RCSketch: Sketch, Build, and Control Your Dream Vehicles

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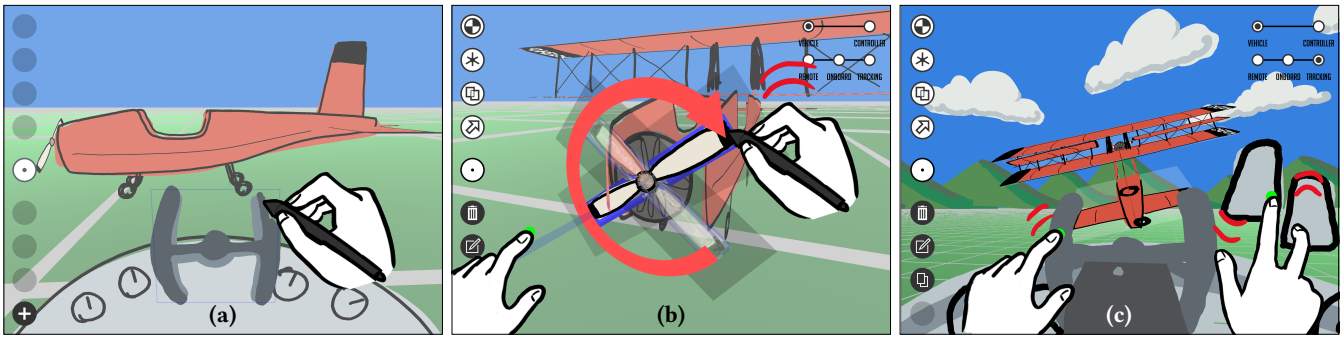

Figure 1: RCSketch is a system that enables children to design their own vehicles as well as controllers with which they can operate the vehicles. For example, children can (a) *sketch*: create a 3D airplane and a controller by drawing and grouping sketch cards; (b) *build*: define each group's movement, such as rotation of the propeller; and (c) *control*: use multi-touch to manipulate the controller and fly the airplane as if operating a remote control (RC) toy.

ABSTRACT

We present RCSketch, a system that lets children sketch their dream vehicles in 3D, build moving structures of those vehicles, and control them from multiple viewpoints. As a proof of concept, we implemented our system and designed five vehicles that could perform a wide variety of realistic movements.

CCS CONCEPTS

• **Human-centered computing** → **Interaction techniques**.

KEYWORDS

Vehicle; 3D sketching; motion sketching; multi-touch

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1 INTRODUCTION

Science museums and art galleries have many installations that make children's drawings come to life in 3D. In these installations, vehicles are a popular subject [2, 6, 7]. However, such an installation often limits the children's imagination because they have to draw on top of given templates of 3D models, and can only observe predetermined movements. Our study aims to unleash the children's imagination by allowing them to express the 3D shapes of vehicles as they imagine, and control the vehicles as they wish.

To design a system for quickly and easily representing the form of a vehicle in 3D, we referred to previous studies on casual 3D sketching. Dorsey et al. proposed a system in which the user creates 3D concepts by arranging planar sketches in 3D space [3], and Bae et al. showed that such a 3D authoring technique can be suitable for students [1]. Similarly, in our system, the user creates complex 3D forms by creating and combining multiple sketch cards in 3D space.

Moreover, to design a system for intuitively rigging and controlling vehicles, we referred to previous studies on motion sketching. Lee et al. introduced a novel widget for rigging parts of 3D sketches through multi-touch gestures [5]. Kazi et al. proposed a system in which the user sets up causal relations between the motions performed by parts of 2D sketches [4]. Similarly, in our system, the user defines 3D motions by utilizing sketch card planes and the axes widget, and remotely controls the vehicles through synchronized motions of sketch cards.

2 RCSKETCH

By integrating the above techniques, we propose RCSketch, a pen- and multi-touch-based system to enable the users to create their dream vehicles quickly and easily, and manipulate the vehicle with custom controllers. To do so, the user follows three stages: *sketch*, *build*, and *control*. (Please watch the accompanying video for detailed interactions.)

2.1 Sketch

In the sketch stage, the user creates the 3D forms and structures of a vehicle, and a controller used for moving the vehicle (Figure 1a).

Drawing sketch cards. The user draws a part of a vehicle or a controller on a digital tablet with a pen. Then, a sketch card, which is either standing up or lying down on the floor, depending on where the camera looks at, is generated from the drawing.

Arranging sketch cards. The user copies, resizes, and places sketch cards into a complex 3D arrangement.

Grouping sketch cards. The user binds the arranged sketch cards into a group so that they move together as a whole.

2.2 Build

In the build stage, the user defines how they can move the vehicle using the controller (Figure 1b).

Defining a linear motion. The user selects a card belonging to a group, and draws a linear arrow on the card plane.

Defining a circular motion. The user selects a card belonging to a group, and draws a circular arrow around a selected axis.

Connecting motions. The user draws a line connecting the motion arrows to establish a causal relation between the motions of the groups.

2.3 Control

In the control stage, the user selects one of three viewpoints from which to manipulate the vehicle (Figure 1c).

Remote viewpoint. The user controls the vehicle from an unlinked viewpoint, as if playing with a remote control toy.

Onboard viewpoint. The user controls the vehicle from the viewpoint that is fixed to it, as if driving the vehicle from the inside.

Tracking viewpoint. The user controls the vehicle from a loosely coupled viewpoint, as if being a wingman.

3 PROOF-OF-CONCEPT

We created our system using the Unity 3D engine and ran it on a Wacom Cintiq Pro 24 Touch tablet with multi-touch and pen input. To showcase our system's potential, we designed five vehicles that could perform a wide variety of realistic movements: a biplane (Figure 1), a car, an excavator, a rocket, and a spacecraft (Figure 2). Each vehicle took less than an hour and only required moderate drawing skills.

4 CONCLUSION & FUTURE WORK

In this study, we propose RCSketch, which is a pen- and multi-touch-based system that can be used to sketch attractive 3D vehicles freely, build various movements intuitively, and control them realistically. We also provide five examples that explore what is possible with this system.

For future work, we will deploy our system in a classroom setting to evaluate its usability and educational effectiveness as a creativity-supporting tool. Moreover, we will bring our system to VR to let children play with their vehicles more immersively. Finally, we will design and develop an online environment in which many children can play together collaboratively.

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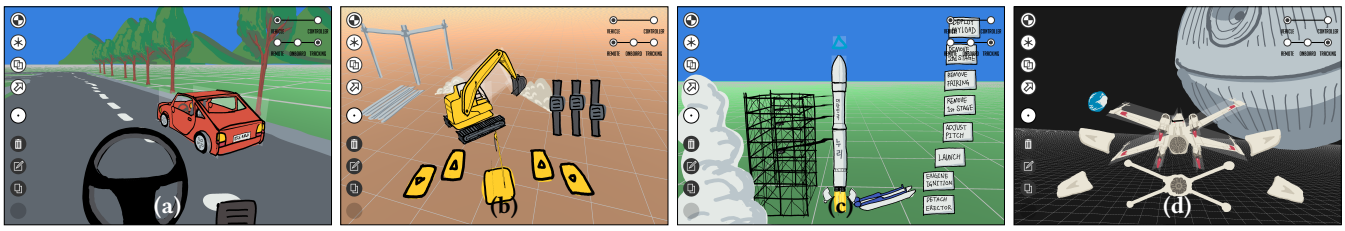

Figure 2: To explore what is possible with RCSketch, we designed (a) *Car*: the user can race the car by pushing the pedal and turning the steering wheel; (b) *Excavator*: the user operate the excavator to dig the ground by driving each of the two caterpillars independently, spinning the cockpit, and actuating the joints of the boom; (c) *Rocket*: the user can simulate a rocket launch, such as engine ignition, stage separation, and satellite deployment; and (d) *Spacecraft*: the user can maneuver a spacecraft around a big space station by unfolding the wings and adjusting the thrust of the four engines separately.