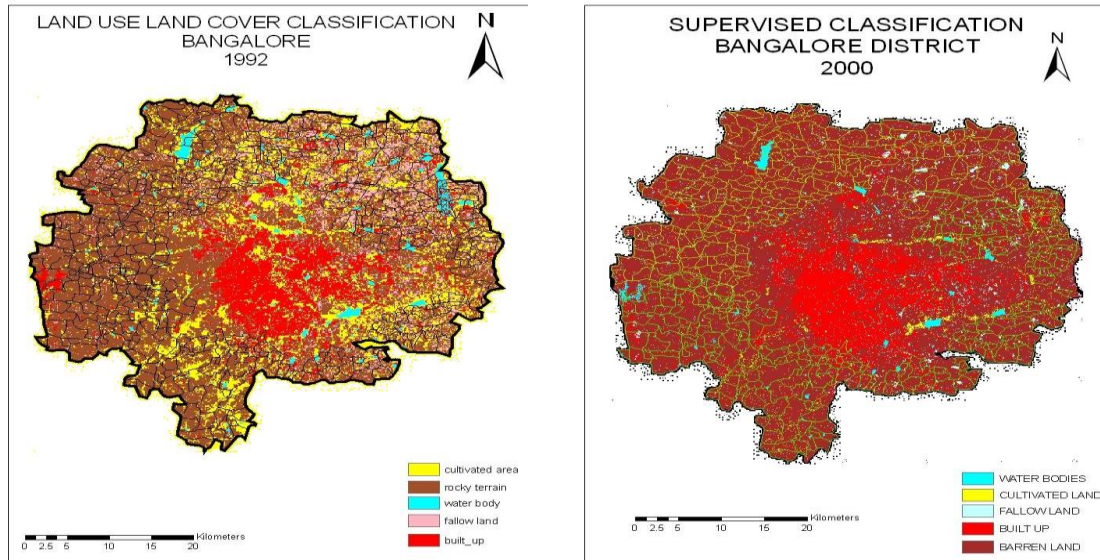


Fig. 1.4

Changing in land cover over the period

4.2 GIS and Sustainable Mobility

GIS and remote sensing is also useful in sustainable mobility in particular area, because it makes many different applications possible, include route planning, real time parking information, real time traffic information, vehicle navigation system, metrological hazard control, tourist information system passenger assistance system etc. and set up intelligent traffic information management control center and parking policy. This is very useful for Car navigation system with GPS which is given a spatial vision of journey, real time information of speed and direction of vehicles networks and communication studies (Joana Maria Seguai Pons et al)

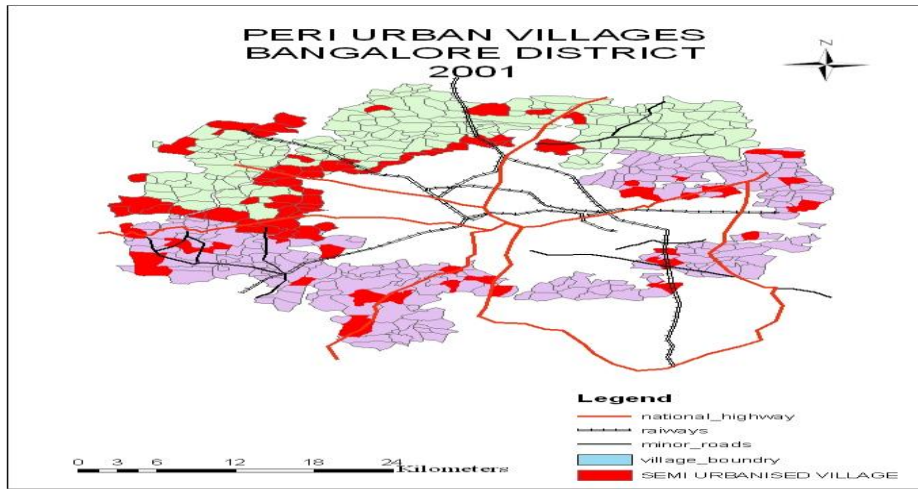


Fig. 1.5 Transport map

In the above figure, we find out the transport route over the place through GIS and Remote Sensing and if layer join another layers of information like population density, commercial places, etc. than find out where develop the more transport route which helpful for fast development of that area. Apart from that from the attribute data of GIS we can also following information which can be useful in smart mobility planning in city.

- Identification of accident sites
- Identification of sanitation truck routes, capacities, and staffing by area
- Use of analysis to identify ideal high-density development areas based on criteria such as established transportation capacity
- Use of analysis to identify potential alternative traffic flow mechanisms
- Analysis of accident patterns by type of site

4.3 GIS and Environment Suitability

Due to urbanization and industrialization, environmental pollution is serious. So it is necessary to environment monitoring time to time for protection strategy of sustainable environment. Environmental protection is dynamic in nature. It involves spatial information from multi-sectorial, multi-region and multi-field and a lot of data processing. So in this context only remote sensing and GIS could be effective tools. It will also study the characteristics and the composite



effects of pollutants and provide the information for decision-making and promote scientific analysis and decision-making in environmental protection.

In the recent time GIS and remote sensing is using in the all area of environment monitoring like ecological monitoring, water monitoring, atmospheric monitoring, noise monitoring, etc.

4.4 GIS and Ecological monitoring

Vegetation is an important component of the urban ecosystem that has been the subject of much basic and applied research. Urban vegetation influences the physical environment of cities through selective absorption and reflection of incident radiation and regulation of latent and sensible heat exchange (Gallo et al . 1993, Carlson et al . 1994, Nichol 1996, Gillies et al . 1997, Owen et al . 1998). It can be considered to be three basic indices to study the urban ecological environment. Due to growth in, both, population and physical size in urban area, vegetation land are replaced with the common urban materials, such as asphalt concrete and metal. This has caused significant environmental implications, including reduction in evapotranspiration, promotion of more rapid surface runoff, increased storage and transfer of sensible heat, and reduction of air and water quality (Goward 1981; Owen et al .1998; Wilson et al . 2003). These changes, in turn, can have negative effects on landscape aesthetics, energy efficiency, human health and quality of living in urban environments (Mcpherson et al. 1997) more rapid surface runoff, increased storage and transfer of sensible heat, and reduction of air and water quality (Goward 1981; Owen . 1997). These physical processes are difficult to monitor solely with in situ instruments. Satellite-borne instruments can provide quantitative physical data at high spatial or temporal resolutions. Visible and near-infrared remote sensing systems have been used extensively to classify phenomena such as city growth, land-use/cover changes and Normalized vegetation index.

Here we discuss about NDVI.

The Normalized Difference Vegetation Index (NDVI) is a simple numerical indicator that can be used to analyze remote sensing measurements, typically but not necessarily from a space platform, and assess whether the target being observed contains live green vegetation or not.



Figure show the NDVI value for Meerut city which is shown a decrease over period of time 1999 & 2006, showing decrease in the vegetation. The maximum decrease could be seen in the Meerut block and its adjoining villages in the south.

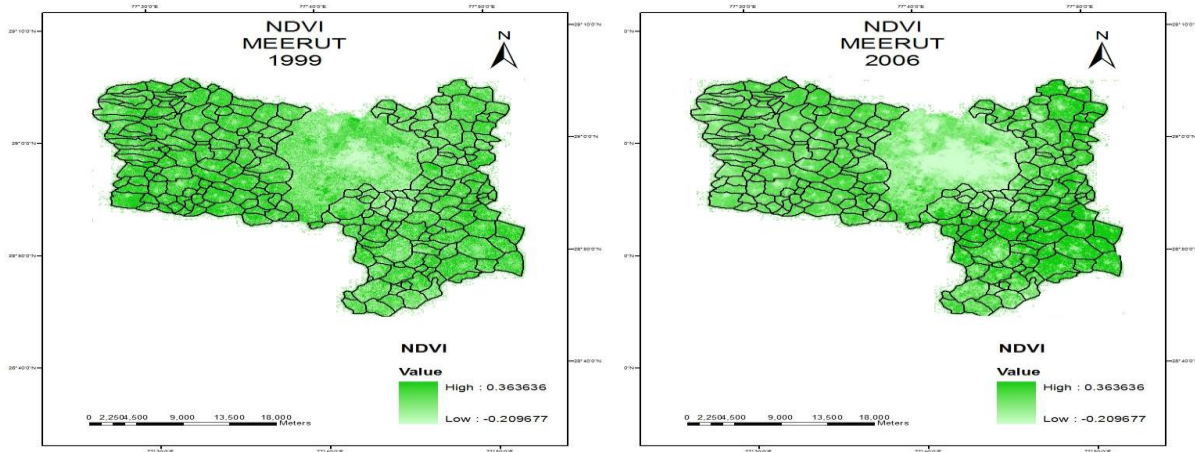


Fig. 1.6 NDVI

So from the analysis of vegetation health we can find the Eco sensitive area over there which can be helpful in further planning like

- Where should be industrial site
- Where should be green corridor, vehicle corridor, and green node
- Which should be conserve area for sustainability etc

Now in future we can use of GIS and Remote Sensing in another Components of Smart Cities like Smart Service delivery mechanism, E-Governance etc. where services can be improved.

Apart from that, overlay which is a feature of GIS which is organization of data into layers like a street layer, a building layer, a parcel layer, and a zoning layer. These layers can be analyzed in isolation or be cross referenced and analyzed together. This method can be useful in fast services for example if we want to setup the health clinic in particular area than we have to take a layer of clinics with respect of the population density. Which will give the view that clinic will be setup where the greatest population density without health clinic.



4.5 GIS and relation analysis

Apart from that GIS is also useful in relation analysis through overlay multiple layers of information or combining of two or more different information in single map which could be useful in decision and future planning. Figure is an example of combining the different information into a single map which shows the relationship between child labor and literacy in India (district wise). It shows that where the literacy is high there is low child labor. There could be another example of visualization in single map like we can combine different information as crime location, roadways and police districts into a single digital map by GIS. This type of information could be useful for new forms of information like if one wanted to find out a location within police district, within a specific distance of a main road, and a specific distance from a the nearest crime, a query could be written to locate the places that meet those requirements(William F. Wiczorek et al.2009). Thus the overlay function facilitates spatial analysis by the creation of combinations of information for smart planning and decision.

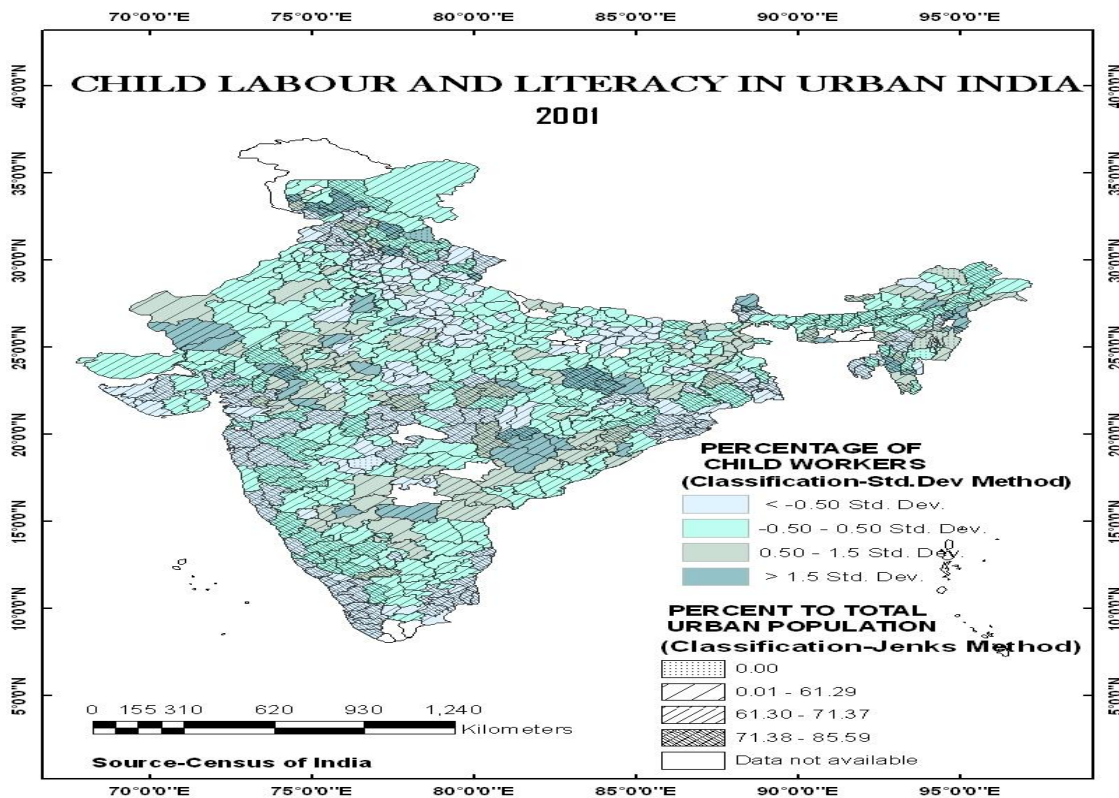


Fig. 1.7



Conclusion : Thus GIS System can be a multidisciplinary and integrated research system for creating of the future of smart cities, Because of it's the unique ability as integration of data, visual presentation of information which is help understand patterns and relationships between these data elements. Which would very helpful while converting existing cities to smart cities or while developing new green-field smart cities. Apart from that from the GIS and remote sensing we can also save the time as well as money for collection of information for planning. The current study presents some example which is justifying the potential of GIS and Remote sensing data in sustainable development in India. Apart from that we can use GIS as a Smart solutions in another area like Real time, online systems of monitoring water quality, City-wide intelligent video surveillance network, etc

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