Fetusoid35: A robot research platform for neural development of both fetuses and preterm infants and for developmental care

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Abstract. We have been developing a robot called Fetusoid35 that resemble a human fetus or preterm infant. We suppose that the robot could contribute to developmental science by shedding a new insight on the understanding the developmental process of fetuses and preterm infants. Based on the understanding of the mechanism, we can developmental care of preterm infant. This extended abstract briefly introduces the design policy of Fetusoid35 with its specifications and the current status.

Keywords: Fetus, Preterm infant, Robot platform

1 Introduction

To understand the development of human fetuses is not only a fundamental issue in developmental science but also in developmental care for preterm infants who have less experience in the uterus. This issue has become more and more serious since it recently turned out that preterm infants might have higher risk of being developmental disorders than the term infants. Developmental care including nesting and swaddling care, that try to imitate a maternal womb, and massage therapy are used in almost cases in Neonatal Intensive Care Unit (NICU), whereas the scientific evidence for the effectiveness of these methods has not been fully found [3]. If we understand a mechanism of fetal development, we can improve the care based on the mechanism.

To investigate a mechanism of fetal development, Mori and Kuniyoshi 2010 [2] constructed a whole body musculoskeletal system of a human fetus as a computer simulation with rigid body dynamics. Using the simulation, we reproduce fetal behavioral development in the first half of the pregnancy with the fetal body model and the nervous system model consisting of a brain stem, a spinal cord and mechanoreceptors from a perspective of self-organization. However, the simulation cannot realize realistic interaction in developmental care.

In this paper, we propose a robot called Fetusoid35 resembling a human fetus and preterm infant having a 35 gestational weeks body, air actuators and somatic

sensors including whole body tactile sensors. The real robot in conjunction with the simulator can contribute to understanda mechanism of fetal development, and we improve developmental care by observing the sensory information within the physical interaction with physiotherapist or special equipment for a nesting care.

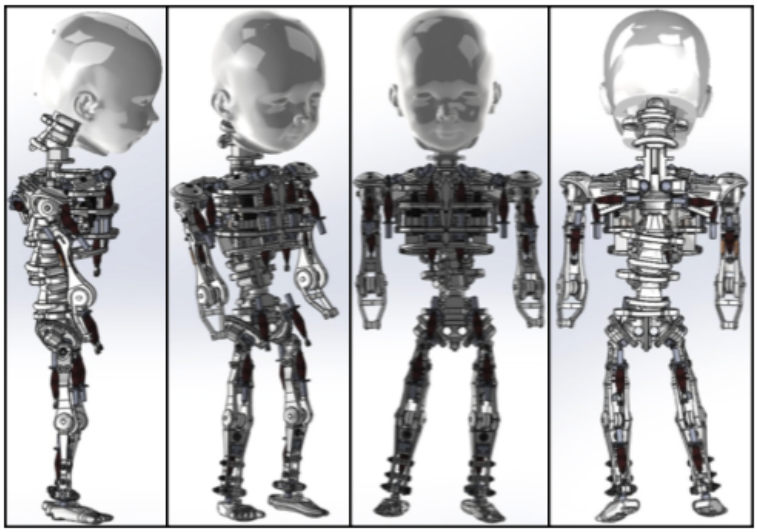

Fig. 1. The design of the Fetusoid35

2 The specifications and the appearance of the robot

The appearance of the robot is shown in Fig. 1. The size of the robot is equivalent to a 35 gestational weeks fetus or preterm infant [1]. The age is appropriate for a study of fetuses and preterm infants because 35 weeks preterm infants mostly survive and have a risk to have a developmental disorder.

The robot has 30 DoFs; The spine including the neck and back bone has 4 Ball joints (3DoFs $\times$ 4), each shoulder has 3 DoFs (3DoFs $\times$ 2), each hip joint has 3 DoFs (3DoFs $\times$ 2), each knee, elbow and ankle has 1 DoF, respectively (1 $\times$ 4). All joints of the robot are driven by McKibben type air actuators [4]. Electric bulbs are embedded in the chest and an air tube, a signal cable and a power cable are bundled analogous to an umbilical cord.

Now we are planing to implement tactile sensors on a whole body skin. Tactile sensation in the uterus might affect development significantly because it responds directly to the fetal movement in the womb.

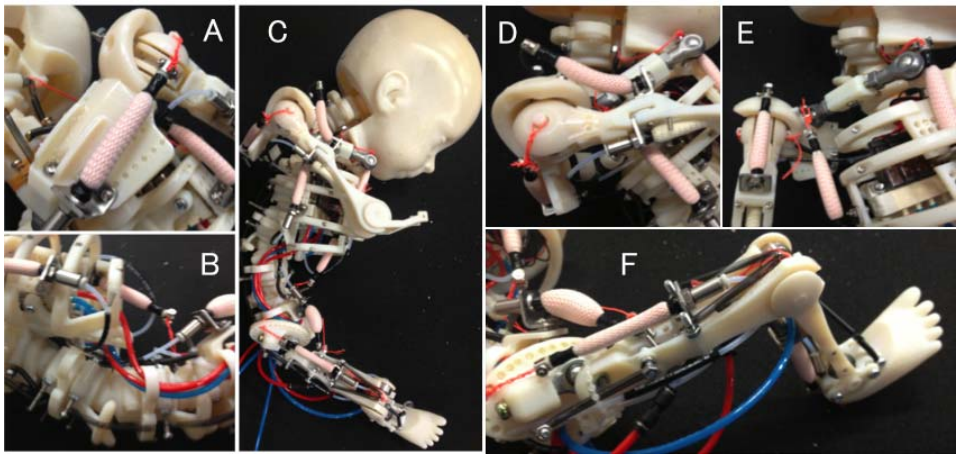

Fig. 2. Fetusoid35. A: Right shoulder joint from a back view. B: Spine from a lateral view. C: Whole body from a lateral view. D: Right shoulder joint (Adduction). E: Right shoulder joint (Abduction). F: Right leg.

3 Conclusion

In this paper, we proposed a robot resembling a fetus and a preterm infant: Fetusoid35. We think that the robot can be used as a moving sensor of the fetal experience in the uterus and of preterm infants in a developmental care, and also a platform for examination of nervous system models.

References

1. J. G. Archie, J. S. Collins, and R. R. Lebel. Quantitative standards for fetal and neonatal autopsy. *American Journal of Clinical Pathology*, 126:256–265, 2006.
2. H. Mori and Y. Kuniyoshi. A human fetus development simulation: Self-organization of behaviors through tactile sensation. In *IEEE 9th International Conference on Development and Learning*, pages 82–97, 2010.
3. J. Sizun, B. Westrup, and the ESF Network Coordination Committee. Early developmental care for preterm neonates: a call for more research. *Archives of Disease in Childhood Fetal & Neonatal Edition*, 89:F384–F388, 2004.
4. B. Tondu, V. Boitier, and P. Lopez. Naturally compliant robot-arms actuated by mckibben artificial muscles. In *1994 IEEE International Conference on Systems, Man, and Cybernetics*, pages 2635–2640.