Intravenous Line Drop Counter App Using Image Processing

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Abstract— The aim of this paper is to explain and develop a software application for Intravenous Line (IV) drop counter for medical purpose. Intravenous line delivers fluids into patient’s body in controlled amount by inserting into a vein (blood vessel) using a needle. It is connected by a long piece of tubing to a bag or syringe containing fluids, nutrients or medications. Infusion Pump is an apparatus which delivers measured amounts of drug or IV solution through IV injection over time. But due to low budget, and the alarming pump failures possible to be sought, manual operation of counting drops per minute still emerge. Therefore, a new application is designed to lessen time-consuming manual IV line drop count and eliminate the chances of health and license risk. From this application, Eclipse will be used to program this system as an IDE (Integrated Development Environment) base workspace, and Java as the programming language. For graphic and computing presentations, OpenCV library will be used all over the system. OpenCV library tools such as image processing and object detection both help for accurate results. This application focuses on the drip chamber part of the IV line where the fluid drops, the time to be taken at the first 2 drops, and the mathematical computation of the total drops per minute. The following sections will discuss more the proposed system and the issues regarding the manual intravenous therapy.

Keywords- camera; counter; drop; image; intravenous; java; network; neural; mobile; monitoring; recognition; opencv; processing; programming; shape;

I. INTRODUCTION

Technology nowadays keeps improving and helps society to simplify human workloads. Accurate and fast functional processes are set as its main goals. Further improvements and inventions continue to grow essentially, and one of the leading fields which strongly bond to technology is medicine.

Infusion of liquid substances towards into a vein is called Intravenous therapy or IV therapy. The word intravenous itself means within vein. Specialty pharmaceuticals are the therapies controlled intravenously. It is used on correcting electrolyte imbalances, fluid replacement, blood transfusion, and delivering medications. Drip chamber prevents air from entering the blood stream that causes air embolism, and allows flow rate estimation as it is commonly pertain as drip. Numerous system of administration employs this [1]. Hypertension, heart failure, pulmonary edema, embolism and others are just some of the consequences a patient may suffer if the assigned medical staff didn't follow the schedule of application in this therapy [2].

Infusion Pump is an apparatus which delivers measured amount of drug or IV solution through IV injection over time [9]. In general, this pump is operated exclusively by an authorized and trained user, who programs the fluid’s duration and rate of delivery through a built-in software interface. The ability in delivering very small fluid volume at precisely programmed rates or automated intervals made infusion pump more advantageous over manual administration. However, several issues are concerned by the health organizations such as the software malfunctions wherein some pumps fail to activate pre-programmed alarms, leading to over- or under-infusion. Also, the user interface seems confusing from on-screen user instructions, which can lead to improper programming, such as the units of measurement to be used. Sparks, battery failures, pump fires, components such as pump housings, are also another four (4) of the main incidents reported as mechanical or electrical failures [10].

Non-premiered Philippine hospitals exist which still used manual configuration by computing time interval [11]. The computed and counted dpm tallying process is described as very sensitive and cautious. Finding the exact adjustment of IV line by trial-and-error slows the task of the assigned medical staff, but if another workload of getting drops per minute dpm computation is removed, the consuming time will be lessen, and this free software application that can support is called "Intravenous Line Drop Counter” app.

II. OBJECTIVES

The concept of this paper shows priority goals to be set in accordance to the following objectives:

• Eliminate manual drop counting
• Eliminate manual dpm computation
• Save consuming time from manual operations
• Save budget
• Ease of use
III. RELATED WORKS

Real-time fast ball object tracking program using OpenCV Library detects ball-shaped objects appearing on the camera [3]. The round shape can still be detected by the program even it move fast and blurry [4]. OpenCV immensely provide complex image processing and vision algorithm effective solutions, applicable in real time applications [12].

The following are collected works related to counter and detection:

A. Moving Vehicle Detection for Measuring Traffic Count

This system using the same library is designed and implemented with Visual C++. This highway traffic counting procedure follows through image filtering, image binary, background subtraction, and segmentation methods. This system counts moving vehicles, such as car, truck, and van from pre-recorded videos [5].

B. Shape Matching and Object Recognition using Shape Context

Measuring and comparing the detected object from shapes and exploiting it for object recognition are the approached used in the development of this paper. The shape context at a reference point extracts the remaining distribution points correlate to it, thus contributing a globally discriminative characterization. The problem of finding solutions on stored prototype shape is then recognized in a nearest neighbor classification framework as vastly similar to that in the image [13].

IV. IV RATE CALCULATION

Further calculation of IV rates through dpm serves as basis of drop counter test app to be performed. Note that (1) is the general formula to be used.

\[
\text{drops per minute} = \frac{\text{total volume}}{\text{time}} \times \text{drop factor}
\]

(1)

To further understand, the following is an example prescription followed by computation.

\[
1200 \text{ mls} / \text{time} \times \text{drop factor} = \text{drops per minute}
\]

(2)

Figure 1. Example of prescription

In the first step, substitute the total volume to be given from the formula (1).

\[
(1200 \text{ mls} / \text{time}) \times \text{drop factor} = \text{drops per minute}
\]

As stated, the given time is 10 hours. Convert this into minutes. Note, that in 1 hour = 60 minutes.

\[
(1200 \text{ mls} / 600 \text{ mins}) \times \text{drop factor} = \text{drops per minute}
\]

(3)

The next step is checking the administration set’s drop factor, commonly 15, 20, and 60 drops/ml.

Therefore,

\[
(1200 / 600) \times 20 = 40 \text{ dpm}
\]

(4)

From this example computation, it is clear that the assigned nurse/doctor needs 40 drops per minute. To achieve this, nurse/doctor needs first to adjust the IV Line. The app is therefore responsible to compute time interval of first and second drop and compute automatically to one minute equivalent. If the equivalent doesn't satisfy to the user computed dpm, user needs to adjust again IV Line roller clamp through trial-and-error.

V. SYSTEM OVERVIEW

In this system, a camera with at least five (5) megapixels will be needed to acquire clearer drops using video recording. Drops must be recognized responsibly through OpenCV library. Program outputs the time interval of the first drop and second drop. Moreover, timer will only display seconds and milliseconds. In able to discuss the system flow, below shows a flowchart.

Figure 2. Administration set

Substitute drop factor from (1), then compute for the dpm.

\[
(1200 \text{ mls} / 600 \text{ mins}) \times 20 = \text{drops per minute}
\]

Therefore,

\[
(1200 / 600) \times 20 = 40 \text{ dpm}
\]

Figure 3. Flowchart
In order to compute \textit{drops per minute} target/goal, system requires valid and complete inputs from user. These are “total volume”, “time”, “drop factor” as prescribed by doctor. Computation follows recently discussed \textit{IV Rate Calculation}, wherein formula is stated. Starting a video snap requires camera on and flash (if has), and timer sets only from the first occurrence of droplet until second. If the first droplet not yet showed, the app must still wait for the appearance as the signal of video start. Also, the second droplet to be showed becomes the signal of video end. Subsequently, system converts given time interval (seconds with milliseconds) into minute, therefore determining in one (1) minute the total drop count. To be accurate, comparison is made between trial and target \textit{dpm} as mentioned. However, if this doesn’t satisfy result, user, such as assigned nurse, needs to adjust the roller clamp before proceeding on the repeated process, “Starting a video snap”.

VI. SYSTEM TESTING

System is tested on mobile phone, with specs eight (8) camera megapixels, camera flash feature, 720 x 1280 pixels resolution, Android operating system platform, 2 GB RAM internal memory, and dual-core 2 GHz CPU.

The above screenshots show the implementation design and function from the flowchart given earlier (see Fig. 3). Notice the red margin as shown in Fig.6. This serves as indicator if a droplet fell and turns into quick yellow when y-axis and x-axis of margin and drop meets. Notice also how the test result conducted. The target \textit{dpm} and trial \textit{dpm} differs a lot, and user must adjust roller clamp to gain another result.

VII. CONCLUSION

This research showed that with the help of our system we can lessen the detrimental effects of over infusion and under infusion of intravenous fluids through proper and accurate regulation. This study also proves that this system has a lot of potential since our technology today is limitless and with ongoing research like this one. We can use this system instead of the expensive infusion pumps which is not only cost efficient but also accessible to everyone in just few touch of their smart phones.

VIII. FUTURE DIRECTIONS

This software application is designed to eliminate slow and sensitive counting of drops in IV Line by nurses, and doctors. Moreover, it helps medical staffs count more accurate since said software’s Object Tracking Feature is responsible for the drop detection. Wrong computation can lead to serious health damage, as well as file cases. As of today, the app
development remains in progress, since several additional features is set to be prioritized in upcoming season.

The user interface itself is on improvement, since the app is on trial version, and functionality was focused. The design, such as buttons, labels, background image, and the app’s responsiveness are major concerns in overall design.

To ensure IV line is being tested, future directions include object detector having ability to recognize IV Line drip chamber.

Circle or droplet-like object distractions, also needs restriction to promote precise results by focusing within the boundary of drip chamber. Creating bounding boxes and circles for contours can help [14].

For best results of video capture, focus control is then to be feature especially users with shaky hands during video snap.

REFERENCES