Expression of Tacit Knowledge by Actors of Smart Technologies

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Abstract. Industry 4.0 is an ever-expanding set of complementary smart technologies and at the same time a system of social interactions of people through technologies. The bottleneck of Industry 4.0 is a discrepancy of, on the one hand, informal dealing with knowledge performed by people meaningfully by means of natural language. On the other hand, the representations and operations of knowledge those being assumed and executed by computer without reference to human's reasoning. As a promising way to overcome this inconsistency, the article analyzes possibility of smart technologies development based on the concept of dual knowledge of Polanyi. There has been done an analysis of researches which touch the concept of dual knowledge and which propose methods to apply the concept in practice. The paper emphasizes the importance of taking into account the features of the use of natural language as a pragmatic way of expressing tacit knowledge by actors of smart technologies. To assist actors expressing their latent ideas the paper proposes a visual linking mechanism (VLM) for natural language utterances. VLM allows creating a technology that assists a person in a "spiral" process of expressing tacit knowledge and coordinates his own outcomes with the views of other people. The article explains the functioning of the VLM by the example of the expression of ordinary human knowledge and reports VLM instrumental features.

Keywords: Industry 4, ICTs, Implicit Knowledge, Human-Machine Interaction, Modeling of Social Processes, Tacit Knowledge, Visual Representation of Information

1 Introduction

Currently the main ideas of the "smart" approach of describing social process can be thought of under the common name Industry 4.0 [1–3]. On the one hand, Industry 4.0 is a conglomerate of smart objects that interact as part of smart grids. In other words, Industry 4.0 is an ever-expanding set of mutually intersecting technologies, such as the Internet of Things, Internet services, multi-agent systems, augmented reality systems and other technologies with sufficient availability of computing resources, communication tools and information storage [4]. As for smart (intellectual) social processes of a modern city, such processes are associated with smart cities [6–8]. "Now the definition of a smart city is interpreted by experts ambiguously. Yet their phrases agree on one thing: a smart city is driven by data, and data management allows municipal services to improve the quality of life of the population. The data cover such spheres of citizens' life as security, transport, medical services, utilities, improvement, etc." [7]. The social diversity of a city based on Industry 4.0 can be imagined by developing an architecture for the interaction of "smart objects" in the context of the urban environment, in which objects exist and interact with other components of this environment [8–11].

Industry 4.0, on the other hand, is the interaction of people through ICT, i.e., H2H conceptual exchanges [6]. Dragicevic et al. [12] proposed a conceptual model of Industry 4.0, representing in the form of a multi-level diagram the information society, functioning under the control of ICT. However, as the authors note [12: 207], in their conceptual model, only the H2M case of knowledge exchange between Industry 4.0 agents is presented.

This means that the fundamentally important act of the appearance in Industry 4.0 of information itself as "codified knowledge" (Mahmood et al. [13]) escapes the consideration.

From the standpoint of the dual concept on which the work of Dragicevic et al. is built, the appearance of information can occur only through the expression of a person's tacit knowledge (see, for example, Polanyi [14, 15]). H2H interaction just means the process of such expression. In practice, humans carry out their H2H interactions through natural language including all means of conveying meanings, i.e. metaphors, analogies, verbal narrations [16]. However, in an explicit form, the H2H transition will be expressed by a carrier of tacit knowledge in the form of text, audio file, video, etc. other speaking in the form of streams of symbols (letters, sounds, pixels). Unfortunately, computer agents of Industry 4.0 are unable to recognize precisely human meanings in such streams because they lack tacit knowledge mechanisms. Based on a comparative literature review, Dragicevic et al. [12] summarize "We were unable to define an integrated framework that would include knowledge-based activities of both machine and human."

The article proposes an approach focused on solving the problem of H2H interactions and not depending on the number of participating actors. The approach allows a person to formulate and transfer his tacit knowledge on his own and independently of other participants through the usual use of natural language, but in the form of graphs of a special kind. Such graphs, on the one hand, have a "meaningful" justification in human activity. On the other hand, working with graphs, where people express their tacit knowledge, creates new opportunities for conceptual integration of the H2M format.

The research tasks of the article are following. Firstly, substantiating the relevance of studying the dynamics of knowledge interaction in modern ICT and analyzing the existing scientific problems of such dynamics. Secondly, the identification of models focused on the instrumental expression of tacit knowledge by its own carriers as part of "smart" technologies. Thirdly, an explanation of the original mechanism for visual linking of natural language denotations a human uses to manifest his tacit ideas. Fourthly, the demonstration of the visual expression by the person himself of his ordinary tacit knowledge for subsequent computer processing.

2 Tacit human knowledge as an information basis for modern ICT

According to the concepts of dual knowledge [14, 15, 17], widely recognized in the field of knowledge management [18], the basis of any information functioning within modern ICT is the tacit (implicit, latent) human knowledge. Dragicevic et al. [12: 204] write "that knowledge is embodied (i.e., it doesn`t exist outside the knower), socially constructed (i.e., it is co-created by the human individual and social sensemaking), tied to a practice (i.e., it is inseparable from the interactions), and culturally embedded (i.e., it is shaped by the sociocultural context in which interactions occur) (e.g., [19, 20]. "All knowledge is either tacit or rooted in tacit knowledge" [21]. Following this view today, researchers continue persistent attempts to make the ideas of tacit knowledge a methodological basis for instrumental methods of knowledge management [22–24]. Participants of modern discussions note three interrelated key features of tacit knowledge of a person. First, such knowledge is inseparable from its carrier [25]. Second, individualized implicit knowledge is actually determined by the context. [26, 27] Third, implicit knowledge is difficult to formalize [28].

In the domestic literature on knowledge management of a philosophical orientation, for example, [29–31], the category of "tacit knowledge" is analyzed as one of the components of information functioning in social systems. This analysis does not aim at developing methods or proposals for the technological development of modern ICT.

In the works on knowledge engineering [32, 33] there is no mention of the "esoteric" category of implicit knowledge. However, the problems of transferring human experience to the information system are characterized as the most difficult in the extraction of expert knowledge [33]. The result of the analysis of emerging problems, de facto caused by the implicit form of people's thinking, are proposals for improving technology, for example, proposals for the development of tools for visualizing human knowledge [33].

The diversity of economic, cultural, demographic, political and other social processes supported by ICT forces researchers to involve actively processes' participants (actors) in the procedures for receiving and processing information. Thus, the idea of obtaining social information directly from those who create and apply this information in their social actions arises. A city under the control of ICT "lives" by the interaction of local government and citizens [8, 34]. As well, one of the most important components of a "smart city" is becoming "smart citizens" who are able to describe life situations with the necessary completeness and relevance [35–37]. Only they can make possible the existence of the best versions of smart cities by describing social processes quickly and with the completeness necessary to themselves.

3 Pragmatic use of natural language in describing social processes

The conventional role of computer agents in any ICT is to automate the retrieval and processing of information through which ICT actors interact. In the case of tacit knowledge, the information retrieval operation presumes an information creation action. This action serves for the manifestation by the man himself of his latent ideas, which exist in 'his individual head' and, consequently, hidden from others [24]. Typically, this explicit form is text (alphanumeric stream).

This transition from internal images of a person to their formulation in textual form is a person's prerogative. Consequently, the expression of tacit knowledge by a person as a part of ICT cannot be controlled by this ICT based on predetermined criteria [12: 204].

However, what truly is out of control in the conceptual actions of a person when he expresses latent knowledge? We believe that ICT cannot follow correspondence between tacit knowledge and its textual formulation, which the bearer of knowledge establishes with the help of speech. At the same time, the presence of the textual formulation itself, that is, the explicit expression of tacit human views leaves the possibility of analytical actions that can be performed not only by a person, but also by a computer program.

Moreover, assisting actions should be placed at the disposal of a person at the stage of expressing his implicit knowledge, and not in relation to an already formed body of texts. We emphasize the importance of computer assistance specifically for the phase of formation of a set of statements. The reason is that only the bearer of tacit knowledge has the opportunity to observe it during articulating in the form of statements. A recipient of these statements, different from the author himself, lacks any opportunity to connect to tacit knowledge already demonstrated textually. For any person, except the author of statements, the author's imagery underlying them is unobservable.

Being in agreement with the developers of dual knowledge conception, we do not know how the tacit knowledge mechanism works [38, 39]. Therefore, in order to solve the problems of expressing internal images by the person himself, we rely on the pragmatics of using natural language. Everyone knows such pragmatics from our general practice of social interaction. The pragmatic use of natural language is the daily actions of any person to describe something with the help of verbal statements, constructing and understanding the meanings of other people's actions through speech. This use of speech stands on the personal experience, knowledge and skills of each actor and is the first and main common feature of an unlimited number of social processes that are to be supported by ICT.

By accepting the pragmatic use of natural language as the basis for human communication, we do not prevent anybody from accessing any existing special resources that can complement his knowledge and experience. Among them are text corpus, survey data, Wikipedia, publications, archival materials, etc. However, we argue that humans will integrate ultimately all the intellectual resources they employ through speech. That is why it is important to teach computer technology to assist in the process of expression by a person of his everyday knowledge.

Every native speaker, in particular, a researcher, knows how the intellectual integration of knowledge takes place through speech. For example, when summarizing the results of a project, its author writes a report in the form of text, which is a set of expressions in natural language. Another example is the city's social development plan. Constructed in the form of documents, instructions, prescriptions, a plan is a set of statements in natural language designed to coordinate the actions of members of society affected by it. While it is possible that a report or plan includes graphs, charts, tables, and other types of information, semantic integration becomes understandable through speech and observable through text.

In order to understand how ICT can contribute to the integration of information in various formats created by people in the course of social processes maintained thanks to speech, we propose a procedure for decomposition of the practical expression of a person's tacit knowledge.

4 Linking tacit knowledge expressed through separate verbal wordings

Bearing in mind our everyday experience, we consider formulating individual statements (separate wordings) the initial action of a person when expressing his tacit knowledge. For example, when one remembers where he lives, he can say "my home", meaning a certain image of a home known to him. Such a verbal description is familiar to and intuitively shared by each person, and is carried out at human's own discretion.

However, the implicit knowledge of a person is his vast experience, existing in his head in some intricately intertwined way. Individual statements, even in the simplest cases, are only scattered aspects of a person's description of everyday situations. Therefore, the person faces always the task of linking separate statements with each other in order to explain how things go. It is not surprising that in practice the thought of a house will first turn into its individual characteristics – where it is located, what rooms it consists of, how many floors contains, and many others that may be required in our communication with other people.

Furthermore, these separate aspects of the knowledge of a house will complete each other through a new verbal statement. For example, "The house has two floors and is located not far from St. Petersburg." Thus, a person has meaningfully combined the aspects of knowledge expressed by the words “home”, “located”, “Petersburg” and others in a new verbal formulation. Summarizing this observation, we can say that verbal formulations are the traditional way of linking the meanings of individual statements. In other words, individual verbal utterances are linked together also by means of verbal utterances.

We propose to modify this traditional way of connecting speech statements. The bearer of knowledge should establish relationships between individual utterances not through new statements, but in the form of graphs that can clearly demonstrate the semantic relationships hidden in a person's head. The visual linking mechanism (VLM) of individual textual formulations will be intuitively understandable to the knowledge carrier due to the visual representation of the structure of relations between individual statements, explanations of these relations through additional statements within the structure itself, and a clear articulation of the order of actions required to build it. The most complete description of VLM under the name of analytical coding is in [40]. The article [41] contains a more formalized development of the VLM called graph context-oriented ontological (GCOO) methods.

The idea of the visual linking mechanism is to invite a person to formulate his tacit knowledge by familiar means through natural language. At the same time, connecting verbal formulations using simple observable graphs (otherwise, pictograms), where links between wordings are reflected in the form of graph edges. In our approach, a pictogram is a semantic chain created by a person based on his implicit knowledge expressed in the form of separate wordings. Such wordings play roles of individual aspects of tacit knowledge.

Such a chain is a separate verbal explanation of a previously made statement. From the examples, one can understand that such an explanation is created "locally", proceeding from a certain situation that a person imagines "in his head". Thus, we believe that semantics, that is, the expression of the correspondence between explicit textual formulation and the implicit knowledge of the person underlying it, resides in the nodes of the graph. The graph, in its turn, can, unlike a text stream, explicitly express the relationship between meaningful statements in order to visually capture the meanings contained in verbal formulations hidden in the text stream. The edges of the graph (pictogram), as well as the verbal utterances at the nodes, are subjects of intuitive comprehending. First, due to the local situation meant when expressing latent knowledge. Secondly, due to the totality of statements already made at the time of the formation of the next clarifying wording.

For example, the knowledge expressed by utterance “my two-story house”, which makes sense for any native speaker, can assume view:

House -> Has -> Two floors (1)

“Has”, “Two floors” are clarifying aspects of the tacit knowledge of the house in the form of corresponding statements in natural language. An intuitive reading of these aspects from left to right as parts of the simplest graph articulates the ‘direction’ of the meanings contained in each of the statements, and thereby sets an elementary chain of explanations of what a house is in my given interpretation.

However, if the association of individual formulations needs many steps in the indicated structural form, then a person will very quickly face the problem of operating with a huge mass of verbal statements that have semantic intersections. His work will degenerate into "manual" creation of graphs: working with such graphs is no easier than formulating hidden representations in the form of unifying verbal statements through speech. To avoid these troubles, we propose a knower to decompose any semantic chain through series of elementary transitions based on his experience and speaking skills. In the case, the chain (1) should assume a form of two transitions (2) and (3):

House -> Has (2)

Has -> Two Floors (3)

Reading this kind of pictograms from left to right, a person clearly reproduces the original meanings laid by himself or another person when creating them. Such elementary structural reproduction articulate on intuitively familiar basis connotations of implicit knowledge at the phase of its expression through speech.

As shown in [40], VLM requires a knower to make separate designations in the form of pairs of statements. The first statement is a traditional formulation describing something at knower’s discretion. The second one captures the context in relation to which the knowledge holder considers his first statement. Such a requirement forces the owner of knowledge to declare explicitly the dependence of implicit knowledge on the context of its expression [27]. For example, in our case, the statement "my house" can be perceived in connection with the article in the given example, or simply with the example itself. It is necessary to indicate this implied connection by introducing an appropriate additional statement and declaring such a connection in an explicit form. We have suggested expressing the relationship between the word designation “house” and its context, say, “example” in the form MY_HOUSE // EXAMPLE_OF_EXPRESSING TACIT_KNOWLEDGE[1]. Read: "my home" in the context of "example of expressing tacit knowledge".

The utterance "my home" which we call *term* and another utterance "example of expressing tacit knowledge" which goes under the name *context* arrange a pair of utterances. In ontological terms, this is a pair of concepts. The knower should establish the basic relationships among the pairs he creates to exhort his tacit views. Those relationships, called branchings, are analogues of ‘one-to-many’ links well known in database management (see [40, 41]).

The requirement for a person to keep track of the contexts of his own utterances significantly disciplines him when articulating his tacit knowledge. As we will see below, it allows controlling actually the coherence of their formation performed by means of speech. True, the result of verbal describing something turns out to appear not in the form of a text stream, but in the form of a structure of connections between its individual fragments.

Interpretation of the arising verbal constructions (a set of individual statements and explicit connections between them i.e. a set of branchings called *thesaurus*) does not imply special knowledge and is based on the natural linguistic experience of a person. The emerging constructions represent the simplest semantic transitions from one aspect of knowledge expressed by a person to another such aspect. It is these semantic transitions that a computer user creates by organizing their computerized materials using a folder tree.

What is the meaning of human actions using the proposed VLM? For a person, making many separate statements is a common practice of describing something using speech. Such a description appears to reach human understandable purposes: to express one’s thoughts, to understand each other, explaining to someone what you think about his actions, to express your feelings, etc. The result of this practice assumes the form

[1] We use uppercase to show that utterances are subject to deal with both by natural language skills and by VLM algorithms.

of a set of visual semantic links between individual statements. Such a structural representation of the implicit knowledge of a person by himself allows suggesting an algorithm that construct a single graph that expresses a coherent part of the entire set of statements made by the bearer of knowledge [40]. Let us look at an example of how to represent meaningful everyday knowledge in the form of graphs.

We are expanding our description of the house to a small paragraph in order to demonstrate how a familiar plain text assumes a view of an intuitive graph that expresses clearly the semantic connotations of the text.

> "The house has two floors and is located near St. Petersburg. On the ground floor, there are an entrance hall, living room and bedroom. From the entrance hall, a staircase leads to the first floor. The entrance hall has one window to the west. The living room has three windows. One of these windows faces west, the second one looks to the north and the third window faces to the east. The bedroom has one window facing south."

5 Features of linking the results of verbal expression of tacit knowledge by means of VLM as a part of ICT

Any knowledge, functioning in ICT as databases, tables, graphs, statistics, textual documents, etc. has an implicit basis, which always can be subject to explicit presentation through natural language by the bearer of knowledge himself. We will call the result of the expression of implicit knowledge by a person in an explicit form information or data regardless whether we deal with text streams or more developed structures.

The creation of information by the actor makes it possible to process it through ICT. From the point of view of "smart" technology, the emergence of information solves the problem of the basic stage of the functioning of knowledge in ICT (interface layer in terms of [12]). In this example, we are trying to demonstrate how to transform the tacit knowledge hidden in the usual representation of the house into data, that is, the basis of any computer processing. Moreover, we use natural language as a tool for expressing everyday knowledge, presenting the results in the form of separate statements. Thus, we imitate the essential feature of the human acting as part of ICT, that is, the original function of a person to describe something through speech.

In Fig. 1, there are two types of information obtained as results of the explicit expression of a person's everyday idea of house. In the first case, the data takes a form of text stream, which continues our informal answer to the question, what is my house? In such a textual way, an ordinary person expresses his knowledge of something. In the second case, the same tacit knowledge about the house becomes a graph that clearly demonstrates the semantic relations between individual verbal statements. Thus, the reader, in contrast to using plain text, clearly sees how we have expressed and connected certain aspects of our idea of the house.

Even if a person who speaks a natural language has no experience of VLM, a visual analysis of the given figure will show the practical identity of the meanings expressed by the text and the graph. Thus, the graph demonstrates convincingly the very unobvious possibility for ordinary people verbally communicating via an ICT to express their tacit knowledge directly in the form of graphs, and not of the usual text stream. Although the visual presentation of information is known to look preferable in comparison with the alphanumeric sequence, we will consider the features of our graph generated approach.

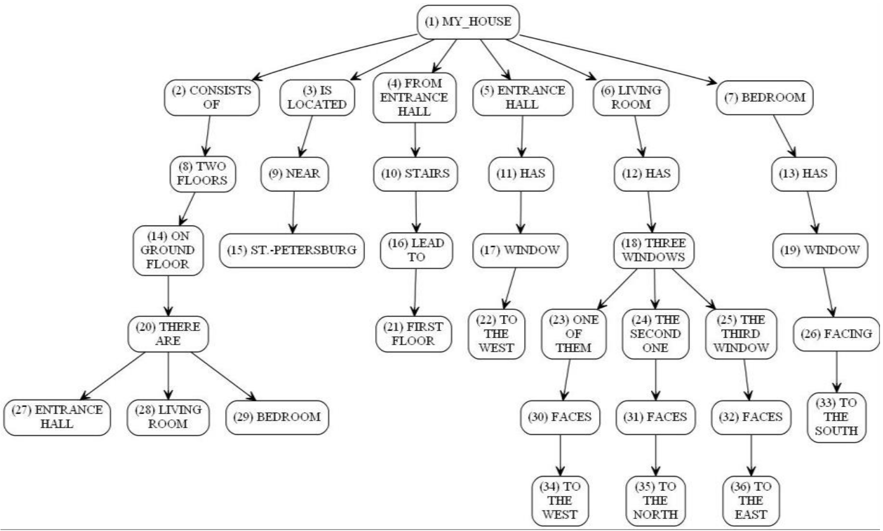

Fig. 1. Visualization of tacit knowledge links through the pragmatic use of natural language (nodes are numbered for ease of mention in the article's text)

First, the proposed approach combines in one instrumental procedure the informal expression by a person of his implicit knowledge through verbal statements and the layout of these statements in the form of visual relations. Let us compare the two nodes 4 and 5 in Fig. 1. They present two different concepts or aspects of our knowledge of house: FROM ENTRANCE HALL and ENTRANCE HALL. The first aspect indicates from which room the stairs lead to the first floor. The second aspect reports that ENTRANCE HALL is part of the house in question. However, as in reading any text, the reader of the graph is free to establish informal connotations between the statements contained in the nodes of the graph. In this case, it will not be difficult for a native speaker to understand that the ENTRANCE HALL statement and the ENTRANCE HALL phrase in the FROM ENTRANCE HALL statement describe the same object in my house. Reader can apply easily his speech skills to comprehend sense relations between words he sees in the graph.

Second, the management of the ambiguity of natural language statements, which is a serious problem in studying the subject areas of sociology. For example, Arnason writes about the contradictory scientific views developed by 2001 in the study of civilizations [42]. In our approach, a necessary control of polysemy arises due to the mechanism of polymorphic definitions of concepts that are nothing more but ordinary wordings.

Let us look at node groups 11–13 and 30–32. The first group presents the same TO HAVE verb, which allows expressing the features of the three rooms of my house with reference to the windows located in them. In the second group, the verb TO_FACE helps to understand where the windows are oriented to in the rooms of my house. Considering these nodes as concepts, the meanings of which depends on their explanations in the form of descending nodes, one can see that such chains in the general case differ. Such discrepancies are due to the very familiar situation: the same statements in different contexts express different meanings. In other words, the statements in the methods described are polymorphic. What structural features make our methods polymorphic one can figure out in detail from [40].

Thirdly, the proposed VLM is also a mechanism for flexible scaling of graphs of any size, based on senses of utterances in the nodes. If the user has a need to clarify any of his statements already presented in the graph, then he does not need to operate with the graph as a whole, going through the possible numerous occurrences of the utterance made (which is a necessary action when operating with text as a tool for expressing tacit knowledge).

It is enough for him to modify pointwise a limited number of branchings presented in the generated graph. Knower performs all modifications based on his need to detail the house description. For example, one wants to clarify the parameters of the window located in ENTRANCE HALL by setting its dimensions. To do this, in the thesaurus, using the already constructed graph (Fig. 1), he finds a branching of a pair of concepts WINDOW // ENTRANCE HALL. In our case it looks like WINDOW // ENTRANCE HALL-> TO THE WEST (for the notation of branching and the approach as a whole, see [41, 42]). Then he puts into the thesaurus verbal designations of the parameters to be added, for example, HEIGHT and WIDTH. As well as the numerical values of these designations. Let us say 100 and 200, respectively.

Next, one will change the existing branching WINDOW // ENTRANCE HALL -> TO_THE_WEST to a new one, taking into account a desire to specify the size of WINDOW // ENTRANCE HALL. The changed branching looks like: WINDOW // ENTRANCE HALL-> TO THE WEST, HEIGHT, WIDTH. Finally, one will create two new branchings that associate HEIGHT and WIDTH with their numerical values. Namely: HEIGHT // COMMON -> 100 and WIDTH // COMMON -> 200. Where COMMON is the context meaning that HEIGHT and WIDTH are wide known ideas. After such local modifications, one can generate the knowledge graph about my house and get a Fig. 2. As we can see, the window in entrance hall has got its dimensions.

Fourth, the opening possibilities of flexible scaling combined with the use of everyday speech to describe something, allow one to get away from the rigid definitions in natural science style. The expression of tacit knowledge by knower is not so much a process of its “final” definition through linking some statements with others. Instead, it is a dialog, i.e. the possibility of unlimited clarification of any statement by their author in response to the corresponding clarifying question. Any knowledge carrier can ask such a question. It is similar to how the practice of verbal definitions works in life situations. According to a Russian proverb, it is unnecessary to lay a route to Kiev, because there is "the language that will bring to it." This opens up a real possibility of organizing the teamwork of actors of social processes based on parallelizing and integrating knowledge about these processes stored “in their heads”.

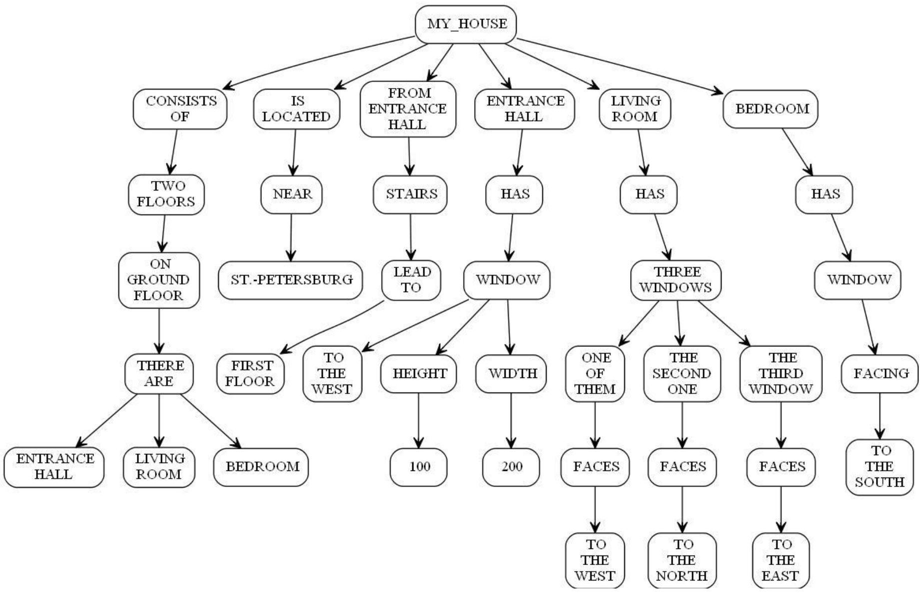

Fig. 2. A scaled graph generated automatically after we have made modifications of branchings to indicate window’s metric properties

Fifth, the presence of a double expression of implicit knowledge – in the form of a text and in the form of a graph – creates an opportunity for a person to self-control the information he creates. For example, the following procedure is possible, which we used when creating the examples. To begin with, we have presented tacit knowledge of the house in the form of text with the completeness that suited us. Then this text was presented in the form of a graph (Fig. 1) based on a simple but informal rule. Semantic connections of the text that we cannot see in it because of its poor structure, but are compelled to guess about, should be expressed explicitly through the graph's components. Following this rule, we sequentially increased a number of branchings and restructured their internal relationships until the separate statements and their senses, figured out through connections between the statements, in the graph would represent clearly the meanings hidden in the stream of words.

At each step of such a build-up, i.e. replenishment of all set of branchings, we generated a graph by means of our pilot program that implements the approach described[2]. This graph demonstrated us visually to what extent we have happened to convey the meanings that we wanted to express when making the textual description of the house. Thus, the construction of a graph by using the VLM is a dynamic process in which the visualization algorithm creates the possibility of visual control of

[2] To get the final form of graphs shown in the article we used the Graphviz 2.38 package [43].

the completeness of a person's presentation of his implicit knowledge. As the procedure itself suggests, the more knowledge a person deals with, the more mental effort he saves due to visual control of his conceptual actions.

Sixth, the approach makes it possible to model the structures of physical or constructed objects mentioned in the text in the form of verbal references. Looking at Fig. 1 nodes 17 and 19, we can make sure that they represent the same verbal statement – WINDOW. However, Fig. 1 clearly shows that this statement refers to different physical objects, one of which is in the ENTRANCE HALL, and the other in the BEDROOM. In the text, such an “explicit” basis remains unclear and reader must reconstruct it in his mind. Let us pay attention to the fact that such "object-oriented" modeling runs thanks to a knower who substantiates his conceptual actions with own practical experience, without involving any scientific theories.

In our view, a logical end of verbal explanations can be physical properties declared in the process of sociological definitions of mental objects constructed through chains of explanations. It is this very simple window modeling that we carried out when we explained the scaling procedure (see Fig. 2).

The practical significance of such models exceeds the idea of visual representation of senses hidden in the text. Considering the structure generated in Fig. 2, one can notice that thanks to appearing graphs, our approach makes it possible to carry out calculations based on the structural features of the graphs generated. For instance, the graph allow suggesting an obvious calculating procedure to get the windows area.

The native speakers can create such graphs (of any size!) collectively in the run of their practical activities. The demonstration of human meanings on graphs looks much vividly than hiding them under weave of wordings found in text. This means that a person becomes able to overcome the vagueness of textual documents by adopting principles of teamwork that have proven to be effective in programming. The main concern of people is to explain in an "obvious to the eye" way what they mean when interacting. As for the computations, they become accessible for "adequately explained meanings". In other words, the calculations turns to be a result of people's agreements expressed visually.

6 Conclusions and Outlook

The article describes an original visual linking mechanism (VLM) for verbal expressions, which allows a person to display visually the semantic connotations of his hidden knowledge in the form of graphs of a special kind. It is fundamentally important that with the help of VLM, an ordinary person acquires an ability to transform his informal knowledge through speech into the structural form of a graph. Such basic articulation opens up opportunities for the subsequent processing of human knowledge by computer agents. Considering the fundamental importance of obtaining reasonable information from a human, we assume numerous possible applications of VLM or its modifications in ICT, as well as subsequent practical applications through ICT aimed to improve social self-organization and public administration.

We see the following reasons for further development of VLM. First, VLM implemented in ICT opens possibilities for supporting a new social practice of actors, in which the natural language familiar to them from childhood becomes a computer tool for expressing the implicit knowledge and semantic communication of individuals. Secondly, it appears a way of analytical control of the coherence of textual formulations articulating the implicit knowledge of both individuals and their communities in the framework of solving unifying social problems. Third, the supply of non-specialists in the field of high technology, interacting through speech, with modern hi-tech teamwork tools, allows the actors themselves coordinating their conceptual actions (introducing and defining concepts, checking definitions' coherence, achieving agreements on assumptions, etc.). Fourth, an intuitively clear visualization of all conceptual actions of a community of actors aiming to express and coordinate their tacit knowledge about something. Fifth, there appears a way to build a social organization, i.e. a system of interactions between people and their groups performed through speech, based on the scientific principles, such as context specification; modular arrangement; decomposition of something, described by people through speech, into human individual views.

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