Current Status of the Development and Implementation of Construction Robots in the Federal Republic of Germany

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ABSTRACT

This paper gives a short overview of the current situation in the Federal Republic regarding robotics in construction. It deals with various research and hardware activities and gives some informations of organizational aspects.
The theme 'Robotics in Construction' is now widely known in construction companies. Due to various factors however a final breakthrough has not been achieved yet.

1. Activities of the research organisations

Several research organizations started in this field in the last years. Here a short overview.

1.1 FhG-IPA

The FhG-IPA started the work with an investigation of possible applications of Advanced Robotics in 1984-1986. This study was performed together with the Nuclear Research Center (KfK). For the construction industry the main result was the idea to start with conventional machinery by adding components already or in a near future within the state of the art.
Following to this study the design, development and realization of a manipulator with very large reach followed as a national project partially funded by the BMfT. The main partners dealing with this theme are the companies AEG for the controller, Putzmeister for the manipulator hardware including controller, Dornier for the sensor systems and the IPA as the systems integrator with various R&D efforts in specific areas not covered by the industry. This project will be completed at the end of 1989.

Another interesting project of the IPA is a study of applications for advanced machinery and manipulators in the construction craft area. This project is also funded by the BMfT. Some activities of the IPA were also related to the tunneling and mining sector. In this area the IPA acts as a consultant .

1.2 Nuclar Research Center, Karlsruhe

From 1984-1986 two departments of the KfK performed the already mentioned investigation together with the IPA.
Dealing with construction robots the KfK aquired in 1988 a manipulator with large reach and payload from Putzmeister-Aichtal on a commercial contract. This machine-hardware was developed by Putzmeister and IPA in the already mentioned national project. The Nuclear Research Center is going to develop amoung other things a controller as a private venture.
On the mining sector the cooperations with IPA continued. The activities are described later.

1.3 Universities

The first work with construction-robotics was performed in the University of Karlsruhe in the early 80th dealing with controller-development for an excavator. This development was cancelled.
Another work is done at the University of Berlin (Prof. Poppy). Potential applications are carefully viewed for possible robotization. Similar work is now also performed at the University of Stuttgart. Here a Dr. thesis is dealing with economics of robotics in construction.

2. Activities related to robotics hardware and applications

2.1 Concrete booms and platform handling

This type of machinery can be described as manipulators with large reach for heavy duty applications equipped with a hybrid controller ('man in the loop'-system).
The most promising work is currently performed by Putzmeister, Aichtal together with AEG-Aktiengesellschaft, Dornier and FhG/IPA. Starting with the experience of a development with an experimental controller for a concrete boom with 32m reach (shown at the BAUMA-fair in 1986) this approach has now reached a state where an implementation on the market can be realized.

Another approach was performed by Ruthmann, Gescher starting in 1986 with the experimental controller mentioned above. In this case platform handling is considered as the main application. The kinematic chain of the Ruthmann-manipulator consists a combination of translatory and rotatory axes.

2.2 Excavators

In this area several powerful companies started with the integration of a hybrid controller.
Liebherr in Biberach has integrated a controller to realize the performance of complex movements at the TCP. This hardware is now available upon customers request.
Orenstein & Koppel has introduced a playback-controller into two versions of their excavators. This development was shown already at the Bauma fair in 1986. Little is known about these developments exept some problems related to the path measuring systems. It can be expected that these problems are now overcome.

2.3 Erection of brick walls

In Germany many private houses are built with bricks. This area is interesting considering applications of manipulators os robotics.
The approach of the Anlicker-Company in Riedlingen is already presented in this syposium. Another similar approach was performed by WIBAU in Augsburg, partially with concrete-destribution machinery from Putzmeister. In this case the brick walls are erected horizontally.
A mobile manipulator for handling heavy bricks was developed by a small engineering company in Esslingen last year. In this case the option for future robotization is studied in detail.

2.4 Tunneling

The most spectacular project in Europe is currently the Channel-project. In this context Putzmeister, Aichtal recieved orders as a princial supplier for muck transport machinery and indection manipulators for the French side.
Manipulators for erecting lining segments were developed at Mönninghoff, Bochum. These chain wheel driven manipulators have a reach of about 6m handling payloads up to 300 tons.
Tübbing-Manipulators in various versions have been developed by Schäfer and Urbach in Ratingen. Within this company robotization is considered as an option for the future.

Concrete spraying machinery in form of mobile manipulators have been developed by various companies, e.g. Putzmeister. Unfortunatly the new railway line from Würzburg to Hannover for fast trains is now nearly completed - so the next generation of robotics in that area has to wait for the next big order from the national railways.

2.5 Coal mine applications

Although clearly outside construction robotics regarding applications, the manipulator machinery for coal-mines is quite close related considering technical features. One important development was realized by the RAG from 1986-1987 with KfK and IPA acting as consultant. This development deals with a mobile, remote controlled manipulator for the recovery of the steel-framework from tunnels which are not used any longer. This dangerous work is now performed by humans. The above mentioned manipulator is now under construction scheduled for service in 1989 and will be equipped with a robot control in the near future.

3. Activities of National Organizations

The VDMA-Frankfurt has formed a group dealing with construction robotics recently. This initiative from the industry can be considered as a major step forward. Dr. Benckert from Putzmeister, Aichtal is head of that group.

4. Conclusions

A steady and firm progress was achieved in the last year. Construction robotics is a very demanding approach regarding different technologies and know-how from various areas, therefore a final breakthrough has not been achieved yet.