

Electronic IV Clamp

BMEN 3151 Medical Device Practicum

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Clinical Problem

Intravenous infusion methods are used in hospitals and clinics all over the world for delivering medication for numerous reasons. However, the technology of a manual roller clamp to adjust delivery rate has been proven to be outdated and inaccurate. Plus, IV bag dosages are given in drops per minute, which is visually measured by doctors and nurses. In an original research study, 107 nurses were observed administering IV medication. Out of the 568 administrations, 69.7% of administrations had at least one clinical error, such as incorrect flow rate, and out of those, 25.5% were serious. Automation is a solution to reduce user error, but current automated intravenous infusion methods, like infusion pumps, are expensive and bulky.

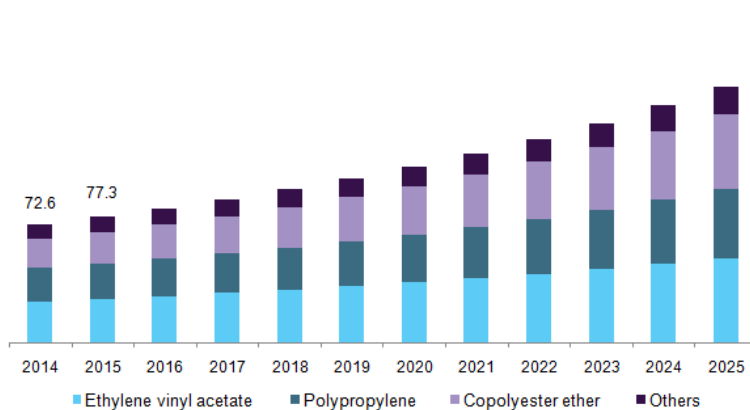
Needs Statement

An affordable and mobile substitute to infusion pumps that remotely measures and adjusts IV bag flow rates to reduce manual control errors and inaccuracy.

Market Analysis

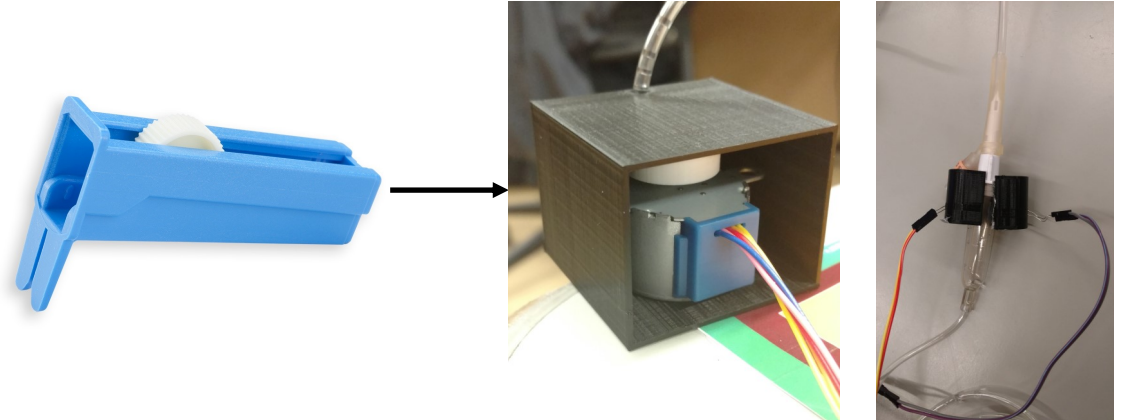
Doctors and nurses without access to infusion pumps would find the electronic IV clamp useful. Less time and training would be required to operate IV bags, which creates an incentive to buy this product.

Germany IV Bags Market (USD Million)



The global infusion pump market was valued at USD \$11.27 billion in 2017, while the global IV bag market was valued at USD \$1.36 billion and is expected to reach \$2.32 billion by 2027. Putting this product on the market would see growth alongside the growth of IV bag usage, complement the IV bag market, and increase the demand for IV bags. Infusion pumps, on average, cost \$627, which is much more expensive than the expected cost of the electronic IV clamp. This creates a potential for a tap into the infusion pump market as well, as electronic IV clamps could replace some infusion pumps.

Medical Device Solution



An Arduino Uno microcontroller is used in junction with a photodiode couple and stepper motor to measure the flow rate and clamp the IV tube, respectively. An LED and photoresistor are placed on opposite sides of a drip chamber, measuring light interference from drops and calculating the number of drops per minute. The stepper motor has an attached 3D-printed part that clamps the IV tube to a certain degree and adjusts the flow rate until the desired flow rate has been met. Users can numerically input their desired flow rate via a computer interface. As per standard practices, the stepper motor completely clamps the IV tube by default and whenever a user inputs a new value, and adjusts to the desired flow rate. In case of flow rate fluctuations, the photodiode couple and stepper motor continuously work to adjust to the desired flow rate, even after the desired flow rate is initially met.

Testing

The photodiode couple was tested to determine the photoresistor values with and without drop interference to make flow rate measurements more accurate. Experimental values of certain stepper motor parameters were found in order to create accurate and meaningful adjustments and ensure that correct adjustments are made. The software was optimized in order to find the right balance between flow rate accuracy with the photodiode couple and stepper motor and run time, as run time can affect the dosage amount given if the measured flow rate is significantly different from the desired flow rate.

Team Photo

