World Academy of Science, Engineering and Technology
International Journal of Architectural and Environmental Engineering
Vol:15, No:2, 2021

Flexible Cities: A Multisided Spatial Application of Tracking Livability of Urban Environment

Maria Christofi, George Plastiras, Rafaella Elia, Vaggelis Tsiourtis, Theocharis Theocharides, Miltiadis Katsaros

Abstract**—**The rapidly expanding urban areas of the world constitute a challenge of how we need to make the transition to "the next urbanization", which will be defined by new analytical tools and new sources of data. This paper is about the production of a spatial application, the 'FUMapp', where space and its initiative will be available literally, in meters, but also abstractly, at a sensed level. While existing spatial applications typically focus on illustrations of the urban infrastructure, the suggested application goes beyond the existing: It investigates how our environment's perception adapts to the alterations of the built environment through a dataset construction of biophysical measurements (eye-tracking, heart beating), and physical metrics (spatial characteristics, size of stimuli, rhythm of mobility). It explores the intersections between architecture, cognition, and computing where future design can be improved and identifies the flexibility and livability of the 'available space' of specific examined urban paths.

Keywords**—**Biophysical data, flexibility of urban, livability, next urbanization, spatial application.

I. Introduction

OVER the last three decades, the advent of digital media has sparked the overlap between design, research tools, and cognitive architecture. The evolution of technological tools and computational models for collecting real-time observed and reported data appears to focus on five board areas [1] related to how the built environment affects the subject's experience, or, alternatively, how the design process is being affected. Although various spatial tools have been suggested, it was after the mid-1980s where most of the spatial models and tools embraced detailed multisided mechanisms. The proposed tools' structure had light up the requirement of sophisticated methodologies, models, and tools for more clarified measurements, hypotheses, and investigation of relationships between space, computing, and behavior.

More precisely, scientific, computational models were developed, translating existing theories to models that allowed the control of experiments in a computable abstraction system. In general, the assumption for the development of computer models was that traditional rules of theoretical models and methods in which development was based could be refined to engender greater explanation parsimony. However, most of the Spatial Computer Models (SCM) that appeared from 1950 onwards were designed based on the fact that their results validation would be checked through the system data, reproducing computer models' interest in a way closest to the real. This led to the automation of SCM and tools, and the most effective calibration of design variables was accomplished. Hence, tools and applications with greater detail and heterogeneity were constructed, supporting multiple formats of documents for automated design, contextually-sensitive design techniques, self-adjusting structures, etc. (some application areas for spatial cognition research appeared in Table I). However, the complexity of those tools and uncertainty within the application domains has been limited in space's Euclidean characteristics and the built environment.

Over the years, various research groups attempted to build complete intelligent tools and applications by combining different algorithms for speech and language recognition and understanding, navigation, vision, planning, manipulation, etc. [2]. All of these attempts hit an insurmountable wall of complexity because of the lack of a unifying framework, letting down 'knowledge engineers', who believed that their limitation would soon become apparent. Inevitably, space, time, and human complexity have rarely been synchronized before.

TABLE I
Application Areas of Spatial Cognition

Areas Spatial Cognition Appears
Location-based Services
Geographic and Other Information Systems
Information Display
Architecture and Planning
Spatial Education

II. Background

The use of SCM and their algorithms, in a predefined framework, has made it possible to adapt effective action orientation and design strategies at the scale of the urban environment, minimizing the complexity's issues. The integration of algorithms such as Voronoi, L-systems, Cellular Automaton, etc., in urban design has been welcomed by two changes in thinking of urban designers about the next urbanization and its design strategies and guidelines. Firstly, in the last few decades, this integration has shifted the planning ideals from master to strategic planning, where the implementation of the design concept is more important than a

M. Christofi and Dr. M. Katsaros are with the National Technical University of Athens, School of Architecture, 42 Patision str, Athens, 10682, Greece (corresponding authors, phone: 00357-99814969; e-mail: christofimaria.arch@gmail.com, m.katsaros@m2k.gr).

G. Plastiras, R. Elia, and Dr. Th. Theocharides are with the University of Cyprus, Department of Electrical and Computer Engineering, and KIOS Research and Innovation Centre of Excellence, 1 Panepistimiou Avenue, · 2109 Aglatzia, Nicosia. P.O.Box 20537 Nicosia, Cyprus (e-mail: gplastiras01@ucy.ac.cy, relia001@ucy.ac.cy, ttheocharides@ucy.ac.cy).

V. Tsiourtis is with the University of Cyprus, Department of Electrical and Computer Engineering, 1 Panepistimiou Avenue, · 2109 Aglatzia, Nicosia. P.O.Box 20537 Nicosia, Cyprus (e-mail: vtsiou01@ucy.ac.cy).

generic master plan. This generated a need for designers to be able to make adaptations to the perpetually or constantly changing patterns of the examined environment. Although simulations and SCM offered that kind of flexibility, multiple variables responsible for the changes in patterns were neglected. However, the extrapolation of simulations and SCM has allowed the designers of urban to assess the implications of their proposals.

Secondly, those tools induced new design proposals that were more integrated [3]. The urban environments have been understood as environments that function in real-time by self-organizing and are dependent on emergent potential entities. What is crucial to be mentioned here is that, one of the most severe disadvantages identified within the majority of intelligent SCMs and tools, is the absence of emotions in the total syllogism of which they are structured. This speculation is what establishes emotions as a critical point of human behavior. Recently, some new tools were intended to collect real-time observed data. Sensors and virtual reality apparatus embedded in the recording process and practices appeared and better understood and planned the human spatial experience [4], [5].

The control of the divergence degree of users', through computational methods, predicted and observed reactions towards their future emotional state, promotes the primary field of research of intelligent algorithms compiled. The fundamental research on computational sciences aims to shift the design methodologies from its somewhat austere-restrictive demands prescribed by the designing and recording programs to the design perceptual, independence of the user's cognitive variables. Considering the general researching of Woolf [6] and being slightly shifting his questions, new scrutiny especially crucial for the architectural community begins. Thus, a computer platform can offer access to the spatial information recording and coordinating structural and spatial content. However, the users' emotions and spatial needs that could be determined through this computer platform are debatable. In other words, this speculation relates to the user's emotions with all the stimuli that could be received. According to this, a dependency between the future spatial tools and the collected spatial and design data is gradually synthesized.

The objective of this research is to introduce the development of the Fragmented Urban Mobility application (FUMapp)- a mobile application to explore the dependency of urban stimuli with human reactions (a vital variable for urban patterns' observed changes that were previously neglected). The results and data that FUMapp will collect aim to reset and answer fundamental questions for new urbanization designs omitted, such as those related to the (re)development potential of the existing environment. The answer to those questions will highlight strategies for 'new wellbeing urbanization' and the development of a framework for a broader debate around a more 'human-centric' urban design approach. Research tools like FUMapp, designed with a sophisticated research methodology based on architectural and computational theories, highlight a fine-tuned examination of the relation between brain, behavior, and urban design, without ignoring crucial architectural and urban principles. This paper documents the steps of developing this multisided spatial application.

A. Connected Data

A simplified representation of the environment on which SCM would apply was the general assumption for those models and tools when they were first developed. The advancement within 'reality capturing' (RC) and 'virtual reality' (VR) served this purpose and made it possible to create full-scale replicas of the examined environment [7]-[9]. This allows the investigation of the human experience of designed and built space in a digitally replicated virtual space, in a different location than the real one. Although studies [10] based on VR and RC document multiple transitions between physical space and their replicas, they have yet to impact significantly design theories of space and SCMs and tools. The cognition of space and architectural features is being applied to multiple spatial issues (orientation, the appropriate level of privacy, level of sociability, feelings of safety, etc.) either during the design and construction of an environment or later during the improvement process of an already constructed environment. FUMapp aims to merge those architectural features and techniques with cognitive technologies in a real environment.

The understanding of human reactions should lead to the design of more efficient spaces. Spatial variables like differentiation of appearance -in terms of form, size, architectural style, color, etc., visual access- related to viewer's position and characteristics such as height and visual acuity, signage -in terms of design placement decision points, and layout complexity- related to the shape and patterns of the space, were identified by Weisman [11] as variables that affect the salience and perceptibility of spatial features. They also appeared to affect the memorability of spatial stimuli and the applicability of different reaction strategies. Although were broadly accepted, the lack of a variety of factors that could influence the spatial reaction of users like the form of some environmental shapes (as it Gestalt concept of Pragnanz) [12] were not included.

Trying to examine specific architectural stimuli, based on previous architectural knowledge, preselected examined urban paths supported by FUMapp, were tested for cognitive distortions toward their forms of the stimuli. The sets of spatial stimuli and data archived on FUMapp form the starting point for a database spatial reaction pattern recognition application, which archives spatial features and cognitive reactions practically usable for space designers. In general, the results exported and archived from the pilot experiments with FUMapp suggest that users have developed cognitive processes and reaction patterns, which lead them to common cognitive reactions to spatial stimuli. The investigation of architectural features revealed that different perceptual effects could be detected in the recalling process associated with multiple variables. FUMapp can also measure and reproduce specific spatial stimuli that cause preconscious reactions of users. This allows the extension of evidence-based design principles to the influential memo-activity and distinctiveness of urban design. The experimental verification process of the application was described in [13].

III. The Nature of FUMapp

FUMapp is a 'drawing strategy' in an application that 'pictorializes' spatial stimuli, making them easier to remember and record. It follows psychological tests that have shown that data divided into steps and pictures receiving more processing attention and acting as more effective stimuli than words, numbers, mainly when people are busy, multi-tasked, or distracted (like in a navigation process) [14].

A. FUMapp Implementation

FUMapp is implemented on Android Studio using Java programming language to archive and synchronize components with different formats and addresses model compatibility aspects of biometric representation and spatial characteristics. This includes devices such as a smartwatch, eye-tracking glasses, and an android device. The experiment methodology, divided into four steps, is presented in Fig. 1. The first step is preparing the context of the application. It includes registration and consent form from the subjects that is updated based on the city/country where the experiment is conducted. The second step is to format the data structure and archive capabilities of the application, including storing and loading, exporting, and deleting data for each subject. In our case, we used the SQL-lite database for storing all the information in our app. The third step is the synchronization of the data between the devices. A set of pupil glasses from Pupil Labs is used for eye-tracking along with a Polar Ignite smartwatch to monitor and capture the subject's vital information. The fourth step comprises the reproduction of a virtual 3D environment for each of the examined paths – and the collection of spatial data and creating the 3D environment-wherein a subject can navigate him/herself. This is part of the recalling process where subjects can mark as a 'Highlighted Recalled Spatial Stimuli' (objects/sidewalks/buildings) of the path, be recalled easier. Although many elements were pre-defined based on architectural theories and background, multiple structural elements and contents had to be established in the design process's first activity.

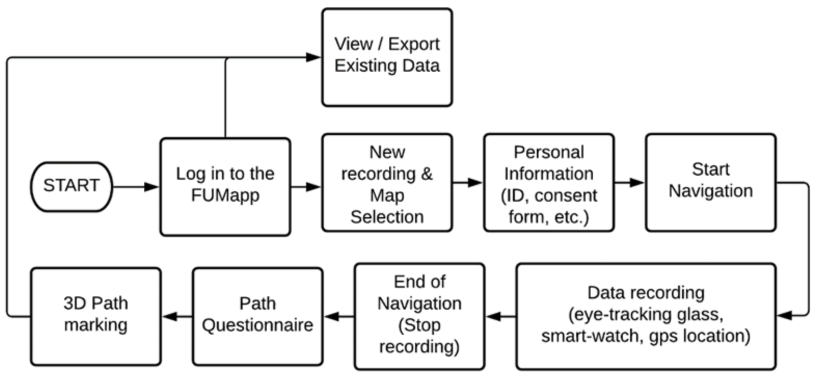

Fig. 1 FUMapp processes

FUMapp starts by presenting a log-in screen, where the researcher, as the primary user of the application, needs to add his/her credential to use and have access to the FUMapp. Since all the information stored in the application is confidential, this step prevents other people from accessing these data. After successfully logging in, the researcher has two options: either examine a saved recording (view, update, delete, export the stored data from subjects) or start a new recording. The first option gives access to the captured data from all the subjects for a specific area, delete the data of a subject using his ID, and export the data into a .csv file by sending them directly to the researcher's email. In that way, there is no dependency on third-party services for exporting or uploading the data, which maximizes the designed application's privacy and security.

Selecting the second option, a researcher can create a new recording, choosing the path where the experiment will be conducted. In the first release of FUMapp, paths from Athens (Greece), Copenhagen (Denmark), Nicosia (Cyprus), and Boston (USA) are included. The subject (a person who takes the experiment) has to select and confirm his/her path choice. After the confirmation, the ID notification appears in a form layout, where the subject needs to fill in his/her personal information. ID notification process includes gender, age, height, nationality, and the country where he/she spends most of his/her lifetime and education. The next step is to fill in the consent form. This form can be updated based on the experiment and also the country where the experiment is conducted. Since FUMapp examines vision-real-environment reactions and connections using tracking sensors for eyes, the subject needs to fill in a few questions about vision problems, epilepsy, or migraine. The consent form is also related to some statements about the stored data and the subject's rights. The application supports e-sign of the form, from both the subject and the person conducting the experiment enabling the better organization and paper-free experiments. Finally, the application creates a new addition to the table based on the subject's ID containing the personal information, signature, and the consent form. The template of the FUMapp as selected flow captions appeared in Fig. 2.

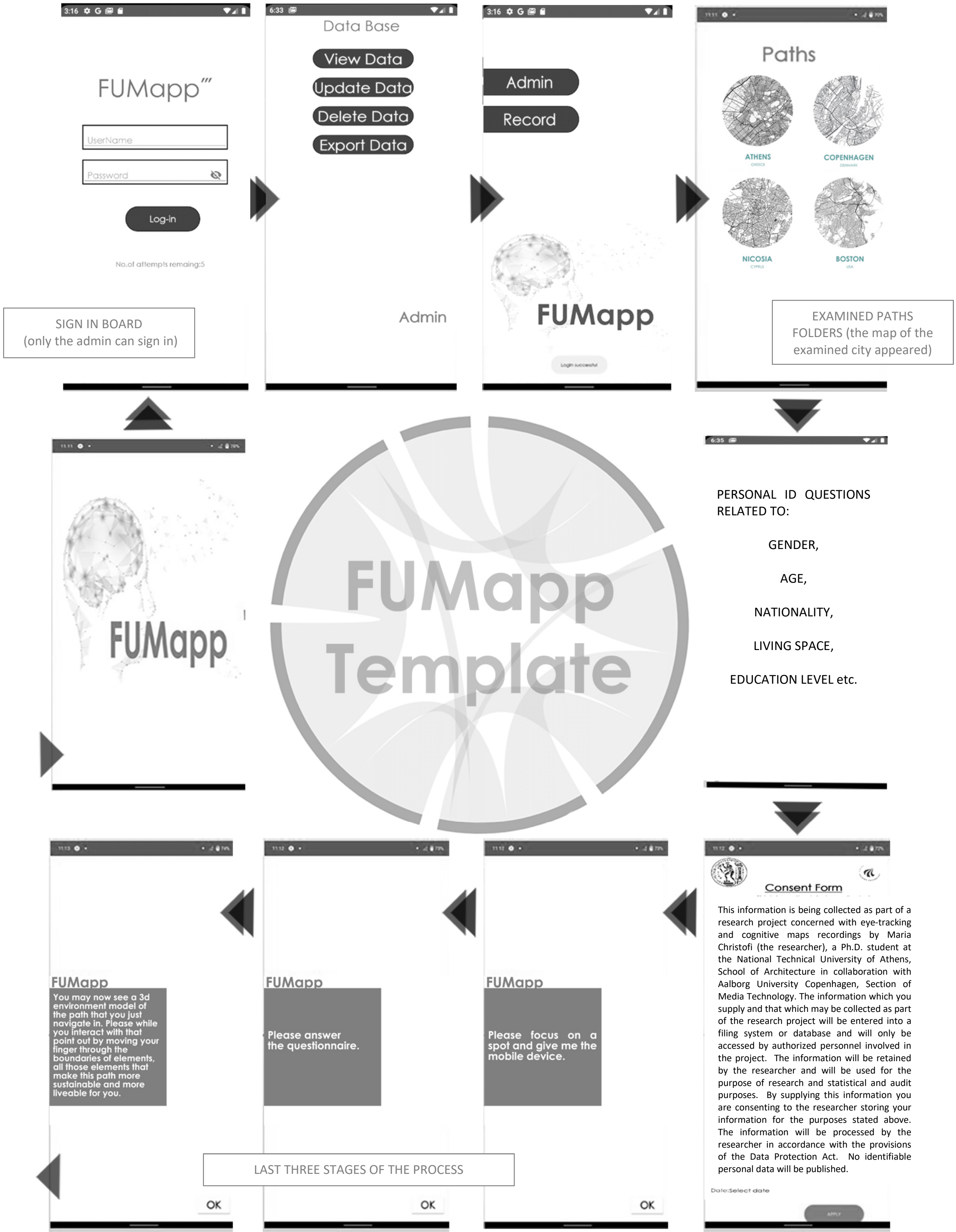

Fig. 2 FUMapp template flow captions

A challenging and important step for creating FUMapp is the synchronization of various devices to collect and store all the information. This phase is done in stages, starting from the calibration stage where the subject wears the glasses and the researcher makes sure that the subject's pupil core is robustly detected and tracked, and that the headset is comfortable for the subject. The calibration starts, and the subject needs to follow a dot presented on the screen so that the data collected during the calibration period are used afterward to correlate the world camera with the eye cameras. In both cases, FUMapp presents a screen message on how both the subject and the researcher need to proceed. After confirming that the calibration was completed, the synchronization starts by pressing a start button on the screen. Since the data acquisition from the glasses starts automatically during the calibration, when the start button is pressed, a timestamp is associated with it making it easier to synchronize the data at the end of the path. This button enables the data synchronization/ acquisition from the glasses and the data collected from both the Polar watch and the android devices. During that stage, the FUMapp screen is turned off and keeps monitoring and collecting the information. FUMapp uses the GPS location of both the android device and the watch during this stage. When the subjects reach his/her final destination, the screen of the application automatically lights up, and a "Stop Navigation" button appears, which ends the sensor's recording. When the button is pressed at the end of each recording, a message appears on the screen, instructing the subject to take off his glasses and answer a series of questions for the device's recalling process.

Lastly, FUMapp supports navigation through a virtual 3D environment where the subjects have to mark the frame of Highlighted Spatial Stimuli (objects/sidewalks/buildings) of the path. The stimuli can be easier recalled and remembered by the subjects. To enable 3D navigation, we used an Unmanned Aerial Vehicle (UAV) to capture a video from the selected sites, flying at low altitude and a predefined angle and speed similar to the subject's walk and view. The UAV video is pre-loaded on the FUMapp for each of the four paths, and the subject can play it and pause it at each frame. The subject can mark each frame (buildings/sidewalks/objects) using the touch screen of the mobile device. If a region is selected, a drop-down list appears where the subject needs to specify the reason for recalling this particular region. The drop-down list is pre-loaded and can be updated according to the experiment. Each frame is stored as an image with its associate marked region and the selection reason.

When the recording ends, all the data are provided, such as the personal information of the subject who participated in the experiment with its corresponding ID, the consent form, eye-tracking data, smartwatch data, path questionnaire, and recalling 3D stimuli data (images and regions) are combined in a folder and stored. However, since there is a dependency of the recordings collected from eye-tracking glasses on the iMotion Software, the analyzed data are exported from the Software, and then the researcher can import them to the FUMapp application and associate them with the smartwatch data and GPS location. As we stated above, these data will be stored in the app for further analysis and can be extracted from the administrator – researcher. The data can be exported as a .csv file, where each column contains the participant's personal information and the answers from the questionnaire. Furthermore, another .csv is created for each participant containing a series of timestamps with the corresponding GPS location and the subject's vital information (Heart Rate, Speed, etc.). Lastly, a folder is created containing the selected frames with their corresponding selected region. FUMapp was tested in an experiment conducted in Copenhagen's urban path presented in [13], showing create potential.

B. The Complexity Problem

FUMapp needs to run within a time frame and need to rate changes in navigation speed, landscape heterogeneity through the recalling process, and the synchronization of multiple sensors. This raised particular issues during the design process that had to be investigated. The first issue was the limitation and the dependency on iMotion Software. The limitation of the use of iMotion Software for extracting the fixation points and aggregate signals extended the step of the exporting and storing data process. To overcome this problem, the application's design team manages to start the recording using the pupil labs application and then import the data directly on the FUMapp, to associate them with the data extracted from the smartwatch and the mobile device. Another issue during the design of FUMapp was the synchronization of various sampling rates between the devices. A timestamp and a GPS position are associated with every measurement, allowing multiple sensors and trackers to synchronize. In that way, the data are grouped, and the path is filled with the corresponding data at each location.

IV. Spatial File Organization

Along with the internal constraints, FUMapp has the capacity to react to exogenous analysis, which in architectural terms can provide responses to particular types of stimuli or how the spatial information is represented. FUMapp has two primary mechanisms for filing data organization - initial spatial data lists (related to the recording part of the experimental process) and multitype import data (related to the analyzed data in exogenous software). The whole process produces folders for each subject that consider from the recording part a .csv list of ID information of the subject, navigation path information, and path questionnaire answers, and .jpg files from the recalling process. Furthermore, from the analyzed data, saved folders include heatmaps .jpg files of the Areas of Interests (AOI), aggregate paths in .csv lists and .mp4 video files, AOI .csv lists with fixation durations, the number of revisits, and the ratio of observation. The structure of FUMapp is summarized in Fig. 3.

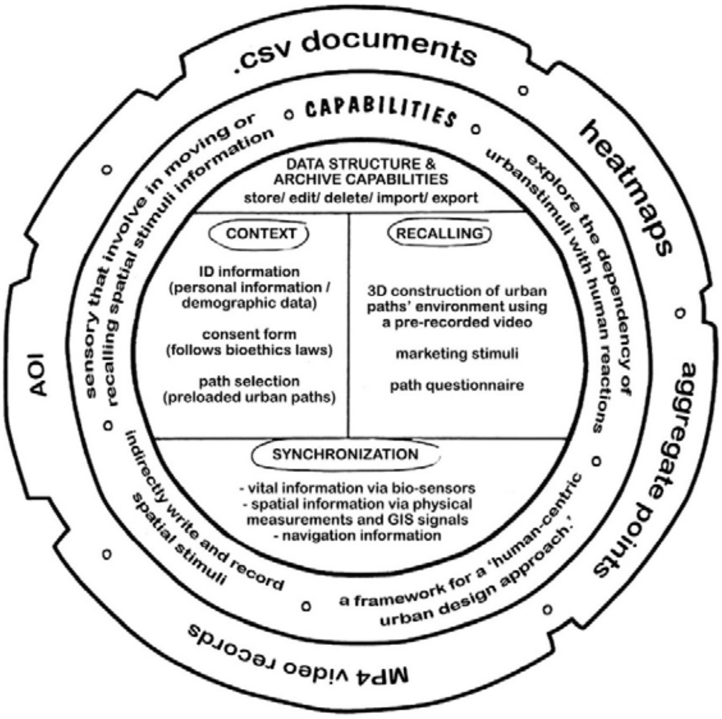

Fig. 3 Summarized structure of FUMapp

V. Conclusion

The paper has presented a multisided spatial application that includes multiple sensors and spatial data. The application's design process used an approach where spatial stimuli were imported in a database to examine possible extensions of design practices for flexible cities more livable. Subjects are given a step-by-step digital experiment via the FUMapp to indirectly write and record spatial stimuli using a Java language. The collecting, entering, and filing of all those data in just one application allow FUMapp to solve a design problem - the hypothetical reaction of users in the built environment. FUMapp attains not only to produce a spatial stimuli archive useful as an analytical tool for designers but also to highlight the human's behavior spatial mechanisms that impact subjects' ability to navigate and recall a livable urban environment. The implication of the overlap between cognitive reactions of subjects, spatial stimuli, computational data collection, and sensored mobility is that perhaps the cognitive reactions of subjects will, at least in part, applied in the design process not as a hypothetical scenario but as real data.

Another important caveat that FUMapp's data show is that not all of what appears stimuli or sensory are necessarily involved in moving or recalling spatial stimuli information. Besides, one significant issue in the flexibility of urban design is dealing with the heterogeneity of the background of the subjects. The preloaded four paths and the subjects' diversity recording data for the application supported this issue of inclusion.

Future work will attempt to solve the issues related to other software to make the application more adaptive. For instance, a code for the analysis of eye-trackers' data may be specified. The improvement of the application will also focus on incorporating other sensors and modeling paradigms. A statistical analytic coding part will be an additional advancement of the application. This will open new possibilities for design strategies tie to spatial context for more flexible urban specifications.

Acknowledgment

This work was supported by the Sylvia Ioannou Charitable Foundation, Cyprus.

References

[1] J. P. Eberhard, *Brain Landscape: The Coexistance of Neuroscience and Architecture.* New York, Oxford, Oxford: University Press, 2009.
[2] P. Domingos, *The Mater Algorithm: How the Quest for the Ultimate Learning Machine will Remake our World.* New York, NY: Basic Books, 2015, ch.1.
[3] P. Schumacher, "Parametricism: A new global style for architecture and urban design," in *Architectural Design, vol. 79*, 2009, pp. 14-23.
[4] F. Benita, G. Bansal, B. Tunçer, "Public spaces and happiness: Evidence from a large-scale field experiment," in *Health and Place, vol 56,* 2019, pp. 9–18.
[5] P. Joshi, S. Srinanda, J. Hobson, "Experience with surveying and mapping Pune and Sangli slums on a geographical information system (GIS)," in *Environment and Urbanization, vol. 14*, October 2002, pp. 225-240.
[6] B. Woolf, "Intelligent multimedia tutoring systems," in *Communications of the ACM, vol. 39, no. 4*, 1996, pp. 30-1.
[7] W. Barford (ed.), *Fundamentals of Wearable Computers and Augmented Reality.* 2nd ed., USA: CRC Press, Boca Raton, 2017.
[8] K. Reaver, "Three case studies in virtual preservation. Applying virtual reality to Cultural Heritage," in *AGATHON-International Journal of Architecture, Art and Design,* no 06, 2019, pp. 210-217.
[9] J. Buthke, N. M. Larsen, S.O. Pedersen, and C. Bundgaard, *Adaptive*

Reuse of Architectural Heritage. C. Gengnagel, O. Baverel, J. Burry, T. M. Ramsgaard, and S. Weinzierl, Eds. Springer, Cham, 2020, pp. 59-68.
[10] Impact – Design with All Senses. DMSB 2019, (Online) Available at: doi.org/10.1007/978-3-030-29829-6_5 (Accessed 30 October 2019).
[11] J. Weisman, "Evaluating architectural legibility: Way-finding in the built environment," in *Environment and Behavior, vol 13,* 1981, pp.189–204.
[12] R. Arnheim, "Prägnanz and its discontents," in *Gestalt Theory, 9*(2), 1987, pp. 102–107.
[13] M. Christofi, M. Katsaros, and S. D. Kotsopoulos, "Form follows brain function: A computational mapping approach," in *Procedia Manufacturing, vol. 44*, 2020, pp. 108 – 115. The 1st International Conference on Optimization-Driven Architectural Design (OPTARCH 2019).
[14] J. M. Groh, Making Space: How the Brain Knows Where Things Are. Cambridge, Massachusetts, London, UK: The Belknap Press of Harvard University Press, 2014, ch.9-10.

Maria Christofi was born in Nicosia, Cyprus in 1989. Christofi is currently a Ph.D. candidate in Cognitive and Computational Architecture in the National Technical University of Athens (NTUA), while she holds a BSc in Architecture and DipArchEng from University of Cyprus (UCY), and a MSc in Space-Design/ Cognitive Architecture from NTUA.

Her recent research explores the intersections between architecture, cognition, and computing. She investigates how our environment's perception adapts to the alterations of the built environment. Her methodology is based on a situated computing practice that investigates spatial-cognitional phenomena across different scales. As a researcher, she has collaborated with Augmented Cognition Lab (AAU), MesArch Lab (UCY), National Technical University of Athens, University of Cyprus, and Franklin and Marshall University. Samples of her work appeared through the papers: M. Christofi, M. Katsaros, S.D. Kotsopoulos, "Form follows brain function: a computational mapping approach," in *Procedia Manufacturing* vol.44, 2020, pp.108-115. M. Christofi, G. Plastiras, R. Elia, V. Tsiourtis, T. Theocharides, M. Katsaros, "Sensor synchronization for android spatial applications," in *2020, 13th Cyprus Workshop on Signal Processing and Informatics (CWSPI),* pp.6,17. and M. Christofi, G. Plastiras, R. Elia, V. Tsiourtis, T. Theocharides, M. Katsaros, "Flexible cities: a multisided spatial application of tracking livability of urban environment (Periodical style-Submitted for publication)," *ICCSAD 2020: 14. International Conference on Computational Simulation and Architectural Design*, submitted for publication.

Christofi is a registered architect in the EU since 2013 and have several years of experience in architecture practice. During her studies received the Athanasios Ktorides Foundation Fellowship, the Sylvia Ioannou Fellowship, the Cyprus State Scholarship Foundation Fellowship, the DOMES International Magazine Award, and the International Allplan Young Architects Award.

George Plastiras is a Computer Engineer Ph.D. student with a full scholarship at the University of Cyprus and he is currently a Researcher at KIOS Research and Innovation Center of Excellence. Plastiras has received his B.Sc degree in Computer Engineering from the Department of Electrical and Computer Engineering at the University of Cyprus in 2016. He received his M.Sc degree. in Computer Engineer in the Department of Electrical and Computer Engineering at the University of Cyprus in 2018. His research is involved in the fields of computer vision, artificial intelligence, neural network optimization for embedded systems.

Rafaella Elia is currently a Ph.D. Candidate in the Department of Electrical and Computer Engineering at the University of Cyprus. Elia joined KIOS Research and Innovation Center of Excellence as a research assistant in the field of biomedical signals processing, including machine learning, pattern recognition and wearable sensors. She has received her B.Sc. degree in Electrical Engineering from the Department of Electrical and Computer Engineering at the University of Cyprus, in 2017.

Vaggelis Tsiourtis is currently an undergraduate student in the Department of Electrical and Computer Engineering at the University of Cyprus. Tsiourtis thesis project focuses in the development of android applications.

Theocharis (Theo) Theocharides is an Associate Professor in the Department of Electrical and Computer Engineering, at the University of Cyprus. Theocharides received his Ph.D. in Computer Engineering from Penn State University, working in the areas of low-power computer architectures and reliable system design. He was honored with the Robert M. Owens Memorial Scholarship in May 2005. He has been with the Electrical and Computer Engineering department at the University of Cyprus since 2006, where he directs the Embedded and Application-Specific Systems-on-Chip Laboratory. He is also the Director of Research at the KIOS Research and Innovation Center of Excellence.

Dr. Theocharides research focuses on the design, development, implementation, and deployment of low-power and reliable on-chip application-specific architectures, low-power VLSI design, real-time embedded systems design, and exploration of energy-reliability trade-offs for Systems on Chip and Embedded Systems. Theocharis focus lies on acceleration of computer vision and artificial intelligence algorithms in hardware, geared towards edge computing, and in utilizing reconfigurable hardware towards self-aware, evolvable edge computing systems.

Miltiadis Katsaros is an Assistant Professor, at the Department. of Technology and Innovation in Architectural Design, School of Architecture, of the National Technical University of Athens, since 2014. Katsaros is the Head of the Acoustics Research & Simulations Laboratory, of the School of Architecture, NTUA, since 2018. Maintains a private practice since 1993. He is an accredited Dipl. Architect Eng. NTUA (1991), and holds an MArch 2nd Professional Degree (1993) and a Cert. in UDes (1995) from the University of Pennsylvania.

Among other awards and distinctions, he is a Fulbright scholar and alumni. His academic activities (research and education) focus in (a) building tectonics, (b) advanced architectural technology & innovation, (c) EPBD & sustainability in architectural design.

Katsaros maintains a private practice since 1993. He has participated (privately or in partnership) in 18 architectural competitions in Greece and abroad, with 10 distinctions (5 First Prize Awards). Co-founder of M2K architects since 2001; Has designed in person or in the context of partnerships, projects for public buildings, mixed-use offices and retail, residential developments, private houses, commercial and industrial buildings, interiors, urban design projects, restoration and conservation of historical buildings.