Towards a coordinated Computer Assisted Maintenance for bridges

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1 Introduction

More and more research efforts are made in Japan to improve bridge maintenance thanks to informatics, and the definition of a "meta-system" might be helpful to relate them all, thus facilitating the development of a *Japanese Bridge Management System* proposed by Miyamoto [1]. As a first step of this definition, a standard language to describe bridges with an object-oriented philosophy would be a useful tool to exchange data: this research proposes a XML-based specification having all chances to be the ideal candidate. It also indicates linguistics as a promising way to think a second step.

2 BridgeML, α version

The original purpose of this research was to add a vocal interface to a system for visual inspections previously proposed (by Mizuno [2]), using the following strategy: the results of the requests sent to the defects database by an inspector should, instead of being expressed directly in HTML[1], rather be expressed in XML[2]. Indeed, appropriate *parser* and *XSL style sheets* can then convert them, on demand, to HTML (so that Mizuno's system is generalized but not changed) or to VoiceXML (which can be coupled with a voice recognition software to implement a vocal interface).

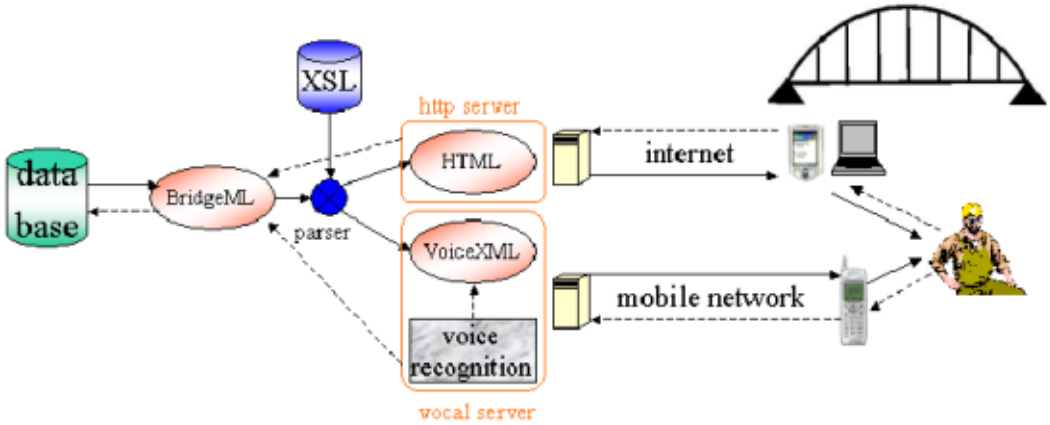

Figure 1: Two channels inspection interactive support system

However, it quickly appeared that XML could be much more than a simple intermediate between a database and different output formats: it could describe an object-oriented model of bridges (structures, pathologies, repair methods, etc). This lead to the idea of a specialized XML specification, baptized BridgeML ("Bridge Markup Language") which, farther than a simple extension to Mizuno's system, could serve as a common vector to exchange data between engineers. Defining a draft ("α version") of this specification, trying to optimize the syntax and the associated object model so that they lead to the fastest applications possible, is precisely one of the major goal of this research: although *Definition Type Documents* are used as a first step, the long term objective is to define BridgeML through *XMLSchemas*.

[1] HyperText Markup Language: the basic language interpreted by web browsers
[2] eXtensible Markup Language: language based on the same principle as HTML (so-called *tags*) but more general

Key words: computer assisted maintenance, visual inspection interfaces, object-oriented philosophy, XML, linguistics
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XML imposed itself as a natural choice because it is becoming *the* standard format to represent data in informatics industry: powerful whereas simple (in principle!) and readible, as can be seen in the following sample.

```
<bridge type=‘‘through girder’’ name=‘‘Blue River’’>
  <location type=‘‘pier’’ name=‘‘P3’’>
    <member type=‘‘bearing support’’>
      <component3>shoe</component3>
      <defect type=‘‘crack of bearing surface’’>severely damaged</defect>
    </member>
  </location>
</bridge>
```

Figure 2: A structured way to express that “on pier P3 of the Blue River bridge, the shoe of bearing support is severely damaged by crack of bearing surface”, based on couples of opening ($< tag >$) and closing ($< /tag >$) *tags*

3 A wide spectrum of applications

It is now clear that BridgeML can have a huge number of applications, in industry (exchanging data between two databases with different data conceptual models, facilitating the connection between a database and a data mining tool, etc) as well as in research (open the way to data mining by helping to turn inspectors/engineers natural language into structured data, prepare a solid basis for artificial intelligence in bridge maintenance...).

4 Bridge linguistics

The two latter outlooks (which Miyamoto already started to investigate: [3]) suggest that a “*bridge linguistics*” could be a fruitful basis for further developments in state-of-the-art computer processing applied to bridge maintenance: practically speaking, it would consist in searching for mathematical models of the natural language of inspectors and engineers on the basis of a semantic study, which could then be computed (making an extensive use of BridgeML!) into smart decision support systems for bridge maintainers. So the initiation of *bridge linguistics* also became a major part of this research, all the more as it can help to determine a logical structure to BridgeML’s object model.

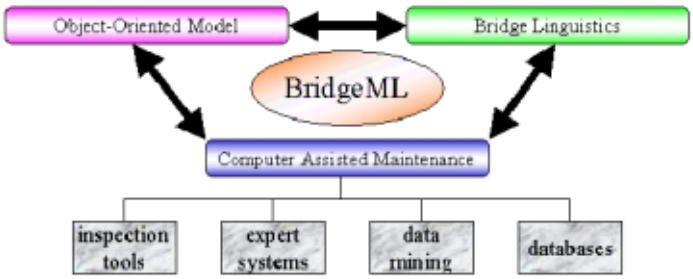

Figure 3: BridgeML at the center of future developments in informatics for bridge maintenance

5 Conclusion

To become really useful, BridgeML must be adopted as a standard. To facilitate this, it must be developped in open source mode by the largest number of participants, which is the purpose of the official site http://www.BridgeML.org. On the other hand, “bridge linguistics” has to be investigated deeper, both as a way to optimize BridgeML and as a promising idea for the future of *Computer Assisted Maintenance*.

References

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