

Intelligent IV sensing and control for the developing world.

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## Problem

Dehydration is the second most common cause of death in the developing world. Intravenous therapy—normally accomplished by manually clamping the IV line and periodically adjusting the flow rate—is one of the most widely used methods of treating dehydration globally. Due to natural variability in the drip rate during infusion, an improper amount of fluid can be given to a patient if not constantly monitored, causing otherwise preventable injury or death. The overwhelming number of patients in the developing world makes consistent monitoring nearly impossible. There is a need for a cost-effective and automatic fluid regulating device to make IV infusions safer in the developing world.

## Objectives

### Monitor Drip Rate and Volume Infused

- Drip rate and volume within 10% of prescription

### Regulate Flow

- Automatic flow control based on physician's prescription

### Alarm

- Notification of problems or completion of infusion

### Affordable

- \$50-100

### Power

- Battery operated and energy efficient

### User Interface

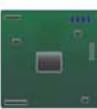
- Simple to select and display drip rate and infusion volume

## How It Works



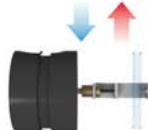
### 1 Infrared sensors

SmartDrip uses infrared sensors to track drip rate and volume. Each drop alters the beam of light that shines through the drip chamber.



### 2 Microcontroller board

The TI MSP430 microcontroller compares the measured drip rate and volume to the prescribed values.



### 3 Flow control

The control system—a gearbox motor and a custom screw pump—adjusts the flow by tightening or loosening the clamp.



### Smart clips.

The chamber clips on Droplet don't just serve as mounts for any standard drip chamber. They also house the sensors that allow it to monitor an infusion. This keeps them exactly where they need to be for the greatest measuring precision and protects them from damage.

### Backlit display.

Infusion information is always available due to SmartDrip's LCD display. Furthermore, the backlight allows for easy viewing in poor lighting conditions.

### Simple controls.

SmartDrip is extremely easy to use. The simple controls of SmartDrip mean that there's no language or experience barrier to operation.

### A Powerful Platform.

SmartDrip's circuit boards are based on the Rice Orbit platform. A TI MSP430 microcontroller gives SmartDrip the power to accurately monitor and process infusion information in real-time. Low-power states and an interrupt-driven design create an energy footprint small enough to be portable.

### Lightweight durability.

SmartDrip was designed with durability in mind. The harsh environment of the developing world means SmartDrip needs a hard shell. The casing is custom-designed of lightweight but strong material to ensure long life.

## Audio/Visual Alarms

Alarms in the device alert the physician when there is an external problem with the infusion—such as a kink in the line—or when the infusion volume has been reached.



## Low Power, Low Cost

By using a high-capacity lithium-ion battery and aggressive energy management, SmartDrip maximizes operating life. This greatly enhances portability and minimizes the need for expensive replacement batteries. SmartDrip's mostly inexpensive, off-the-shelf components cost under \$100 when purchased in bulk.



## Simple, Safe

Physicians no longer need to manually count drips using a watch. A simple user interface allows a physician to enter any two of three parameters (volume, drip rate, time); the third is determined automatically. Motorized control automatically adjusts to the desired drip rate, reducing calibration time and user error.



## Conclusions

- Infrared sensors detect every drop.
- Motor assembly provides autonomous and accurate flow control as well as flow shutoff at the end of an infusion.
- SmartDrip uses a variety of power-saving techniques to maximize battery life and portability.
- Total parts cost is under \$100.
- SmartDrip will be taken to Lesotho during the summer of 2008 for field testing.

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## Results

