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Exploring Robotics and Automation in the City

Sree Southry S[1*], B. Prasad[2], Vedanarayanan.V[3], K Umapathy[4]

[1]*Department of Electronics and Communication Engineering, Sona College of Technology, Salem, Tamil Nadu, India.*
[2]*Department of Electronics and Communication Engineering, Dhirajlal Gandhi College of Technology, Salem, Tamil Nadu, India.*
[3]*Department of Electronics and Communication Engineering, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India.*
[4]*Department of Electronics and Communication Engineering, Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya University, (Deemed University), Kanchipuram, Tamil Nadu, India.*

[*]*Corresponding author: southrysouthry@gmail.com*

Abstract. New types of robotic and automation technologies are being tested in cities throughout the world in a wide range of economic and social contexts. This paper examines how robotic, and automation systems are being layered onto preexisting urban digital networks, expanding the capability and capacity of human agency and infrastructure network and ultimately reshaping the cities and the citizens each day experience as these innovations leave the laboratories and factories. Most of the work in this area has been theoretical and individualistic up to this point. Outline a research agenda that extends beyond the analysis of isolated applications and impacts to look at the interconnections between different urban domains and the resulting effects on cities' socio-spatial stratifications, the qualities of life for its residents, and the scope of opportunity for responsible innovations

Keywords: Splintered urbanism, socio-spatial sorting, automation, Robotics, artificial intelligence

INTRODUCTION

The concept of "smart cities" encompasses several different but equally vital areas of study and application. This is reflected, for example, in the many ways it has been conceptualized. Different methods prioritize different factors; some prioritize technological advancement, others prioritize social justice, and others prioritize ecological sustainability. The digital transformation of the city is a hot subject of debate right now, and its relevance has only grown considering the recent COVID-19 epidemic [1]. Robotic process automation (RPA) solutions may play a role in this shift since they use sophisticated software to automate activities formerly performed by people. This method has so far been implemented most frequently in the context of businesses (especially those in the financials and BPOs/SSCs sector, but less frequently in the utility sectors), but the first application of this solution in the contexts of process automation for the city are also beginning to emerge in different parts of the world. Case studies were used as the basis for this essay. With the Bydgoszcz city hall (Poland) power billing document management as an example, the implementation requirements (including limits) of such an approach are explained along with the advantages realized and the lessons learned (which may be useful for other local government units). Based on the findings of this case study, it could be concluded that the city of Bydgoszcz may save time and money by using RPA technologies to streamline the processing of power billing documents. This paves the way for the claim that RPA may be considered a component of smart city infrastructure [2].

The use of robots and other forms of AI technology is growing in the travel sector. Options integrating human and robotic contact are available to customers in today's market. Multiple experiments were conducted. Four trials showed that while COVID-19 was front of mind, guests at robot-staffed hotels were more satisfied than those at hotels with human employees. The findings contradicted those of research done before the COVID-19 epidemic. Consumers' Preference for hotels operated by robots was ascribed to the global health crisis since perceived danger had a substantial moderating impact on this choice. This study has important theoretical and managerial implications for knowledge of how people adopt new technologies in the face of a health crisis [3]. Cities and urban social life may be drastically altered by developments in robotics, artificial intelligence, and automation. However, the use of robots to alter urban landscapes is controversial and fraught with difficulty. There are technical, trust, and safety issues in integrating robots into human-populated, fast-paced urban settings because of

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the rapid pace of technological development, the high cost of robotic infrastructure, and other factors. This article explores the emerging area of "urban robotics" via the lens of three iconic but distinct national-urban settings that serve as pioneering hubs for urban robotic research. This essay focuses on the uses of autonomous social robots in experiments, and it examines (i) the motivations for and the stakeholders in urban robotic experiments and (ii) the difficulties and rewards of designing relevant urban areas for robotics experimentations. The essay provides a unique service to urban studies by shedding light on an important but little-studied facet of city planning. It offers a theoretical basis for charting and making sense of robotic urban experimentation, which is notoriously haphazard, unevenly distributed in space, and socially selective [4]. Using data collected from cameras installed on moving vehicles during two separate tours of a city offers a technique for identifying changes to the built environment. To begin, use Structure-from-Motion (SfM) to convert each set of photos into a 3D point cloud that approximates GNSS/INS data. Due to inaccuracies in the geo-location information and potential drifts in the SfMs, a direct comparison of the two-point cloud is not optimal for change detections. Suggest deep learning-based non-rigid registrations on the point cloud as a solution, which will enable us to compare the point cloud to discover structural changes in the picture. In addition, incorporate a post-processing phase and a dual threshold check to further strengthen the method's stability. To the testing method, compile a total of two datasets. The results of the experiments demonstrate the effectiveness of technology in detecting scene changes regardless of the camera angle or lighting conditions [5].

To automate work that is hard for a human to do cost-effectively, "Starship" grocery delivery robots were first launched in 2018 in Milton Keynes (MK), a new town in England. When the COVID-19 outbreak hit two years later, everyday tasks like grocery delivery and store visits suddenly became risky. The COVID-19 pandemic put into sharp relief the capability of robots to operate in environments that are dangerous for humans, but it might also be relevant in crisis situations caused by heat waves, blizzards, and other extreme events associated with climate change. This proposal, inspired by the Starship robot in MK, explores the possibility of robotics and autonomous systems to provide the city with capabilities to deal with such unforeseen events [6].

LITERATURE SURVEY

Matching live camera feeds with historical maps of the area is the goal of a process known as Visual Place Recognition (VPR). Although early VPR systems relied on direct image approaches or manually built visual features, researchers have recently shifted their attention to learning more robust visual features and enhancing performances through sequential matches/filters or hierarchical matching processes. In both circumstances, the sequences matching or (in the cases of the hierarchical system) pose refining phases are under severe strain due to the subpar performances of the original single-image-based systems [7]. This research provides a unique hybrid approach that generates high-qualities initial matching hypotheses with the use of brief, sequential descriptors learned from a single picture. This allows for the selective aggregation of sequential scores. Temporal convolutional network SeqNet encodes brief visual sequences using 1-D convolutions to create sequential descriptors, which are then compared to their corresponding temporal descriptor in the reference datasets to provide prioritized lists of place match hypotheses. After prioritizing single-image-learned descriptors in a different pipeline, aggregate their scores sequentially to construct a global place-match hypothesis. In-depth studies on tough benchmark datasets show that the suggested technique outperforms advanced algorithms that have recently been developed while still making use of the same amounts of sequential information. Both the source codes and any additional materials are available online [8].

The teaching example studies the management of robotic process automation in the Nordic banking conglomerate Nordea. Numerous software robots have been put into service by Nordea for various tasks ranging from transaction processing and internals and externals reporting to interacting with customers and answering their questions about the EU's General Data Protection Regulations (GDPR). At Nordea, three people gather to discuss the present status of robotic process automation installation. Agnieszka Belowska Gosawska, Heads of Robotic, Piotr Stolarczyks, Heads of Robotics Processing Automations Operation, and Jaroslaw Motylewskis, Interim Heads of Robotic Executions [9]. The presentation details a number of governance-related concerns and decision points that should be considered before using robotic process automation on even a moderate scale inside an organization. The primary concerns are software creation and upkeep, robotics process automation governance, and information technology support systems. After reading and digesting the case, students must be able to (1) explain archetypal and hybrid governance forms for robotics process automation and (2) assess the merits of each mode regarding the creation and upkeep of reliable infrastructure and high-quality software.

Improved sustainability and a higher quality of life for residents are only two of the many reasons why smart mobility is crucial in a smart city. Driverless In order to drive toward their intended destinations and find their way about, automatically guided vehicles use data gathered from their surroundings. Even if it is difficult, these vehicles will benefit by having access to many environmental data points. With that in mind, this paper presents the Responder-dependent Additive Information Fusion (RAIF) strategy for fusing sensor data in guided vehicle environments [10]. This method keeps an eye on sensor feedback to ascertain how close the guided vehicle came to meeting its recommended goal. The data from the various sensors is collected by an IoT-based linked device. The accuracy of the guided vehicles' navigation is enhanced by correlating the data from the sensors' rapid responses with their past performance. This method uses classification machine learning to fuse information and determine which instances are remitting and which are not. This allows us to isolate the problematic sensor data and remove it from the fusion process, hence increasing the accuracy with which goals are attained [11].

Research on efficient paths-planning algorithms to close the loop of autonomous navigations has been blossoming as it has become clear that vision-based navigations of small aircraft have reached a rather mature stage. Despite several excellent efforts in literature, solving the issue of effective path-planning for jobs like inspection and coverage remains a challenge. With this goal in mind, this letter introduces web-based path-planning algorithms for rapid reconnaissance and 3D modeling of uncharted territory. Due to their agility, micro aerial vehicles (MAVs) are a good fit for this mission, but their limited processing power and flight time need careful planning [12]. Common sampling-based approaches take a small subset of possible MAV configurations and then assess the value of each perspective considering the data gained from that subset. However, time and energy are often wasted calculating the information gained from unpromising perspectives. This letter suggests a new technique of informed sampling that uses surface frontiers to focus on exploring areas with the highest potential for information acquisition. Investigate the effects of informed sampling across a variety of photos-realistic landscapes and demonstrate that the method is faster and yields higher quality reconstructions than state-of-the-art explorations route planners [13].

Building and comparing perception systems relies heavily on data sets for autonomous vehicles. However, most available datasets are only collected when the weather is ideal for the use of camera and LiDAR sensors to promote research on object identification, tracking, and scene interpretation using radar sensing for secure autonomous driving, publish the RAdar Datasets in Adverse weaThErs (RADIATE) in this work. More than 200K tagged road actors are included in RADIATE's 3 hours of annotated radar data. This works out to an average of 4.6 incidents per radar image. It includes eight types of characters and a wide range of challenging environments (including suns, nights, rain, fog, and snow) and driving settings (including parked, urban, freeway, and suburbia) [14]. Believe this is the first publicly available radar collection that includes high-resolution radar photos of public highways with an abundance of road actors annotated. Fog and snowfall conditions provide data that cannot be duplicated under any other conditions. For severe weather conditions when vision and LiDAR fail in automobile applications, few baseline findings of radar-based object identification and recognition are provided. Applications like sensor fusion, localization, and mapping may make use of the stereo pictures, 32-channel LiDAR, and GPS data that are available in RADIATE. Visit http://pro.hw.ac.uk/radiate/ to obtain the publicly available dataset [15].

PROPOSED SYSTEM

"A distributed robot, a collection of sensors and functions linked through invisible networks of communication," as one author put it, is what modern cities have become. What this allows for in terms of extended and enlarged capabilities is a marked departure from earlier iterations of technologically mediated urbanization. However, up to this point, most of the focus has been on evaluating the developments and predicted benefits and concerns around specific technological developments, like drone technology; the future of specific sectors, like mobility or social care; or concerns, like labor or ethics, without making the necessary connections to larger academic and policy debate or societal problems. By zooming out and looking at the larger picture, one can make several important distinctions regarding the dispersed landscape and urban function of RAS technologies: Robotizations of urban service refers to the use of mobiles-controlled and partially autonomous devices (robot and automatons) to replace, augments, or extends previous approach by enabling task that is too dangerous, repetitive, or monotonous for human beings to perform alone. Argue that automated system management and the roboticization of urban service must be seen as complementary rather than competing forces in the modern city. As governments and tech firms collaborate to institutionalize developments like these, as well as update the legal framework and increase global investment in these industries, the number of RAS tests-beds and urban living labs will increase, as will the size, diversity in sector, location, and automation of urban networks. Collectively, these shifts pave the way for more complex robotic and automated urban ecosystems. Figure 1 shows the system architecture of the proposed system.

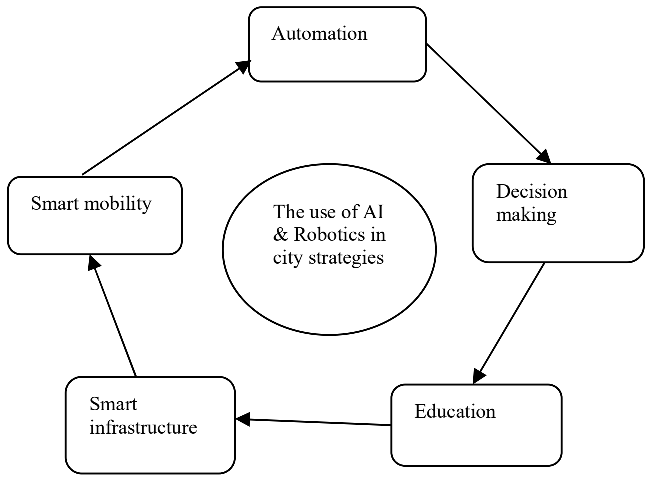

FIGURE 1. System architecture of the Proposed System

As this gradual transformation becomes increasingly obvious, people's views on how far-removed RAS technologies are from their daily lives will alter swiftly. Discussion of digital technologies to improve urban flow and public services management, foster more participatory and transparent urban governance, and introduce new spatial media technologies in the cities can be seen as harbingers of such techno-optimistic transformations. The "digital skin" of the city, which consists of a network of underground cables, sensors, and mobile devices with geo-locations and automated processing, is essential to the operation and expansion of RAS features. In the urban setting, RAS technologies and systems are likely to be intertwined with the logic (and, frequently, the values-extractive proprietary processes) of digital platforms-based infrastructure and service. Despite the obvious interdependencies and overlaps, the breadth and complexity of urban RAS technologies and their affordance represent a more profound reworking of cities' process, materiality, and experience than is presently accounted for by previous forms of urbanism. As automated system management and the roboticization of urban service converge, they are also producing eco-systemic urban dynamics.

Research suggests three ways in which urban RAS interventions go above and beyond the current state of technology-mediated urbanization. To begin with, the management goals of urban RAS implementation extend beyond better municipal planning and administration. There is a clear reworking, augmenting, and extending of infrastructure network capacity brought on by the expanding breadth and interconnectivity of RAS urban applications. When taken as a whole, RAS technologies provide novel possibilities for remote functioning and autonomous actuation (e.g., UAV, AV, socials, and maintenance robots), advanced computational processing, surveillance, biometrics identity, and geo-locations. Challenges in transportation (autonomous vehicles and unmanned aerial vehicles), healthcare (telecare, surgical, and companion robots), service robotics (robotic waiters in restaurants), logistics, surveillance and security, and other areas of urban life are being met with these technological advances. To become the "happiest city on Earth," Dubai (United Arab Emirates) is heavily robotizing public services, transportation, police, and surveillance. Japan has similar goals.

RESULTS AND DISCUSSIONS

New opportunities for revolutionary expansions of networked digital infrastructures are made possible by real-time data and predictive analytics in the RAS-restructured city. While algorithmic models improve monitoring and forecasting skills, RAS technologies make it possible to manage complex systems in the setting of considerably increasing digital data. For this reason, cities have automated street lighting, traffic control, and surveillance systems to regulate the movement of people, goods, and vehicles. These advancements allow for autonomous control systems to handle urban operations with minimum human activity, with the goals of minimizing disturbance, increasing efficiency, and optimizing network capacity. The "centralized control room" exemplifies the automated expert system by forcing individuals to submit their preferences to those of the networked system. Since the corporate smart city (shown by the dashed line) is preoccupied with communal administration, place automated control of infrastructure systems there. The goals of the UA agenda are consistent with those of "smart cities" in many ways. The automated management of urban infrastructures, which makes use of recent advances in RAS, adds precision and emphasis to the smart city approach.

For instance, the Chinese e-commerce giant Alibaba's City Brains use AI to collect data from all over the cities of Hangzhou, including footage from intersection cameras and GPS data on the location of car and bus, analyzes the data in real-time, and coordinate over a thousand road signal to reduce gridlock. City Brain's "comprehensive cognition" can immediately identify collisions, roadblocks, or parking offenses, going above and beyond the capabilities of traditional "smart" monitoring systems. With 90% accuracy, the platform can forecast traffic conditions 10 minutes in advance, allowing users to get text messages that provide directions for alternative routes. While the City Brain's vast data pool may be utilized to discover and monitor "non-normal" behavior patterns, allowing state controls, it also has a darker side under an authoritarian capitalist society. Concerns regarding the inherent bias of these systems are algorithmically trained to "know," and the consequences of individual profiling emerge when RAS technology in these quadrants is utilized for surveillance and predictive policy. As one example, the COMPAS software used by police was shown to be biased against black defendants in a 2016 Pro-Publica study into racial prejudice in policing. Figure 2 shows the system performance of error distance, and Figure 3 shows the system performances of robot walking time.

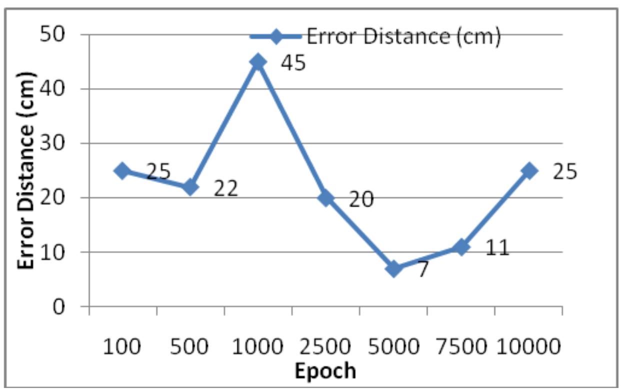

FIGURE 3. System performance of robot walking time (s)

These prejudices are pervasive in everyday urban life, not simply in the realms of law enforcement and criminal justice. Eubanks calls this automated eligibility and ranking algorithms "new tools of digital poverty management" because of their increasing prevalence in the administration and tracking of public services like welfare advantages, social housing, and medical care. In Indiana, for instance, a new computer system reads every application's error as "failure to cooperate," leading to the denial of one million applications for health care, food stamps, and cash assistance over the course of three years. Having "automated inequality" and "software-sorted geographies" has tangible and possibly fatal repercussions on people's day-to-day lives because of such processes. So, even when locating this kind of RAS development in the business district, the results of such communal management could not be fair. Rather than managing resources for communities directly, choices may be made based on aggregate big data, practical data analytics, and short-term algorithmic forecasts, raising the issue of whether automated urban infrastructure advances fundamentally affect how governance is performed. What this entails for innate biases, social control, and urban inequities must be analyzed, as must the implications for private ownership of public data and ideas of urban citizenships.

CONCLUSIONS

New-generation robots and automation are currently being tested in a crucial context: the urban environment. The rationale for these new trends is that RAS technologies provide a more effective way of making decisions and acting in the city, which in turn will increase urban efficiency and benefit urban infrastructures, health care, and daily life. While reorganizing the RAS may improve some aspects of city life (at least for certain people in some cities), it also has the potential to exacerbate existing inequalities and create new ones. To make educated decisions about which parts of urban life must be automated or robotized and to manage and control these developments within frameworks of equitable and responsible innovations, urban research must urgently scrutinize claims of the potential of RAS technologies.

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