Chapter 7
Agents Network for Automatic Safety Check in Constructing Sites

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ABSTRACT

Compliance with safety standards in constructing sites is a mandatory activity that helps prevent a high number of fatalities during working activities. Unfortunately, because of negligence or limited resources, safety checks are not performed with regularity and this causes a high number of accidents. This paper proposes a distributed solution for automated checking of safety rules, secure logging of violations, and real-time execution of reactions. The constructing site is modeled as a pervasive environment where software agents, executing on smart devices, can detect and interact with people, machineries, and safety equipment to check the compliance of common behaviors with the safety plan designed for that site. The design is presented as a working prototype of a three layered software/hardware architecture.

INTRODUCTION

Safety in construction sites is today a relevant problem because of an increase of *white deaths*, that is the high number of fatalities during working activities. Even if the risk depends on the specific kind of job, it grows up exponentially when the safety standards are violated. Although the legislation provides for the establishment of a Safety Plan, which regulates the working activities, and at the same time safeguarding the health of workers, the attention about the compilation of

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this document, and especially the implementation of measures are at least neglected in almost all cases. There are currently no resources or tools that help to ensure compliance with the measures prescribed by law, to warn in real time the staff about dangers, due to the violation of the specified rules, or allowing a posteriori verification of the correct implementation of the plan for the specific site. We aim at designing and implementing a service that monitors the compliance of workers' activities with the safety standards. Misconducts by workers, accidents and critical situations must be detected, notified, traced and eventually corrected.

Such scenario is characterized by the presence of many mobile workers and machines, by many pervasive objects whose presence affects the correct development of human activities. The complexity of the system is due to the heterogeneity and to the high number of elements to be monitored in a dynamic changing environment. The dependability of the designed solution must be guaranteed because it affects safety of involved people and infrastructures.

- Security is relevant because privacy of monitored people must be granted. Furthermore nobody should be able to tamper the system and the integrity of the logged history.
- Performance affects the time necessary to detect a dangerous situation and to provide necessary reactions in real-time.
- Reliability is necessary to prevent a period meanwhile we miss the detection of a dangerous situation and we do not activate reactions.
- Availability is important to get the required response when we notify the occurrence of a relevant situation and there are not resources to activate necessary countermeasures.
- Scalability must be provided because dimension of working area, number of peoples and objects can increase a lot between one scenario to another one. It can affect not only performance but also the cost of the infrastructure.

In the following we model the application scenario as an ubiquitous system where pervasiveness of sensors and mobile devices can be exploited to design and develop an effective solution. We provide details about the designed architecture and describe a prototypal implementation which works to detect the violation of some significant rules as it is already required by our government and it is (should be) currently done manually by dedicated people.

The proposed distributed solution is based on autonomous agents which represent the connection between a centralized control service and its extensions, implemented by pervasive sensors and actuators. Agents will check the compliance of detected situations with a set of rules which compose a global plan that regulates common activities. When a failure has been detected, agents can execute some actions. They can react proactively to handle specific events using pervasive actuators, services or supporting users in doing it. An agent here is a software entity that is able to sense the environment, to evaluate the context and to react according its configuration profile.

In a prototypal implementation we use smart devices to estimate relative positions of pervasive objects worn by workers (e.g., special clothes and safety accessories such as helmets, shoes and glasses), in order to check safety rules, to apply needed local reactions and to notify violations to adopt centralized countermeasures.

The next section presents application context and requirements. We then introduce the problem formulation and provide our proposal for modeling the safety plan and a language to define its rules. Next, we give an overview of the architectural design of our solution and some details about its prototypal implementation. Finally related work and conclusion are due.