Intelligent Multimedia-A New Computing Technique And Its Applications

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Abstract

Intelligent Multimedia techniques and paradigms are defined. We propose multimedia paradigms with many facets and application areas. The computing techniques, a language, the MIM deductive system and its model theory are presented in brief. Basic application areas we start with as examples are designing predefined visual scenes with diagram composition and combination for scene dynamics. The second application area is based on AI planning[5]. Reasoning and planning can be applied to define scene dynamics based on scene descriptions and compatibility relations. The project allows us to predict scene dynamics. We apply our recent Intelligent Language paradigm and intelligent visual computing paradigms to define the IM multiagent multimedia computing paradigm. The paper is further a basis to multimedia database design.

Keywords: IM, Multiagent AI Computing, Trans-morphing, Hybrid Pictures, Multimedia, Intelligent Languages, Intelligent Diagram Models, Dynamic Situation Epistemics, KR on Diagrams, Context Abstraction, Intelligent Syntax

1. Introduction

A new computing area is defined by Artificial Intelligence principles for multimedia. The area for which the paper provides a foundation for is what multimedia computing is bound to be applied at dimensions and computing phenomena unimagined thus far, yet inevitable with the emerging technologies. The principles defined are practical artificial intelligence and its applications to multimedia. Multimedia

AI systems are proposed with new computing techniques defined. Multimedia Objects and Rules and Multimedia Programming techniques are presented via a new language called IM[20].

The concept of Hybrid-Picture is the start to define intelligent multimedia objects. Trans-morphing, a term I invented to define automatic hybrid picture transformation, is defined and illustrated by a multimedia language. A preliminary mathematical basis to an IM computing logic is presented. The foundations are a new computing logic with a model theory and formal system. Multimedia AI Systems.

Multimedia Objects and Rules are presented and shown in programming applications. Hybrid-Pictures are defined opening a new chapter to computing techniques. TransmOrphing is presented as a dynamic computing principle applied to hybrid pictures and its computing importance is brought forth by way of new techniques and examples. It defines hybrid picture transformation. Intelligent Multimedia context defines the applications. Practical Multimedia Design is illustrated by pictorial examples. The preliminaries to a new computing logic termed MIM-Logic is defined with a brief model theory. The complete foundations are the subject of a paper elsewhere[10].

The application areas are based on advanced Artificial Intelligence available techniques. There are at least a few areas worth mentioning. Artificial Intelligence reasoning and planning can be applied to define content based on personality descriptions and compatibility relations being viewed. The project allows us to predict scene dynamics before viewing. Some of the applicable techniques, for example G-diagrams for models and AI applications have been invented and published by the author over the last decade.

The paper's structure is as follows. Section two starts with basic multimedia programming paradigms with intelligent object computing and the visual goals in design techniques applied to multimedia with applications to motion pictures and television. Section 3 presents a brief overview onto the KR basics applied to depict relevant worlds with diagrams world model functions. Section 4 is a brief onto situation dynamics, diagrams for models, compatibility relations, and context abstraction and descriptions as it applies. Section 6 is a preview to multimedia programming with intelligent multimedia presenting morphs and trans-morphs with intelligent multimedia objects. Sections 7 presents the MIM mathemati-

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cal logic basics and sections 8 its model theoretic mathematical overview.

2. Programming Decorative Views

The most basic programming paradigm for digital art, motion pictures and television we our project had started with, is designing inanimate visuals based on decorative objects. By defining compatibility and visual effects relations, objects can be selected by to design the area viewed. Scene object content programming defined in a section below can be applied. Multimedia programming can be combined with object content programming and applied to stage and scene definitions.

2.1 Visual Scenarios

By applying recent artificial intelligence paradigms we intend to define viewer scene dynamics for Content Programming. There are many types of dynamics to define. There are four types of basic scene dynamics.

(a)Single personality viewed composed with scene objects.

(b)Multiple personality viewed perhaps composed with scene objects.

(c)Viewer dynamics.

(d)Combining the three categories above.

3. KR and Relevant World Models

We presented the method of knowledge representation with G-diagrams[22,28] and applications to define computable models and relevant world reasoning. G-diagrams are diagrams defined from a minimal set of function symbols that can inductively define a model. G-diagrams are applied to relevance reasoning by model localized representations and a minimal efficient computable way to represent relevant knowledge for localized AI worlds. We show how computable AI world knowledge is representable.

G-diagrams are applied towards KR from planning with non-determinism and planning with free proof trees to partial deduction with abductive diagrams presented by [4]. The applications to proof abstraction and explanation-based generalization by abstract functions are alluded to in [3] A brief overview to a reasoning grid with diagrams is presented in [28].

In order to point out the use of the generalized method of diagrams we present a brief view of the problem of planning form [2] within the present formulation. The diagram of a structure in the standard model-theoretic sense is the set of atomic and negated atomic sentences that are true in a structure.

The generic diagram, abbreviated as G-diagram for models, [6,91,3,21,28] is a diagram in which the elements of the structure are all represented by a minimal family of function symbols and constants. Thus it is sufficient to define the truth of formulas only for the terms generated by the minimal family of functions and constant symbols. Such assignment implicitly defines the diagram. This allows us to define a canonical model of a theory in terms of a minimal function set.

4. Situation and Dynamics

4.1 Personality Dynamics

Applying artificial intelligence programming, combining personality descriptions, scenarios projected to be viewed, and scene objects can define projected scene dynamics.

Combining single personality dynamics, scenarios, and their relations to reason to define scene dynamics to be viewed. Viewer dynamics based on general principles can be projected and the effects of scenes projected on viewers can be predicated. The ratings for the shows can thus be predicted based on the relations amongst Scene Dynamics and Viewer Dynamics.

4.2 Compatibility Dating Game

What the dynamic epistemic computing [2,94] defines is not exactly a situation logic in the [17,b] sense. The situation and possible worlds concepts are the same as [17,18]. However, we define epistemics and computing on diagrams, with an explicit treatment for modalities. The treatments of modalities are similar to [19] Model Sets.

The correspondence of modalities to Possible Worlds and the containment of the possible worlds approach by our generic diagrams techniques implies we can present a model-theoretic formulation for the dynamics of the possible worlds computing. Starting with the formal representation of epistemic states as presented by [2,94], the generalized diagram formulation of possible worlds, and the encoding of epistemic states by G-diagrams and ordinals we can define epistemic computation on diagrams.

4.3 Situations and Compatibility

Now let us examine the definition of situation and view it in the present formulation.

Definition 4.1 A situation consists of a nonempty set D, the domain of the situation, and two mappings: g,h. g is a mapping of function letters into functions over the domain as in standard model theory. h maps each predicate letter, pn, to a function from Dn to a subset of {t,f}, to determine the truth value of atomic formulas as defined below. The logic has four truth values: the set of subsets of {t,f}.{{t},{f},{t,f},0}. The latter two corresponding to inconsistency, and lack of knowledge of whether it is true or false. []

Due to the above truth values,, the number of situations exceeds the number of possible worlds. The possible worlds are the situations with no missing information and no contradictions. From the above definitions the mapping of terms and predicate models extend as in standard model theory. Next, a *compatible set of situations* is a set of situations with the same domain and the same mapping of function letters to functions. In other worlds, the situations in a compatible set of situations differ only on the truth conditions they assign to predicate letters.

Definition 4.2 Let M be a structure for a language L, call a subset X of M a generating set for M if no proper substructure of M contains X, i.e. if M is the closure of X U {c(M): c is a constant symbol of L}. An assignment of constants to M is a pair <A,G>, where A is an infinite set of constant symbols in L and G: A → M, such that {G(a): a in A} is a set of generators for M. Interpreting a by g(a), every element of M is denoted by at least one closed term of L(A). For a fixed assignment <A,G> of constants to M, the *diagram of M, D<A,G>(M)* is the set of basic (atomic and negated atomic) sentences of L(A) true in M. (Note that L(A) is L enriched with set A of constant symbols.) []

Definition 4.3 A G-diagram for a structure M is a diagram D<A,G>, such that the G in definition above has a proper definition by a specific function set.

Remark: The minimal set of functions above is the set by which a standard model could be defined by a monomorphic pair for the structure M.

The dynamic of epistemic states as formulated by generic diagrams [2,94] is exactly what addresses the compatibility of situations. What it leads us to is an algebra and model theory of epistemic states, as defined by generic diagram of possible worlds. To decide compatibility of two situations we compare their generalized diagrams. Thus we have the following Theorem.

The compatibility principle <Nourani 1994> Two situations are compatible iff their corresponding generalized diagrams are compatible with respect to the Boolean structure of the set to which formulas are mapped (by the function h above, defining situations).

The principle is proved as a theorem in [8].

By applying KR to define relevant worlds, personality parameters, combined with context compatibility and scene dynamics can be predicated.

4.4 Context

A preliminary overview to context abstraction and meta-contextual reasoning is presented from our [Nourani 11,27]. Abstract computational linguistics with intelligent syntax, model theory and categories is presented in brief from[27]. Designated functions define agents, as in artificial intelligence agents, or represent languages with only abstract definition known at syntax. For example, a function Fi can be agent corresponding to a language Li. Li can in turn involve agent functions amongst its vocabulary. Thus context might be defined at Li.

An agent Fi might be as abstract as a functor defining functions and context with respect to a set and a linguistics model as we have defined in[7,9]. Generic diagrams for models are defined as yet a second order lift from context. The techniques to be presented have allowed us to define a computational linguistics and model theory for intelligent languages. Models for the languages are defined by our techniques in [9,22]. KR and its relation to context abstraction is defined in brief.

The role of context in KR and NL systems, particularly in the process of reasoning is related to diagram functions defining relevant world knowledge for a particular context. The relevant world functions can proliferate the axioms and the relevant sentences for reasoning for a context. A formal computable theory can be defined based on the functions defining computable models for a context[Nourani 21,11].

5. Contents As Intelligent Objects

5.1 An Example

The example below is illustrating what object programming is where a space age coffeeshop outlet scene is programmed.

Object:= Coffee_Constellation

OPS:= Serve_Coffee (Type,Table_no) | ......

Serve_Coffee (Spectacular_Brew,n) => Signal an available robot to fetch and serve (Spectacular_Brew,table n)

Exp:= Serve_Coffee (Angelika,Table_no) |...

Serve_coffee(Angelika,Table_no) => if out_of_Angelika notify Table_no; offer candy; and look for alternative coffee to offer.

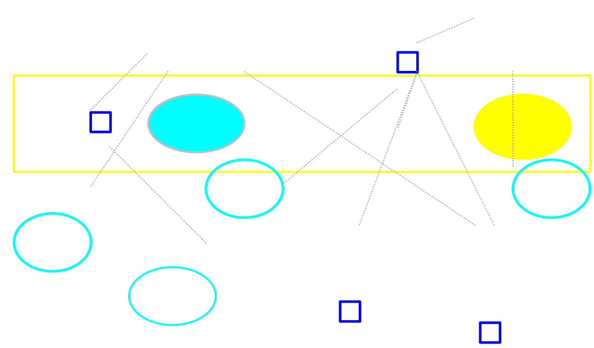

Figure 1 Multiagent object-coobject pairs.

Circles are objects, the squares are agents, and <object,co-object> pairs are enclosed by a rectangle. The dotted lines are agent message passing paths.

In the above example OPS denotes operations, EXP denotes exceptions, and the last equation defines the exception action. APs are activities causing exceptional functions to be activiated. Examples are pauses and forgotten script lines by a personality being televised. In the example there is a process(action) that is always checking the supply of Angelika coffee implementing the exception function.

5.1 Visual Computation On Boards

A problem solving paradigm[16] is presented in the Double Vision Computing paper [15]. The basic technique to be applied is viewing the televised scene combined with the scripts as many possible worlds. Agents at each world that complement one another to portray a stage by cooperating. The AI techniques can be applied to define interactions amongst personality and view descriptions. The double vision computing paradigm with objects and agents might be depicted by the following figure.

The object co-object pairs and agents solve problems on boards by cooperating agents from the pair *without splurges across the pairs*. The term splurge has a technical definition for object level computing presented in [Nourani 22] analogous to side-effects. Computing by agents might apply the same sort of cooperative problem solving methods.

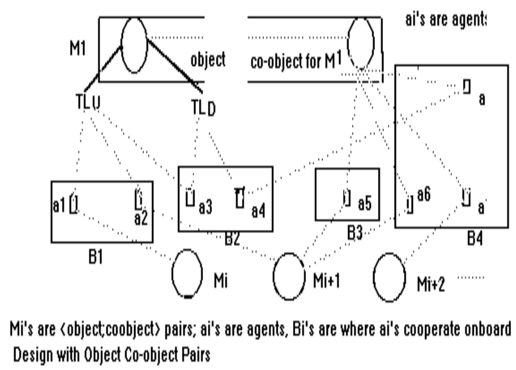

Figure 2 Multiboard Computing

The IM paradigm can define multiagent computing with multimedia objects and carry on artificial intelligence computing on boards.

6. Hybrid Multimedia Programming

6.1 Trans-Morphing Hybird Pictures

The programming language IM defines syntax for computing with programming constructs for Morphing, Hybrid Pictures and Trans-morphing. A Multimedia[23] AI Systems program can be written in IM. IM includes Multimedia Objects and Rules and multimedia Programming. *Hybrid Pictures* are IM Hyper-pictures which can be automatically transformed based on computing, images, or rules defining events. Hybrid pictures are context and content sensitive hyperpictures.

6.2 Trans-Morphing

A term we invented to define automatic event-driven or otherwise, hyperpicture transformation. Trans-morphing is the basic visual computing event defined for hybrid multimedia computing.

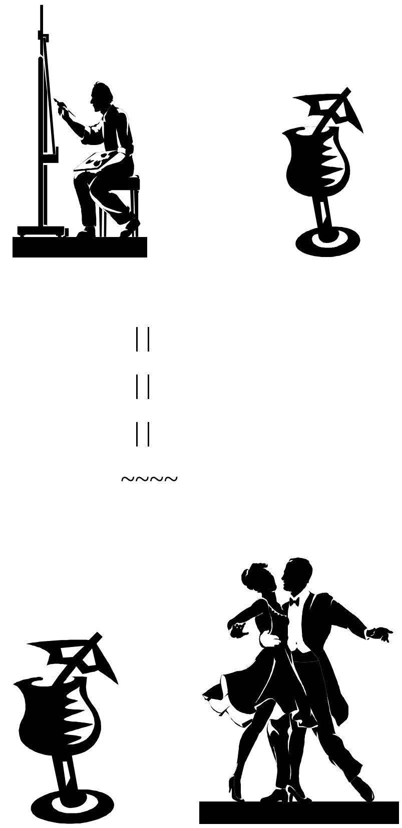

Figure 3 A Trans-Morph

The drink appearing might be the event to cause a Trans-morphing to the depicted evening image on the mind. It can be one of few items appearing in conjunction with the artist.

7. The IM Computing Logic

7.1 MIM Morphic Computing

The IM Hybrid Multimedia Programming techniques[28] have a computing logic counterpart. The basic principles are a mathematical logic where a Gentzen [12] or natural deduction [14] systems is defined by taking multimedia objects coded by diagram functions. By trans-morphing hybird picture's corresponding functions a new hybrid picture is deduced.

Multimedia objects are viewed as syntactic objects defined by functions, to which the deductive system is applied.

Thus we define a *syntactic morphing* to be a technique by which multimedia objects and hybrid pictures are homomorphically mapped via their defining functions to a new hybrid picture. The deduction rules are a Gentzen system augmented by Morphing, and Trans-morphing. The logical language has function names for hybrid pictures.

The MIM Morph Rule - An object defined by the functional n-tuple <f1,...,fn> can be morphed to an object defined by the functional n-tuple <h(f1),...,h(fn)>, provided h is a homomorphism of intelligent objects as abstract algebras[25]

The *MIM Trans-Morph Rules*- A set of rules whereby combining hybrid pictures p1,...,pn defines an Event {p1,p2,...,pn} with a consequent hybrid picture p. Thus the combination is a trigger event.

The deductive theory is a Gentzen[12] system in which hybrid pictures are named by parameterized functions; augmented by the MIM morph and trans-morph rules. The complete formal AI and mathematics has its starting basis at [10]. The foundations start with proving the logic is sound and complete for the applied infinitary languages and their structures.

Theorem 7.1 MIM logic is sound and complete for the specific infinitary languages and structures applied.

8. The Model Theory

8.1 Intelligent Models

Intelligent syntax languages are defined and their linguistics parsing theories outlined. A computational logic for intelligent languages is presented in brief with a soundness and completeness theorem. A brief overview to context abstraction shows how context free and context sensitive properties might be defined. Intelligent syntax with Agents, String and Splurge intelligent functions define the properties. A preliminary parsing theory is defined by establishing a formal correspondence between String functions and computable grammars.

By an intelligent language we intend a language with syntactic constructs that allow function symbols and corresponding objects, such that the function symbols are implemented by computing agents. Agents are in the sense defined by [22] and the A.I. foundations in [26]. A set of function symbols in the language, referred to by Agent Function Set, is the set of function symbols that are modeled in the computing world by AI Agents.

A function symbol is intelligent iff is an Agent Functions Set Member. To be nontrivial an intelligent function symbol must at be defined with a signature that implies message passing between at least two functions in the set, for example, by carrier sharing on the signature.

The idea is to do it at abstract syntax trees without grammar specifics. As an example, suppose I told you I have an academic department with a faculty member which is Superman, and two faculty members which are Swedish speaking, and three which do not talk to anybody outside their expertise areas. Without telling you anything else about what they do, I have defined abstract syntax properties. Once I tell you the signature has few specific agent functions , it implies the signature has defined message paths for them. From the signature I define a model to assign to abstract syntax trees.

The IM multimedia objects, message passing actions, and implementing agents are defined by syntactic constructs, with agents appearing as functions. The computation is expressed by an abstract language that is capable of specifying modules, agents, and their communications. We have to put this together with syntactic constructs that run on the tree computing theories presented by this author in [9,22].

The implementing agents, their corresponding objects, and their message passing actions can also be presented by the two-level abstract syntax. The agents are represented by function names that appear on the free syntax trees of implementing trees. The trees defined by the present approach have function names corresponding to computing agents. The computing agent functions have a specified module defining their functionality.

A signature defines the language tree compostionality degree and defines the abstract syntax. The following definitions have allowed us to define a computational linguistics and model theory for intelligent languages. Models for the languages are defined by our techniques in [7,9,22].

Definition 8.6 We say that a signature is intelligent iff it has intelligent function symbols. We say that a language has intelligent syntax iff the syntax is defined on an intelligent signature

Definition 8.7 A language L is said to be an intelligent language iff L is defined from an intelligent syntax.

Intelligent functions can represent agent functions, as in artificial intelligence agents, or represent languages with only abstract definition known at syntax. For example, a function Fi can be agent corresponding to a language Li. Li can in turn involve agent functions amongst its vocabulary. Thus context might be defined at Li with it s string and splurge functions. An agent Fi might be as abstract as a functor defining functions and context with respect to a set and a linguistics model as we have defined in [7,9].

The intelligent syntax languages we have shown have a model theory[22]. The Gentzen system defined on MIM can be assigned an intelligent model theory. The mathematics is to appear[10].

8.2 Relevant KR and Models

Knowledge representation has two significant roles: to define a model for the AI world, and to provide a basis for reasoning techniques to get at implicit knowledge.. An ordinary diagram is the set of atomic and negated atomic sentences that are true in a model. Generalized diagrams are diagrams definable by a minimal set of functions such that everything else in the model's closure can be inferred, by a minimal set of terms defining the model. Thus providing a minimal characterization of models, and a minimal set of atomic sentences on which all other atomic sentences depend.

We want to solve real world problems in AI. Obviously for automating problem solving, we need to represent the real world. Since we cannot represent all aspects of a real world problem, we need to restrict the representation to only the relevant aspects of the real world we are interested in. Let us call this subset of relevant real world aspects the *Relevant World* for a problem.

AI approaches to problem solving represent the knowledge usually in some kind of first-order language, consisting of at least constants, function and predicate symbols. Our primary focus will be the relations amongst KR, AI worlds, and the computability of models Truth is a notion that can have dynamic properties. The real world is infinite as are AI worlds at times. We might be interested to figure out in which AI worlds a theory or a sentence will be valid. Furthermore, we might like to perform abstract inferences over equivalence classes of models.

We have to be able to represent these ideas with computable formulations. We usually have to contend with difficulties in even finite AI worlds with an exponential number of possible truth assignments. To keep the models which need to be considered small and to keep a problem tractable, we have to get a grip on a minimal set of functions to define computable models with.

8.3 Computable AI World Models

The techniques in [1, 87,3,9] for model building as applied to the problem of AI reasoning allows us to build and extend models by diagrams. This requires us to define the notion of generalized or generic diagram. The G-diagrams are used to build models with a minimal family of generalized Skolem functions. The minimal sets of function symbols are those with which a model can be built inductively. We apply initial models since they are computable[1,2,22]. The G-diagram methods applied and further developed here, allows us to formulate AI world descriptions, theories, and models in a minimal computable manner. It further allows us to view the world from only the relevant functions. Thus models and proofs for AI problems can be characterized by models computable by a set of functions. The G-diagram functions can define IM objects and be applied by MIM logic.

8.4 Relevant Worlds and KR

The real world is complex, complicated and infinite. Thus we need to restrict any representation, so that it becomes computationally feasible. It is however possible, as we have shown in the papers referenced, to define new computation paradigms for KR and AI reasoning based on G-diagrams, that have appealing computing properties. Hence, we focus during modeling on parts of the real world. We use only problem-relevant statements to formalize our theories to allow us to draw plausible inferences.

What we do not know on a generalized diagram is defined in terms of generalized Skolem functions. We like to call such a restriction of the real world the Relevant World. Clearly, even such a restricted AI world may in some cases be still complex and infinite. However by such a restriction, we have already made the number of possible interpretations and thus the semantics of a formalization considerably smaller.

8.5 Model Sets and Complete Worlds

A possible world may be thought of a as a set of circumstances that might be true in an actual world. The possible worlds analysis of knowledge began with the work of [19] through the notion of model set and [13] through modal logic. Instead of considering individual propositions, the focus is on the `state of affairs' that are compatible with what is known to be true. Rather than being regarded as possible, relative to a world believed to be true, not being absolute. For example, a world w might be a possible alternative relative to w', but not to w".

Possible world consists of a certain completeness property: for any proposition p and world w, either p is true in w or not p is true in w. Note that this is exactly the information contained in a generalized diagram, as defined in the previous section. Let W be the set of all worlds and p be a proposition. Let [p] be the set of worlds in which p is true. We call [p] the truth-set of P. Propositions with the same truth-set are considered identical. Thus there is a one-one correspondence between propositions and their truth sets. Boolean operations on propositions correspond to set-theoretic operations on sets of worlds. A proposition is true in a world if and only if the particular world is a member of that proposition.

8.6 Diagrams For Models

We are interested to show the applicability of our method of generalized diagrams and model theory of AI to such problems of computational linguistics. To that end, let us examine the approach to defining models and denotations in brief. Models are defined in [6,7] for Intentional Logic as a from of possible worlds semantics.

Definition 8.8 A G-diagram for a structure M is a diagram D<A,G>, such that the usual definition of diagram in model theory has a proper definition by a specified function sets.

A surprising consequence from our planning techniques and theories defined since 1987 is [8] where we proved as a theorem that G-diagrams can encode possible worlds.

The diagrams can be applied to define models for the IM Intelligent trees [22,97] with which intelligent syntax multimedia MIM defines a formal system and computing theory.

8.7 Agent Morphisms and Design

In [25] we present new techniques for design by software agents and new concepts entitled Abstract Intelligent Implementation of AI systems (AII). Multiagent morphisms are proposed to facilitate software agent design. Objects, message passing actions, and implementing agents are defined by syntactic constructs, with agents appearing as functions. The proposed AII techniques provide a basis for an approach to automatic implementation.

AII techniques have been applied to Heterogeneous KB Design and implementation. The application areas include support for highly responsive planning. AII techniques are due to be an area of crucial importance as they are applied gradually to the real problems. The applied fields are intelligent systems, aerospace, AI for robots, and multimedia.

9. Conclusion

As a science IM and MIM are developing concepts and vocabulary to help us understand intelligent multimedia. The overview to a multimedia language, a logic-the MIM-logic and a brief view to the MIM's model theory is presented. The MIM morphed logic, hybrid pictures, trans-morphing, agent morphisms are all novel concepts and techniques. General ways to define typical situations for sectors are defined by generic diagrams and are viewed with respect to a knowledge base and hypotheses. The knowledge base consists of behavior descriptions, vocabulary definitions, objects and relations, decision rules and uncertain facts. The preliminary practical application areas are the multimedia technologies as depicted in [22].

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