Joint Angular Position Sensing Algorithm for Mobile Hydraulic Manipulator

Seongjin Park[a], Jinyi Lee[b], Wonsuk Jung[a], Jongwon Park[b*]
[a]*Chungnam National University, 99 Daehak-ro 76beon-gil, Yuseong-gu, Daejeon, Republic of Korea*
[b]*Korea Atomic Energy Research Institute, Daedeok-daero 989-111, Yuseong-gu, Daejeon, 04535, Republic of Korea*
[*]*Corresponding author: jwpark@kaeri.re.kr*

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1. Introduction

Accident Response Manipulator, ARMstrong is a hydraulic robot developed for disaster response. It is equipped with a high energy density hydraulic system to perform demanding tasks in extreme environments and rugged terrain. ARMstrong is designed to be human-operated using a master controller that mimics the movements of the robot's manipulator. Because human judgment and intervention are crucial in disaster response, considering the unpredictable situations of disaster sites**.**

For agile and accurate movements, it is necessary to increase the control rate of the robot. This paper discusses increasing the sensing rate by optimizing sensing algorithm.

2. Sensor and communication configuration.

2.1 Angular Position sensor

ARMstrong has 16 angular position sensors. Considering the characteristics of the mobile robot, a position sensor using serial communication protocol was selected**.** Angular position sensor from CUI was selected for angular position measurement.

And a Serial to USB converter was chosen for communication between the mini PC and angular position sensors. USB communication protocol is used between the PC and the converter, while RS485 communication protocol is used between the converter and the sensor.

Fig 1. ARMstrong robot (a) and controller (b)

2.2 USB communication

USB is communication between host and devices. Host periodically checks the status of the Device and transmission data from devices. This process is called polling and is performed at an interval of 1ms.

3. Improving sensing algorithm

To receive position data from the Angular Position Sensor, A three-step process is required.

(1) Sensor Data Request
The mini PC sends request commands to sensor via the communication bus. Upon receiving a request command, the sensor measures its current position and transmits the position data. Then this data stored in the converter buffer.

(2) Polling
Data in the converter buffer is transferred to the PC buffer through a polling process. The program waits for the polling to complete before reading the data.

(3) Read Sensor data
Getting data from the PC buffer

3.1 Original sensing algorithm

The original sensing algorithm performs the above steps sequentially to receive data from a single sensor. This process is repeated 16 times to collect data from all axes.

In this algorithm, 16 polling operations are performed each time the sensors of all axes of robot are read. Therefore, it takes 16ms. Converting this to frequency, it is 62.5Hz.

3.2 Improved sensing algorithm

Reducing the polling latency in Figure 3(a) is expected to increase the sensing rate**.** To minimize the polling latency, improved algorithm continuously performs Sensor Data Request 16 times. And stored

data in the converter buffer and then reading all axes at once.

The execution time of the SensorDataRequest function is 0.05 ms, and when added to the Delaybefore_Tx of 0.05 ms, it takes 0.1 ms to sending request command once. If this process is repeated 16 times, it takes 1.6 ms. Considering the polling latency, it takes about 2 ms. This translates to a frequency of 500 Hz.

Through improve in the Sensing Algorithm, the Sensing Rate was increased by about 8 times from 62.5 Hz to 500 Hz.

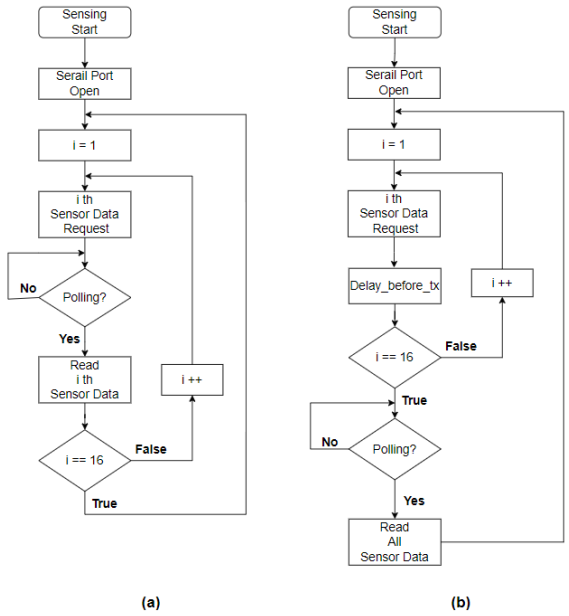

Fig 2. Flow chart of original (a) and improved (b) sensing algorithm

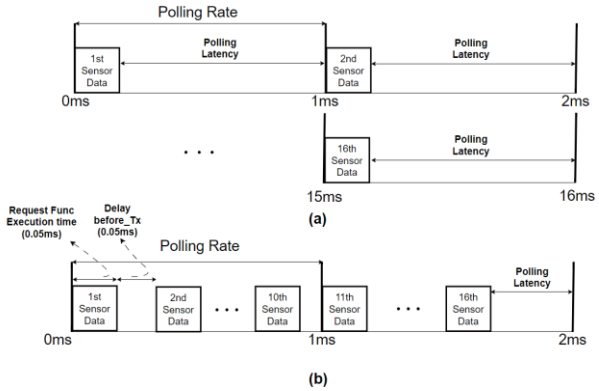

Fig 3. Sensing rate of original (a) and improved (b) sensing algorithm

3 Coclusion

This paper discusses the process of optimization sensing algorithm for Mobile Hydraulic Manipulator. It analyzes the sensor and communication architecture of the ARMstrong robot and identifies a bottleneck in the USB communication process. Subsequently, the sensing algorithm is optimized to improve the sensing rate.

In the Future, we will focus on developing a more precise controller based on the improved control rate.

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