Chapter 12
Brushbots for Educational Robotics:
Low-Cost Robots for Building and Research Activities in Schools

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ABSTRACT

Due to their simple construction, brushbots are popular and widely known as craft objects. Building instructions promise tinkering fun and a promoting effect but minor as low-cost research objects. They are regarded as microbots and give opportunities for discussions. One questions to answer is whether their chaotic motion can be influenced. Therefore, this contribution deals with an examination of factors influencing their movement behaviour. The aim was to show experimental work and to discuss the potential of brushbots in three directions: first, to propose a cheap platform to evaluate the motion capabilities of different designs; second, to offer an approach to improve vibrobots concerning experimentation results in the design process; and third, to provide a sample that can be transferred to schools. For this purpose, the basics of brushbots are presented, and the experiments and their results are described. The results offer inspiration for teaching applications that go beyond mere tinkering and provide approaches for further research.

INTRODUCTION

In the education sector, the call for technology education is increasing. Because in a constantly evolving digitalized world, young people should be able to familiarize themselves with technical areas and be able

DOI: 10.4018/978-1-7998-7443-0.ch012

to act in them (ITEEA, 2007, 2020). Therefore, pupils are introduced to machine and robot technology at an early age, while educational robots are appreciated as one of the tools to technology education.

Robots in general are ubiquitous in today's world, so it is almost unimaginable to live life without them. They are used in all areas of life and the world. They are not only considered a core area of physics, technology and industry, but also play an interesting, important role in natural disasters, bomb disposal, medicine, education, in the home as a supportive cleaner or as toys, and have long since become indispensable.

Brushbots in particular are popular in schools and the maker scene. They offer options to propose a cheap research platform for design and research activities in schools. To enhance this, all experiments presented later in this chapter may be used as examples to show that research is an immanent part of the design process and how a design process can be supported through research activities. In addition a few examples of school activities will illustrate the use of brushbots in schools not only as tinker stuff.

Brushbots are also a frequent cause for discussion and debate. The questions that come to the fore are how is a brushbot constructed, why does it move through the vibration motor? Are there similar bots that work according to the same principle and is it possible to influence the movement behaviour of brushbots, as they have so far been characterized by their chaotic movements in space. These questions have received little attention in the scientific context so far. In order to make a contribution to this topic, this work is concerned with the practical investigation of factors influencing the (un)directed movement behaviour of brushbots. The aim is to develop a solution approach in which a brushbot can be steered.

Subsequently, the focus is on experiments about locomotion through vibration. Due to a lack of relevant literature and insufficient research about the movement of classic brushbots, information on the state of research is given but largely based on internet sources and forum discussions in the technical maker scene.

Equivalent to suggestions and assumptions from children in learning settings those from the maker scene will be taken into account for the experiments. The aim is a development of scientifically based findings on the influencing factors of brushbots in the form of tests and studies. All intermediate results will be recorded in reports and pictures.

With this background knowledge, the paper introduces the practical investigation and the function of brushbots is examined in more detail and various assumptions about movement behaviour will be presented. Different assertions and ideas are worked out that can influence movement behaviour, in order to subsequently substantiate or resolve them through various experimental set-ups. The factors influencing the movement behaviour will be analyzed in the form of experimental set-ups in order to be able to verify or falsify them. To begin with, a classic brushbot is built in order to look at and document the undirected movement behaviour more specifically. The classic brushbot is then modified by various changes in order to be able to examine the influencing factors of its movement more closely. Different brushes, mounting positions, bases and additional elements are considered in order to approach conscious control and most successful approaches were varied and investigated in further runs.

These experiments can be carried out in a didactically reduced manner with pupils of primary and lower secondary schools in the area of technology teaching in school lessons. The focus is on the practical implementation of different experimental set-ups which also may be applicated in schools. Different prototypes have been used for the experiments and should be able to provide information about which changes in the structure, the elements, the brushes or other factors influence the movement behaviour of brushbots.