Automation in architecture and its effect on the regeneration of traditional buildings: Al-Shawi House as a case study

Osamah Abdulmunem Al-Tameemi¹, Tara A. Toma¹
Dept. of Architectural Engineering, University of Baghdad, Baghdad, Iraq

Abstract
The increased applications of technology in the field of architecture, especially digital technology and aspects of automation, have made a major impact on various aspects of local architecture, especially the traditional ones. As these technologies have succeeded in integrating many technological applications in many traditional and heritage buildings and taking them to more complex uses. And included in it characteristics that were not contained, therefore the research problem was concentrated in the absence of a holistic view of the role of the aspects of automation as a technological and design effect and its mutual effects on traditional buildings (especially the traditional Baghdadi houses), in terms of their foundations, indicators and use aspects, where the research aims to apply the characteristics of automation through the complementarity of its features, and an attempt to formulate new traditional local architectural text strategically rooted by the technology. This contributes to the advancement of the declining reality of selected models of Baghdadi houses and the attempt to elevate the architecture and use of them through the use of the effects of automation in them. Communication between the past, present and future towards creating a building with a new spirit.

1. Introduction
The technological developments we are witnessing make it clear that the future is going beyond unexpected limits, which clearly appears to the person who follows the history of technology and the architectural creativity and the developments of the present. These changes coincided with the increase in technology applications in the field of architecture, especially digital technology and aspects of automation. As those technologies succeeded in integrating many technological applications and launching them into more sophisticated applications, which directly affected the architecture.

In order to demonstrate the importance of automation in architecture, this concept must be defined in general. This concept is generally called everything self-working without human intervention. It is defined as:
- The mechanization and integration of the sensing of environmental variables (sensors).
- Data processing and decision making by computers.
- Mechanical action, by motors or devices that apply forces in the environment, or information action by communication of processed information to people [1].

The development and diversification of automation systems has reached the point that some buildings whose construction is barely one-decade old have become unable to adapt to the new requirements of electronic connections in building modern and advanced communication networks and the feeding networks that characterize these systems.

Whereas the buildings equipped with automated control systems are those that are intelligent, so that they are able to respond and adapt continuously with improving the conditions of comfort for their
residents through a rapid automated response to achieve their functional, visual and psychological requirements, and provide comfort and safety, based on the work of a group of service systems consisting of automated and information systems. In addition to all this, building automation systems contain energy conservation systems, considering that the smart building contains computer, communication and control equipment that mainly depends on electrical energy, which requires the need to use technologies that help reduce the consumption of energy of these equipment, and energy savings throughout the building [2].

2. Research methodology
The research relied on the transition from general concepts of automation in architecture, to extracting the influencing aspects of automation in traditional architecture. So the methodology of the research depends on comparison analysis style through the creating of a theoretical framework that starts from the mentioned above knowledge rule and applying it to a local example to get some indicators that explain the role of Automation in the local architectural results. And that is through simulating the original house by building a design model similar to the original house on a certain scale, and inserting the effects of automation techniques on it to measure the extent of its impact on the resulting design.

3. Aspects of automation interventions in traditional architecture
- Kinetic systems: the use of modern technologies based on automated kinematic systems and operational systems by integrating the adaptability capabilities of kinematic systems with computer control mechanisms using building elements with flexible mobility controlled by the computer to adapt and respond according to the changing needs of the user.
- Safety: Automation applications provide safety requirements to control buildings automatically, by using advanced electronic systems to achieve safety, control, access control, fire protection and security systems for controlling the functions of the internal environment.
- Control of the internal climate: by using sensors that give the system the ability to respond to the environmental changes, it controls the heating, cooling, ventilation and air conditioning systems, so that the behavior of the system can be changed even without a person controlling it.
- Lighting: automated buildings provide lighting control system.

4. Traditional houses in Iraq (reuse and regeneration)
Heritage buildings are exposed to several temporal, climatic and human conditions that cause their fabric to deteriorate and erode their structure and elements, which made these buildings over time not adaptable to the requirements of the times.
Reuse of the building is one of the processes of preserving heritage buildings by modifying the building to be effective through the use of some advanced technologies, so that it can prevent the issue of abandoning these buildings. The building can be used either for its original functions or for a new one, and this is done either by preserving the building’s important features or preserving only part of it. The reuse of heritage buildings can be achieved in several ways:
1 -Renovation: It is the inclusion of new elements to the building in order to be compatible with modern requirements, such as modern lighting, elevators or any structural elements which are necessary for achieving its function while preserving the shape of the building, its interior spaces and its personality.
2 -Retrofitting: Retrofitting has the same meaning as regeneration, but taking into consideration the energy efficiency of building modernization. This is done within the framework of the building's adaptive reuse, whether it will be reused in its old function or in a completely different one.
3- Remodeling: Reconstruction of heritage buildings is a mean of reusing the building in order to achieve new functional requirements.
4 -Facadeism: is the preservation of the facade of the building, with the demolition and replacement of what remains behind.
5. Practical study: Al-Shawi traditional House

5.1 overview
A model of a traditional house, Saadoun Al-Shawi House, which overlooks the Tigris river, is taken as a case study to show the possibilities of reviving it and its effects. In order to revive this building, automation applications are added, to enable it to adapt to the requirements of the present and the future by adding new parts and technologies that were not available when it was originally built. As the building life cycle must be able to adapt to any kind of changes that can happen over time for the long run. Figure (1).

Architectural condition: The house consists of two floors, with a central courtyard overlooking all the spaces of the house, an external terrace overlooking the Tigris River, the condition of the existing ornaments is good, so it must be preserved.

The new function: The new program of the project is designed to achieve the continued usability of the building and its integration into the current and future cultural life of the city, therefore it has been suggested to be a cultural center with a museum, including (library, administration, seminar hall, exhibition rooms, terrace that overlooks the river).

Restoration plan: Although the new function is completely different from the original one, the interior spaces were preserved with only a change in the space functions. The new design respects the original exterior facades, which needs some restoration.

Figure 1. Al-Shawi House details (photos by Author)

5.2 Application of automation aspects to Al-Shawi traditional house
The research set out indicators extracted from the main axes of the theoretical framework, which reflected the possibilities of achieving aspects of impact for automation according to a set of applications and architectural treatments that have been associated with automation techniques and what can be applied to the local architectural model elected, and what this application produces from the evaluation values possible to come out with general intellectual standards which can be adopted as conceptual standards that embody the correlation between automation and its technologies as an influencer, and the reproduction of the building as a result.

5.3 Technical and automation interventions
A number of interventions were made using automation to achieve the required reuse according to the new function, resulting in the achievement of a set of characteristics as design outputs that respond to the effects of the application of automation techniques: movement, adaptation, flexibility and response. In addition to the necessity of doing primary means to revive this building before using automation techniques, it includes maintenance and repair of the building to ensure the continuous importance of the place and enhance the life of the building, including: insulating and protecting the walls to improve the thermal efficiency of the house by covering the walls from the inside only and not the outside To preserve the ornament, and also replace the windows of the house with double-glazed windows, as well as separate the floors using thin horizontal panels for protection. Figure (2).
5.4 Outputs of application of automation in architecture

1. Movement: There is an importance to the apparent movement in architecture and how it has the ability to release architecture from the state of stillness in which it is, in addition to the importance of the dynamic beauty resulting from the use of these technologies and its ability to give new dimensions to the building such as changing shape, ambiguity and moving from one state to another [3]. Movement is through moving parts, such as walls, openings, or structure. This concept was reached by using several means of automation, including the movable roof over the central courtyard, and also by lighting elements and modern techniques were programmed, which leaves a luxurious impression on people, especially in the exhibition area where filming Full 3D scene using lighting techniques with some 3D visual aids. An animated water scene was also created in the stair zone in the central courtyard. Figure (3).

2. Adaptation: It is the ability of the building to provide certain functions under changing conditions through design variables that have the ability to change their physical properties over time [4]. The movable roof over the central courtyard gives many possibilities for use depending on the function. Figure (4).

3. Flexibility: Flexibility allows buildings to remain in use for a longer period, thus avoiding the cost of mass demolition or reconstruction. These buildings are more suitable for their purpose by enabling adjustments to be made as needed to respond to changes in the function. This includes the ability of the building to respond to the future climatic changes taking place regarding adding, removing, and modifying communication and information networks according to the evolution of the technological progress steps of the information developments, which means providing flexibility factor in buildings [5]. Flexibility in the building was achieved through a set of mobile design elements that give the possibility for design and performance flexibility for spaces, and according to the internal functional effectiveness, that is clearly presented in figure (5).

4. Response: The term (respondent) means that the environment takes an effective role, as it begins to change according to effectiveness, whether it is complex or simple [6]. This concept was reached upon application by using interactive screens that respond to users, especially in the exhibition area.
Figure 3. Al-Shawi House modified section (Drawn and Designed by Author)

Figure 4. Al-Shawi House modified Plans (Drawn and Designed by Author)
6. Analysis

After reviewing the most important items and criteria that form the concept of automation techniques and its role in architecture and determining the most important variables and their possible values that relate to the items, this part will explore the extent to which these items, variables and possible values of the concept of automation as an influential standard in a traditional heritage building in Baghdad and how to achieve a set of outputs that has multiple architectural and non-architectural dimensions. Table (1) shows items and sub-variables related to it, which will be the measuring mechanism adopted to achieve these outputs and the desired results from the use of automation in such type of building.

| House as built | Automation Items | Automation outputs | Results from the use of automation |
|----------------|------------------|--------------------|-----------------------------------|
| walls          | Mechanical movement of new design elements | Visual and functional movement | ![ ]( ) |
| courtyard      | Moving ceiling   | Lighting input, interior climate control | ![ ]( ) |
| Internal spaces| Electronic sensors and systems | Response, interaction, control | ![ ]( ) |
| Details & ornaments | Lighting systems | Revive the details | ![ ]( ) |
7. The results from the application of automation in traditional architecture

Maintenance of heritage buildings and the associated use of a group of technical entries on them, have positive results in social, economic and tourism terms, as they aim to preserve the much-needed resources such as the physical fabric of these buildings, as well as intangible social and cultural values that form the basis of society. Among the most prominent results extracted from the impact of the use of automation on the building are:

- **Economic Results**: Automation applications are closely related to the economic side. Where these applications contribute to reduce the building's energy consumption as well as controlling all systems inside the building. All of these capabilities have operational implications that bring economic benefits, but they also provide a critical benefit to enhanced sustainability.

- **Environmental results**: Automation applications have a clear environmental impact, with many contemporary trends calling for reducing energy and natural resource waste, the impact of automation is significant in the area of building adaptation to the surrounding environment during the hours of the day to reduce unwanted solar gain and increase natural light, and reduce waste in energy, especially through the courtyards of traditional architecture.

- **Tourist results**: The use of automation applications in traditional buildings has major tourism implications, which are to revive these buildings with the same or other functions, which increases the opportunities for attraction to those areas.

- **Social results**: The development in various areas of life has reflected on the requirements of people, and they have become more complex and demanding for functional, psychological or aesthetic purposes. From a functional point of view, the use of automation means helps to revive buildings and urban heritage areas and encourages the various uses in these areas. Also these applications provide security to those buildings, that will encourage reviving them.

- **Aesthetic results**: From a psychological or aesthetic point of view, beauty values can be explored through the creative ability of the designer to find new aesthetic values by creating variable technical shapes in the same architectural product. This is closely linked to the use of impressive and automated technical elements such as modern lighting and influencing displays. Figure (5).

8. Conclusions

- Automation has succeeded in integrating many technological applications of architecture and launching them into more complex applications, which directly affected its products.

- Buildings equipped with automated control systems are often smart, as they are able to continuously respond and adapt to improve comfort conditions for their residents.

- The use of modern technologies based on automated motor systems and operational systems working on direct response that are related to the changing needs of use.

- Automation applications provide safety requirements to control buildings automatically to improve performance of internal environment functions and tools.

- Maintenance of heritage buildings and the associated use of a set of technical entries on them, which have positive results in social, economic and tourism terms, as they aim to preserve the resources that are most needed and achieve many social and cultural values.

- Rapid automated response to achieve their functional, visual and psychological requirements, and to provide comfort and safety, depending on ensuring this on the work of a group of service systems consisting of automated systems.

- Reuse of heritage buildings using modern technologies can be accomplished in a number of ways, including Renovation, Retrofitting and Remodeling, as well as Facadism Preservation.

- Adding automation applications in the traditional Al-Baghdadi house that made it able to adapt to the requirements of the present and the future by adding new parts and technologies that were not available when it was originally created.

- Outputs of automation application in architecture in general and heritage architecture in particular have produced many design features on the original building (movement, adaptation, flexibility, response)
- There are a lot of results drawn from the effect of introducing automation on the building, the most important of which are economic results related to aspects of economic feasibility.
- The use of automation applications in traditional buildings has major tourism implications represented in the revival of these buildings, whether with the same or other jobs, but having a great tourist attraction.
- Aesthetic values can be explored through the creative ability of the designer to find new aesthetic values by creating variable technical shapes in the same architectural product, and this represents the expressive aspect of automation applications in architecture.

References
[1] Sheridan T 2003 Humans and automation: system design and research issues, ISBN-13: 978-0471234289, Vol. 21.
[2] John A B 1992 the intelligent building, ISBN-13: 978-0134689357, Prentice Hall press.
[3] Moloney J 2011 Designing kinetics for Architectural façades – state change, ISBN-13: 978-0415610346. (British library).
[4] Loonen R 2010 Climate adaptive building shells: what can we simulate. MSc thesis (Eindhoven University of technology)
[5] Achen D 1998 Business development 1996/1997 . krantez-TKT Bday group. media log GMBH (Germany)
[6] Thun G Velikov K 2012 Responsive building envelopes, Routledge Press: London, UK, 2012; pp. 75–92.