A KNOWLEDGE BASED SYSTEM FOR COMFORT ANALYSIS OF INTERNAL ENVIRONMENT OF HOTELS

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ABSTRACT

A prime objective of hotel design is the provision of a good environment within the hotel. Several physical variables are usually involved in each aspect of the environment and indices have been developed to combine them in various ways which relate to people's responses. User expectation of comfort have been steadily rising and most people expect their accommodations in the hotels, motels or similar premises to be adequately comfortable. Therefore, careful analysis of its environment is essential. A solution of this analysis may well be provided by the use of computer.

In recent years, Knowledge Based System (KBS) and related Expert System (ES) have become increasingly popular computer software approaches and used to solve a wide variety of application problems. This paper addresses the KBS as an approach for comfort analysis of internal environment of hotels. The development of KBS for comfort analysis and the architecture of KBS is illustrated. The sources of knowledge of KBS is pointed out and the potential benefits of applying KBS to enhance the internal environment of hotels are discussed.

1. INTRODUCTION

In most countries a hotel is defined as a public establishment offering travelers, against payment, two basic services: accommodation and catering.

The internal environment and decor of hotels, motels and similar premises providing accommodation has to meet a number of specific requirements as follows.

A. Merchandising:

It must be attractive, create awareness, interest, and measure up expectations, provide a suitable level of sophistication, engender confidence in the standards of the premises and leave a memorable impression.

B. Operational:

It must be easy to clean and maintain a good standard of appearance, resist damage and facilitate repair, replacement and rehabilitation with minimum disturbance or difficulty.

C. Financial:

It must provide the maximum benefit of space and facility for the minimum cost including costs to upkeep and renewal [1].

D. Amenity:

A major function of buildings is to provide a comfortable environment, which conventionally is defined in terms of the following: acoustic comfort, lighting comfort, thermal comfort and indoor air quality. Building services specialists and architects have to consider these factors into buildings, with specified values and comfort conditions which laid down by regulatory bodies [2]. These comfort conditions are dependent on the standards of environmental control provided. The method of illumination and color emphasis, warmth or coolness of air temperature and surroundings, air freshness and movement, relative humidity and level, pitch and variability of noise will all affect the comfort of the occupants [1].

This paper attempts to enlarge the usefulness of comfort analysis of internal environment of hotels in order to enhance the comfort conditions of hotels to meet the user needs. The need for comfort analysis and comfort analysis components are discussed in section 2. Section 3 presents, Knowledge Based Systems approach and its structure. The Development of

KBS for comfort analysis of internal environments of hotels is discussed in section 4. The potential benefits of KBS and the conclusion are presented in section 5.

2. COMFORT ANALYSIS COMPONENTS

In any case, user expectation of comfort have been steadily rising and most people expect their accommodation to be adequately, heated in winter, cooled in summer. They also expect a reasonable standards of acoustic isolation and privacy. Therefore, careful analysis of the internal environment, control and comfort is essential [3].

The most important aspects of comfort analysis of internal environment of hotels are to maintain lighting comfort, acoustic comfort, thermal comfort and indoor air quality.

A. Lighting Analysis:

Lighting is an important element in architectural and internal environment. Internal lighting serve to emphasize features of the decor, to reveal or conceal surfaces, apparently heighten or diminish spaces, create patterns and textures and provide color and contrast. Illumination is used to draw attention to signs, directions, and hazards.

B. Acoustical Analysis:

The acoustical behavior of spaces is an important aspect of comfort analysis. There are several different considerations, acoustic isolation being perhaps the most important. Normally, this is the amount of interface within the space [3]. The transmission of noise from area to another within a hotel and the high levels of noise which can be generated and reverberated within large lobbies and public rooms and in work areas such as kitchens are acoustical problems should be solved in an efficient way. External noise is also a potential source of annoyance, not only in hotel and motel rooms facing the high

speed or concentrated traffic noises of high ways and streets, but also from adjacent car parking areas and from low flying aircraft [1].

C. Thermal Analysis:

The most important financial aspect of the environmental performance of a building is of course heating or cooling necessary to maintain comfort. Recommended standards exist against which the performance can be measured, thus evaluations straight forward [3]. Thermal comfort is defined as that condition of mind which expresses satisfaction with the thermal environment. The main requirement of the thermal environment is to create and maintain thermal comfort for the occupants. A second requirement is to do this at the lowest possible energy cost. However, due to the biological variance between people it is usually not possible to obtain thermal comfort for all occupants at the same time. The aim should be then to create optimum thermal conditions, i.e. condition where the greatest possible of the occupants are satisfied with the thermal environment [4].

D. Indoor Air Quality:

One of the main aims of the built environment is to provide its human occupants with an acceptable indoor air quality. The quality of the air that we breathe indoor is of great importance for our health and well being. An acceptable indoor air quality was defined by ASHARE as air in which there are no known contaminates at harmful concentrations. Also, as air with which a substantial majority (usually 80%) of the people exposed do not express dissatisfaction [5]. There are many factors affect the quality of indoor air such as interior building materials and furnishing, building moisture control, ventilation rate, indoor air pollutants, etc.

Comfort Ranges Assessment

Comfort is a subjective sensation. There is no such thing as a perfect combination of conditions for comfort since it is not possible to satisfy every one at the same time. Even when the optimum comfort conditions is achieved, only 50% to 70% of the population may feel comfortable, with the reminder feeling slightly comfortable or slightly uncomfortable. For instance, the comfort ranges of thermal environment were compared with average daily maximum temperatures. In order to be able to achieve comfort through the day, if it is also necessary to know the average variation in temperature at different times of the day. The average variation of air temperature and radiation will also affect the average variation in wind speed during the day [6]. On the other hand, the design of hotels should create a comfortable conditions for the activities which are likely to take place at a given time, even when the pattern is not optimal from a climatic point of view. A subjective assessment should be undertaken simultaneously with the physical measurements. A seven point scale of comfort condition ranges was used to evaluate the comfort sensation.

3. KNOWLEDGE BASED SYSTEM APPROACH

In recent years, Knowledge Based Systems (KBS) and related Expert System (ES) have become increasingly popular computer software approaches used to solve a wide variety of application problems, in a scientific domain, that are sufficiently complex as to require significant human expertise for their solutions [7, 8, 9]. KBS are more appropriate for use in solving semi structured or unstructured problems, i.e., problems for which a numerical model does not exist. The environmental analysis for comfort conditions field, like many other multidisiplinary areas is full of ill-structured problems in which social, political, economic and technical consideration are involved.

KBS are computer systems that advise on or help solve real world problems which would normally require a human expert's interpretation. Such

systems work through problems using a computer model of expert human reasoning. Thus, they are designed to reach the same conclusion that human expert would be expected to reach if faced with a comparable problem [10].

Knowledge Based System Structure:

The structure of expert system consists of: Knowledge Base, Knowledge acquisition module, inference engine, user interface and explanation of results. The Knowledge Base contains information from human experts in addition to facts provided by the user during interaction with the system. The knowledge acquisition system is a software module that helps in the collection of knowledge for the base from the set of human experts as shown in Figure (1). The inference engine deduces knowledge that is not directly contained in the base. The inference engine turns the KBS into an interactive system with which the user can interact. The inference formulates questions and may understand answers provided by the user in a natural language, it is also the mechanism for conveying recommendations to the user. Intelligent user interfaces, possibly employing an object - oriented environment, allow efficient interaction with the user. The explanation part provides a description to the user of why the system asked for some information and how the system arrived at a specific conclusion [11].

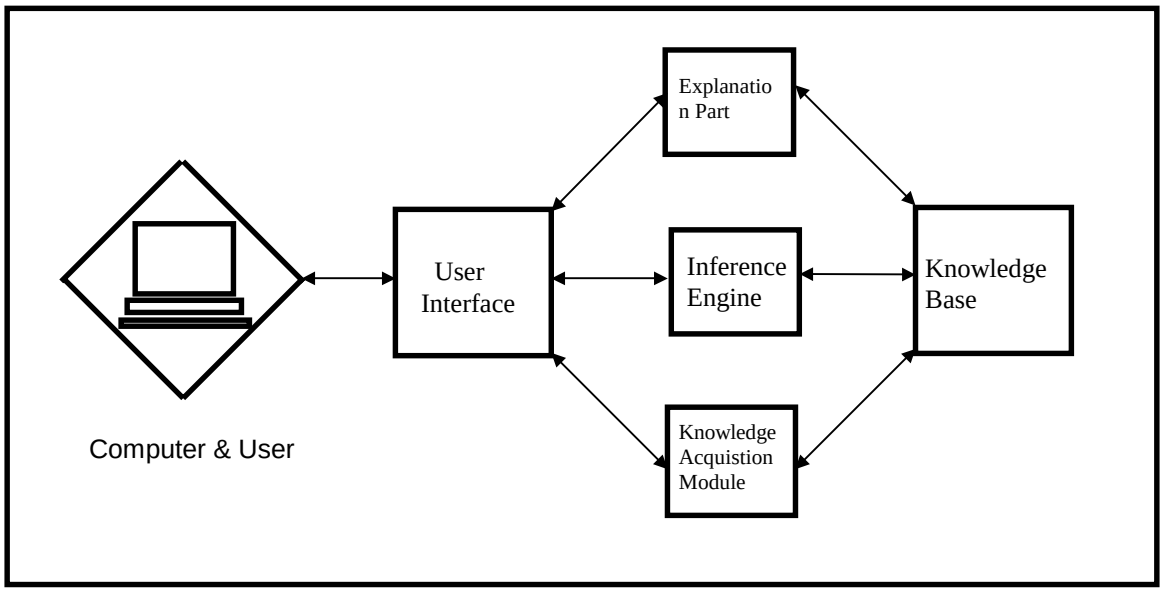

Figure (1) The Knowledge Base structure.

Knowledge Based Sources (Knowledge Acquisition)

Knowledge acquisition has been described as the bottleneck in KBS development. The goals of knowledge acquisition is to extract and Build the Knowledge base from human expertise[11]. The knowledge was extracted from an extensive literature review through related books, reports, projects and published papers. In addition to that, A structured questionnaire was developed covering most of the related aspects of comfort analysis of internal environment of hotels. Fifty professionals who considered experts in this area were interviewed and filled out the questionnaires. The analysis of their inputs integrated with the knowledge from literature were used to build the knowledge base of comfort analysis of internal environment of hotels.

4. DEVELOPMENT OF KBS FOR COMFORT ANALYSIS OF INTERNAL ENVIRONMENT OF HOTELS

Lighting, acoustic, thermal and indoor air quality are the main components of the knowledge base of comfort analysis of internal environment of hotels. Each one of those main components, for instance lighting, consists of a series of criteria used to investigate the internal lighting conditions and determine how these conditions meet the users need and satisfy their requirements. These analysis of comfort through a knowledge base used to figure out such a conclusion of the comfort of the internal environment of hotels.

The knowledge base of a rule based expert system consists of a large number of rules and objects. Rules are collections of "IF --THEN---" conditions, which are employed by the system to synthesize its solution. Objects are attributes that describe items of interest, objects are related to other objects by symbolic links through the "IS---A--" Mechanism [10]. The rule is composed of parameters and values. The rule assigns a value to the parameter if all or some of the conditions in the clause IF are met [12].

In this study, 185 rules are developed by creating a series of qualifier (sixty qualifiers). A qualifier has two parts: the first is an incomplete sentence

ending with a verb, and the second is associate values representing all the possible relevant situations to the qualifier. Some examples of the qualifiers are illustrated in Figure (2). The IF part of the rule consists of one or more of the qualifier's value and conditions that can occur The THEN part consists of another qualifier value or variable or choices and represents actions that must be taken [13, 14]. Examples of rules developed to carry out the comfort analysis of internal environment of hotels are illustrated in Figure (3).

/* Qualifier 20
Q> The Daylight Factor over the Whole Area (assume external reference illuminance = 10,000 Lux) is
V> Less than 2%
V> Greater than or equal 2% to less than 3%
V> Greater than or equal 3% to less than 5%
V> Greater than or equal 5%
Maximum acceptable = 1

/* Qualifier 46
Q> The Temperature Shifts (degree centigrade) is
V> Less than + or - 1
V> Greater than or equal + or - 1 to less than + or - 3
V> Greater than or equal + or - 3
Maximum acceptable = 1

Figure (2) Examples of qualifiers developed to build the KBS of comfort analysis.

/* RULE NUMBER: 59
IF:
The Daylight Factor over the Whole Area (assume external reference illuminance = 10,000 Lux) is {Less than 2%}
or: The Daylight Factor over the Whole Area (assume external reference illuminance = 10,000 Lux) is {Greater than or equal 3% to less than 5%}
THEN:
> The Daylight Factor over the Whole Area - Confidence = 7/10
and: [DFWA] IS GIVEN THE VALUE ((0.04) * 7)
NOTE:
Daylight Factor is the percentage of the illuminance on a horizontal plane due to an unobstructed hemisphere on the same sky.
REFERENCE:
"CIBS Code For Interior Lighting," The Chartered Institution of Building Services, London (1984).

/* RULE NUMBER: 60
IF:
The Daylight Factor over the Whole Area (assume external reference illuminance = 10,000 Lux) is {Greater than or equal 2% to less than 3%}
THEN:
> The Daylight Factor over the Whole Area - Confidence = 10/10
and: [DFWA] IS GIVEN THE VALUE ((0.04) * 10)
NOTE:
Daylight Factor is the percentage of the illuminance on a horizontal plane due to an unobstructed hemisphere on the same sky.
REFERENCE:
"CIBS Code For Interior Lighting," The Chartered Institution of Building Services, London (1984).

/* RULE NUMBER: 139
IF:
The Temperature Shifts (degree centigrade) is {Greater than or equal + or - 1 to less than + or - 3}
THEN:
> The Temperature shifts - Confidence = 7/10
and: [TS] IS GIVEN THE VALUE ((0.087) * 7)

Figure (3) Examples of the rules developed to constitute the KBS of comfort analysis.

5. CONCLUSION

The potential benefits of such system are to bring expert knowledge within the reach of less experienced engineers, thus reducing the need for an experienced professional in this area to attend to every step of analysis. Also this system would save a considerable amount of man hours and would allow the user to preserve the experts valuable knowledge and provides anew way to preserve knowledge. By using this KBS, appropriate decisions and accurate comfort analysis could be made quickly and the enhancement of the internal environment of hotels could be carried out directly and in an efficient approach.

A knowledge based expert system is capable of developing overall comfort analysis aspects of the internal environment of hotels and similar premises. As knowledge based system become more wide spread, the question of knowledge ownership will become of concern. The KBS is used as a tool for investigating the comfort analysis and is considered as a first step in the production of an integrated system for total buildings assessment

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