

Chapter 3.4

Modelling Spoken Multimodal Instructional Systems

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ABSTRACT

The use of speech and spoken dialogue is a relatively recent addition to instructional systems. As, almost invariably, human instructors and students talk during teaching and training, spoken dialogue would seem to be an important factor in systems that emulate aspects of human instruction. In this chapter, the origins and state of the art of spoken multimodal instruction are described. Strengths and weaknesses of the speech modality, key roles of spoken dialogue in multimodal instruction, functional issues in current spoken teaching and training systems, commercial prospects, and some main challenges ahead are then discussed.

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INTRODUCTION

A key advantage of instructional systems is to enable instruction in the absence of a human expert or teacher. From pre-school kids to adults of all ages, everybody needs to learn and benefit from the expertise of others when doing unfamiliar tasks. The classical solution is to be helped by a *human instructor* who has two kinds of expertise: in the subject-matter in question and in effectively communicating or transferring the expertise to students. While this approach has worked for millennia, it suffers from the problem that expertise remains expensive and rare, relative to the number of those who wish to acquire or draw upon it. A language instructor in class, for instance, has little time for coaching each student individually.

An interactive instructional system, or *system instructor*, offers to supplement the human instructor's contributions to individual student learning and problem-solving. In the ideal case, the system's expertise, both subject-wise and pedagogically, is near-equivalent to that of a good human instructor. Since systems can be copied infinitely, this would enable students to work with an expert all the time, in class, at home, and elsewhere, and not just when the student has a human instructor's undivided attention in class. It is hardly controversial that removing the difficulty of access to expertise and dramatically reducing its price is a worthwhile technological goal.

The roles of speech, spoken dialogue, and conversation in instructional systems, most of which include modalities other than speech, are described and discussed. Characteristically, human instruction involves spoken conversation with students no matter whether spoken interaction is central to the instructional task or has an auxiliary role. In relative terms, speech is a newcomer in the field of instructional systems, which for a long time was characterised by typed text input/output. Spoken interaction is insufficient for most instructional purposes, however. Other interactive modalities are needed for optimising instructional effectiveness and efficiency. New modalities and modality combinations hold the additional promise of providing system instructors for *all* users no matter their perceptual or motor disabilities.

Instructional systems are defined (the second section), their history reviewed and the state of the art of spoken instructional systems are described (the third section), and conceptual architectures and component technologies are presented (the fourth section). Using a simple example, how to approach instructional systems analysis and specification is discussed (the fifth section) and a functional model of instructional interaction sketched (the sixth section). Since speech is not a catch-all for instruction, when (not) to use speech is asked and key roles of spoken dialogue are proposed (the seventh section). Examples of spoken

multimodal dialogue systems (the eighth section) and commercial prospects (the ninth section) are discussed, and some main research challenges are presented (the tenth section).

INSTRUCTIONAL SYSTEMS

By an (interactive) *instructional system*, an application whose main purpose is to teach or train the user or help the user solve a particular problem is understood. Although often combined in practical applications, these goals are somewhat different. A *teaching system* primarily teaches *understanding* of some subject-matter, such as the periodic system, basics of genetics, astronomy, planet geography, phases in the history of humanity, and so forth. A *training system* primarily trains *practical skills*, such as language skills, how to operate some artefact, play golf, or fly a commercial airliner. Teaching and training systems are aimed at long-term learning effects in the learner. By contrast, *problem-solving support systems*, such as one helping to install IP telephony on a laptop, rarely incorporate ambitions of producing long-term learning effects. If they help solve the problem at hand, they fulfil their purpose.

Aiming at long-term retention which largely depends on the amount of elaboration done on the education material, *teaching/training systems* typically focus on providing opportunity for solving or otherwise addressing as many and as different problems or issues as possible in the application domain. Key challenges in developing a good system are to make it *pose* the right challenges, *evaluate* the student's attempts to cope, *feed back* evaluations, *monitor* progress, *modify* challenge level depending on learning progress, and *stimulate* motivation to continue learning. *Problem-solving support systems* focus on system problem-solving because the user is challenged already and needs help. Problem-solving support systems thus partially reverse the roles described, so that the user poses the challenge, evaluates the

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