One-piece molding method adapted to uneven surfaces using ADAMs (Additional Distance Adjustment Machine system)

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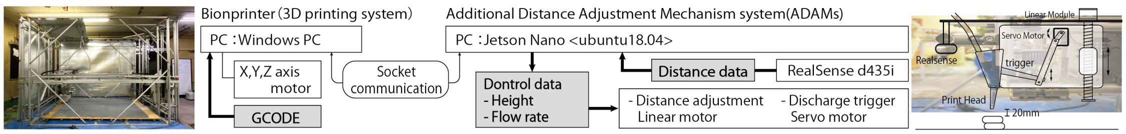

Fig. 1. ADAMs configured by Moving parts and Realsense are shown. The ADAMs are attached to the X-axis of the Bionprinter. The distance data by Realsense controls the ADAMs so that the distance between the print head and the surface of the object is 20mm.

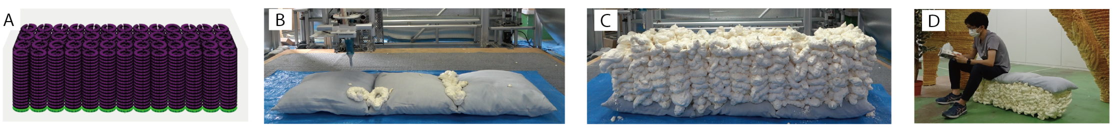

Fig. 2. A) GCODE of the final shape without unevenness information of the lower layers. B) 1st layer modeling. It can be seen that it is being dispensed into a place that is recognized as a dent. C) 12th layer modeling. D) Example of using as a chair.

There are cases where we want to create an integrated object by direct layered modeling on an existing uneven surface. However, the challenges of additive manufacturing on an uneven surface are lack of foothold and collision between the print head and the object. Solutions include a proposal by Hildebrand et al. to separately form and glue additional objects[1] and a proposal by Wu et al. to print by rotating the base of the 3D printer in five axes without the need for gluing[2]. To reduce the cost of the machine, Yamamoto et al. proposed a molding method that uses an infrared depth camera.[3]. However, in large-scale modeling and other applications, the target object may not fit within the sensor tolerance range, and invisible modeling surfaces may occur. Therefore, we propose a machine system that uses a distance sensor to respond to the unevenness of the lower layer and to form a single piece without limiting the forming range or size. Furthermore, even if the modeling data, GCODE, does not have information on the state of the unevenness of the underlying surface, we have confirmed through experiments that it is possible to create an integrated model using only the data of the shape that we want to obtain in the end. First, we created a mechanism called Additional Distance Adjustment Machine system (ADAMs), which consists of a camera module, a linear module moving in the Z direction, and a print head. In addition, we built a large 3D printing system called Bionprinter and attached ADAMs to it. The system is shown in Figure1 Control the height of the print head and control the flow rate according to the difference between the stacking height on the data and the actual height of the stacking surface. Two types of fabrication experiments were conducted using ADAMs to create objects on top of existing uneven surfaces. In the "Real-time-method" controlled the distance between the print head and the surface of the object directly underneath to be kept constant in real-time on a relatively low uneven surface. The "Grid-method" assumes a higher level of unevenness, subdividing the modeling surface into grids, and sensing and modeling once for each grid. The modeling process is shown in Fig2 In both methods, collision did not occur, and the height was approximately constant at the end of fabrication by distance-flow compensation control.

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Additional Key Words and Phrases: Architecture, Robotics, 3D Printing, Furniture, image recognition

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