Development of Integration Software for Multiple Inkjet Functionalization Systems

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Abstract

Inkjet printing is widely used in functional product manufacturing. Performing a printing task requires communication and synchronization among multiple subsystems (e.g. motion and drop ejection), which introduces complexity in the overall printing system. A user interface has been developed, which enables users to input printing parameters and patterns for printing functional materials. The interface then sends commands to the controllers that execute the printing process. The software can also be expanded to carry out standard experiments for functional printing research and characterization. Moreover, the software is transferable to multiple systems. One application explored using the software is drug anti-counterfeiting research by printing edible coloring onto pills.

Introduction

Inkjet printing is a versatile tool in manufacturing. Two drop-on-demand (DOD) inkjet technologies are dominant in this area :

- piezoelectric inkjet printing
- thermal inkjet printing

In addition to its traditional role in graphic and text output, it can also be utilized in functional device production, if we use functional materials as the "inks" to be jetted.

The customized nature of functional inkjet printing systems often results in the need for an integration software to allow control at the user level. Thus, it is important that we make a user interface that meets the special needs of our customers.

This research will address the gap by developing a user interface that coordinates all sub-systems. Its basic functionality is to execute print routines based on patterns and parameters defined by users. It should also be expandable, so that user can add standard printing experiments for characterization.

Methodology

The components that need to be controlled in a typical inkjet printing system include (but not limited to):

- Print head (for jetting ink)
- Jet driver (for sending an excitation to print head upon receipt of trigger signal)
- Motion stage (for positioning substrate relative to print head)
- Motion Controller (for controlling motion of stage and triggering jet drive)
- Camera (for observing printing process)

The communication scheme of various components are shown in figure 1.

A graphical user interface (GUI) has been developed as a solution to this problem. It combines the control of all these components into a single interface, so the user can seamlessly access and transmit data without switching between sub-system softwares.

Considering the efficiency of the software and accuracy of control, both MATLAB and C have been employed in developing the GUI. MATLAB is efficient in image processing and image acquisition, while C communicates with controllers directly through serial port. A hierarchy of the software communication is shown in figure 2.

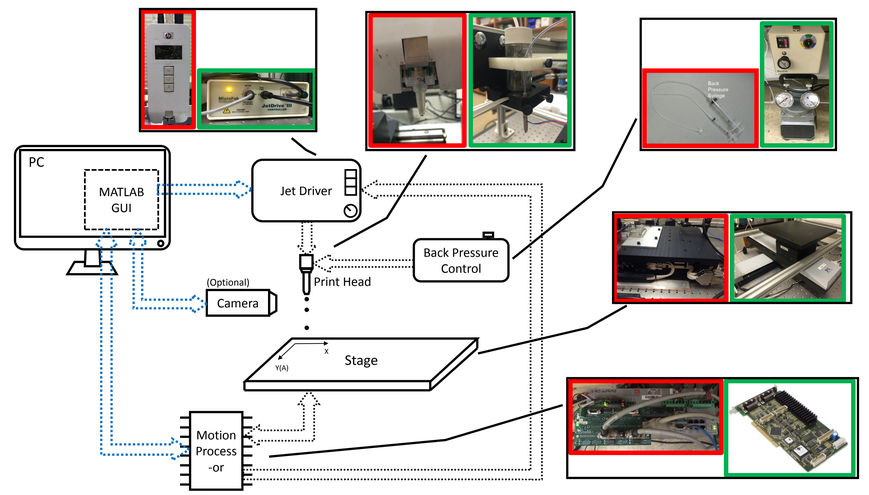

Fig 1. Schematic of a typical inkjet printing system. The dotted arrows represent the data flow within the system, with the blue ones controlled by GUI. The pictures correspond to the components that are used in labs: ones with red frames are in the Spira Lab and those with green frames are in Faboratory.

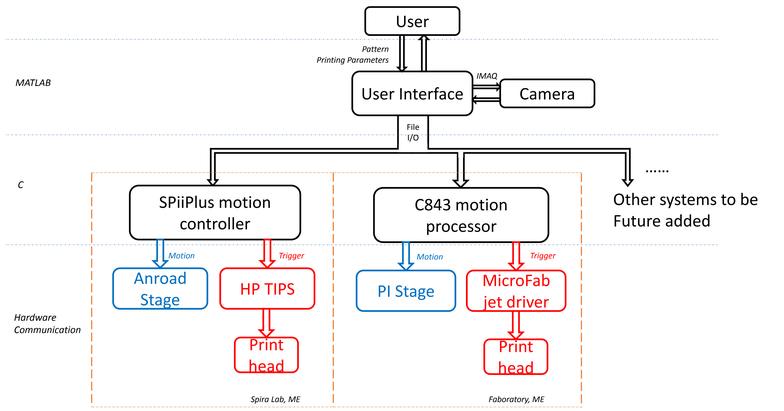

Fig 2. The hierarchy of communication. The user specified printing pattern and parameters are passed into the system through a Matlab GUI. The GUI then communicates with motion controller using C and factory-provided hardware interfaces. The coordination among stages and print heads are completed by the motion controller.

EZ-Printing

The front panel of EZ-Printing GUI is presented in figure 3. This software accepts user input of printing pattern as well as the printing parameters, specified on the main panel and in advanced settings. It then translates the information into a pseudo-code. The pseudo-code only contains a set of numbers that describe the movement of stage. It serves as an intermediate code, since each motion controller has its own command set. The code can then be translated into a controller-compatible language according to user selection and then be executed by the motion controller to perform the printing task.

One outstanding feature of the software is its extensibility. It can easily be adapted to other systems with different motion controllers only by adding a customized translator. It can also carry out customized printing-routines in the "task" pop up menu, and it can be extended according to user needs.

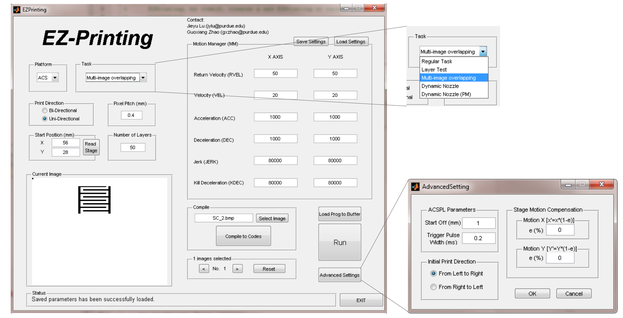

Fig 3. Front panel of the "EZ-Printing" software. The expanded view of the "task" pop-up menu and the "Advanced Setting" panel is provided.

Application

One application explored using this software is pharmaceutical anti-counterfeiting research.

Pharmaceutical counterfeiting is becoming a serious problem both in developed and developing countries. Although numerous methods have been applied, most of them focus on markings on the package. Customers can't verify the authenticity if they buy retailed drugs from pharmacy.

A new method has been proposed to put markings on pills. Figure 4 shows the feasibility of printing QR codes onto the pill using food coloring. Information embedding can further enhance the difficulty of reproducing drugs.

Fig 4. Printing QR codes onto pills using food coloring

Conclusions

The EZ-Printing software is a user-friendly, versatile and efficient solution for functional inkjet printing research.

It address the research question in that it:

- provides convenient way to print a user-defined pattern
- is adaptable to multiple systems
- provides basic routines for functional material characterization
- can easily be extended to improve its functionality.

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