SMART WATER MANAGEMENT SYSTEM

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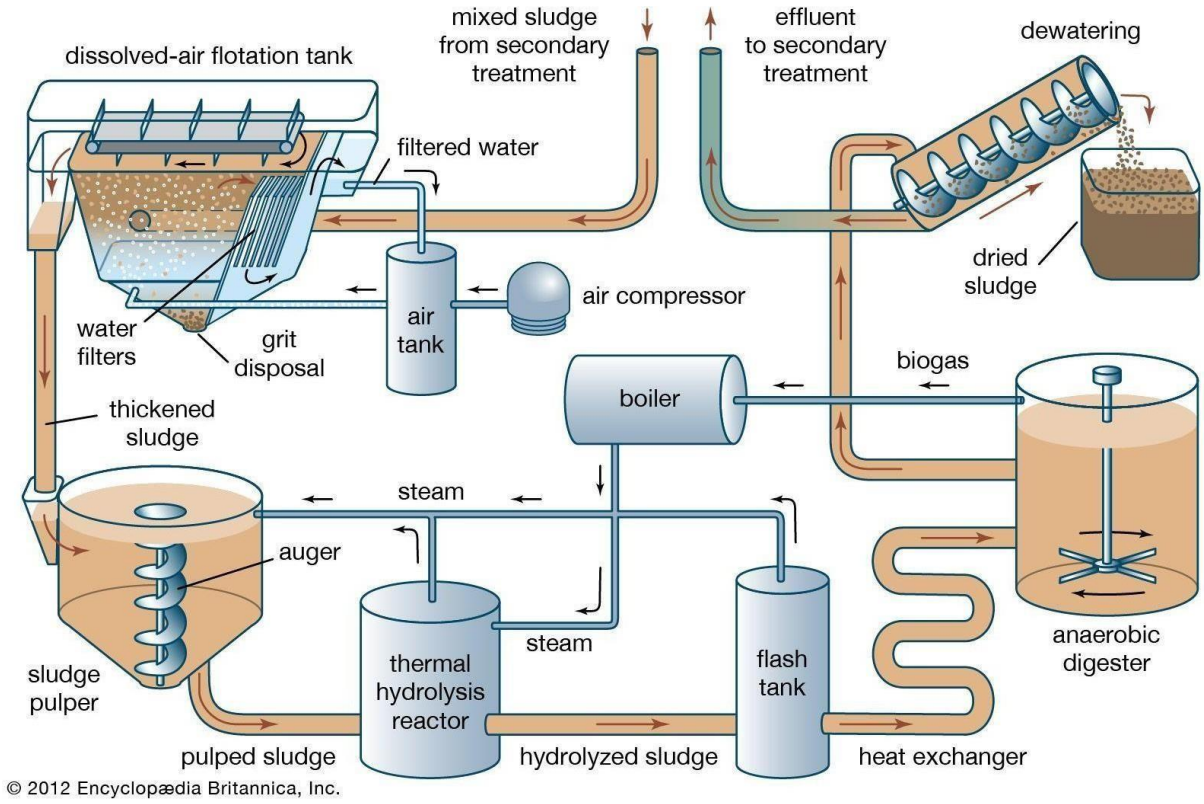
DEVELOPMENT PART 1

Wastewaters are waterborne solids and liquids discharged into sewers that represent the wastes of community life. Wastewater includes dissolved and suspended organic solids, whichare “putrescible” or biologically decomposable. Two general categories of wastewaters, not entirely separable, are recognized: domestic and industrial. Wastewater treatment is a process in which the solids in wastewater are partially removed and partially changed by decomposition from highly complex, putrescible, organic solids to mineral or relatively stable organic solids. Primary and secondary treatment removes the majority of BOD and suspended solids found in wastewaters. However, in an increasing number of cases this levelof treatment has proved to be insufficient to protect the receiving waters or to provide reusable water for industrial and/or domestic recycling. Thus, additional treatment steps have been added to wastewater treatment plants to provide for further organic and solids removals or to provide for removal of nutrients and/or toxic materials.There have been several new developments in the water treatment field in the last years. Alternatives have presented themselves for classical and conventional water treatment systems. Advanced wastewater treatments have become an area of global focus as individuals, communities, industries and nations strive for ways to keep essential resources available and suitable for use. Advanced wastewater treatment technology, coupled with wastewater reductionand water recycling initiatives, offer hope of slowing, and perhaps halting, the inevitable loss of usable water. Membrane technologies are well suited to the recycling and reuse of waste water. Membranescan selectively separate components over a wide range of particle sizes and molecular weights. Membrane technology has become a dignified separation technology over the past decennia. The main force of membrane technology is the fact that it works without the addition of chemicals, with relatively low energy use and easy and

well-arranged process conduction. This paper covers all advanced methods of wastewater treatments and reuse.



PROGRAM SCRIPT:

```
#


        import RPi.GPIO as GPIO
        import time
        import threading




        class HX711:


            def__init__(self, dout, pd_sck, gain=128):
                self.PD_SCK = pd_sck
```

```
self.DOUT = dout


# Mutex for reading from the HX711, in case multiple threads in client
# software try to access get values from the class at the same time.
self.readLock = threading.Lock()

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)
GPIO.setup(self.PD_SCK, GPIO.OUT)
GPIO.setup(self.DOUT, GPIO.IN)


self.GAIN = 0


# The value returned by the hx711 that corresponds to your reference
# unit AFTER dividing by the SCALE.
self.REFERENCE_UNIT = 1
self.REFERENCE_UNIT_B = 1


self.OFFSET = 1
self.OFFSET_B = 1
self.lastVal = int(0)
```

```
self.DEBUG_PRINTING = False

      self.byte_format = 'MSB'
      self.bit_format = 'MSB'

      self.set_gain(gain)

      # Think about whether this is necessary.
      time.sleep(1)

  def convertFromTwosComplement24bit(self, inputValue):
      return -(inputValue & 0x800000) + (inputValue & 0x7fffff)

  def is_ready(self):
      return GPIO.input(self.DOUT) == 0

  def set_gain(self, gain):
      if gain is 128:
          self.GAIN = 1
      elif gain is 64:
          self.GAIN = 3
      elif gain is 32:
          self.GAIN = 2

      GPIO.output(self.PD_SCK, False)

      # Read out a set of raw bytes and throw it away.
      self.readRawBytes()

  def get_gain(self):
      if self.GAIN == 1:
          return 128
      if self.GAIN == 3:
```

```
        return 64
    if self.GAIN == 2:
        return 32


    # Shouldn't get here.
    return 0



def readNextBit(self):
   # Clock HX711 Digital Serial Clock (PD_SCK).  DOUT will be
   # ready 1us after PD_SCK rising edge, so we sample after
   # lowering PD_SCL, when we know DOUT will be stable.
   GPIO.output(self.PD_SCK, True)
   GPIO.output(self.PD_SCK, False)
   value = GPIO.input(self.DOUT)


   # Convert Boolean to int and return it.
   return int(value)




def readNextByte(self):
   byteValue = 0


   # Read bits and build the byte from top, or bottom, depending
   # on whether we are in MSB or LSB bit mode.
   for x in range(8):
      if self.bit_format == 'MSB':
         byteValue <<= 1
         byteValue |= self.readNextBit()
      else:
         byteValue >>= 1
         byteValue |= self.readNextBit() * 0x80


   # Return the packed byte.
   return byteValue



def readRawBytes(self):
```

```
    # Wait for and get the Read Lock, incase another thread is already
    # driving the HX711 serial interface.
    self.readLock.acquire()


    # Wait until HX711 is ready for us to read a sample.
    while not self.is_ready():
       pass


    # Read three bytes of data from the HX711.
    firstByte  = self.readNextByte()
    secondByte = self.readNextByte()
    thirdByte  = self.readNextByte()


    # HX711 Channel and gain factor are set by number of bits read
    # after 24 data bits.
    for i in range(self.GAIN):
       # Clock a bit out of the HX711 and throw it away.
       self.readNextBit()


    # Release the Read Lock, now that we've finished driving the HX711
    # serial interface.
    self.readLock.release()


    # Depending on how we're configured, return an orderd list of raw byte
    # values.
    if self.byte_format == 'LSB':
       return [thirdByte, secondByte, firstByte]
    else:
       return [firstByte, secondByte, thirdByte]




def read_long(self):
    # Get a sample from the HX711 in the form of raw bytes.
    dataBytes = self.readRawBytes()




    if self.DEBUG_PRINTING:
```

```
            print(dataBytes,)

        # Join the raw bytes into a single 24bit 2s complement value.
        twosComplementValue = ((dataBytes[0] << 16) |
                               (dataBytes[1] << 8)  |
                               dataBytes[2])


        if self.DEBUG_PRINTING:
            print("Twos: 0x%06x" % twosComplementValue)

        # Convert from 24bit twos-complement to a signed value.
        signedIntValue =
self.convertFromTwosComplement24bit(twosComplementValue)


        # Record the latest sample value we've read.
        self.lastVal = signedIntValue


        # Return the sample value we've read from the HX711.
        return int(signedIntValue)



    def read_average(self, times=3):
        # Make sure we've been asked to take a rational amount of samples.
        if times <= 0:
            raise ValueError("HX711()::read_average(): times must >= 1!!")


        # If we're only average across one value, just read it and return it.
        if times == 1:
            return self.read_long()


        # If we're averaging across a low amount of values, just take the
        # median.
        if times < 5:
            return self.read_median(times)


        # If we're taking a lot of samples, we'll collect them in a list, remove
        # the outliers, then take the mean of the remaining set.
        valueList = []
```

```
        for x in range(times):
            valueList += [self.read_long()]

        valueList.sort()

        # We'll be trimming 20% of outlier samples from top and bottom of
collected set.
        trimAmount = int(len(valueList) * 0.2)

        # Trim the edge case values.
        valueList = valueList[trimAmount:-trimAmount]

        # Return the mean of remaining samples.
        return sum(valueList) / len(valueList)



    # A median-based read method, might help when getting random value spikes
    # for unknown or CPU-related reasons
    def read_median(self, times=3):
       if times <= 0:
          raise ValueError("HX711::read_median(): times must be greater than
zero!")

       # If times == 1, just return a single reading.
       if times == 1:
          return self.read_long()

       valueList = []

       for x in range(times):
          valueList += [self.read_long()]

       valueList.sort()

       # If times is odd we can just take the centre value.
```

```
   if (times & 0x1) == 0x1:
      return valueList[len(valueList) // 2]
   else:
      # If times is even we have to take the arithmetic mean of
      # the two middle values.
      midpoint = len(valueList) / 2
      return sum(valueList[midpoint:midpoint+2]) / 2.0
```

```
# Compatibility function, uses channel A version
def get_value(self, times=3):
    return self.get_value_A(times)
```

```
def get_value_A(self, times=3):
    return self.read_median(times) - self.get_offset_A()
```

```
def get_value_B(self, times=3):
    # for channel B, we need to set_gain(32)
    g = self.get_gain()
    self.set_gain(32)
    value = self.read_median(times) - self.get_offset_B()
    self.set_gain(g)
    return value
```

```
# Compatibility function, uses channel A version
def get_weight(self, times=3):
    return self.get_weight_A(times)
```

```
def get_weight_A(self, times=3):
    value = self.get_value_A(times)
    value = value / self.REFERENCE_UNIT
    return value
```

```
def get_weight_B(self, times=3):
    value = self.get_value_B(times)
    value = value / self.REFERENCE_UNIT_B
    return value



# Sets tare for channel A for compatibility purposes
def tare(self, times=15):
    return self.tare_A(times)


def tare_A(self, times=15):
    # Backup REFERENCE_UNIT value
    backupReferenceUnit = self.get_reference_unit_A()
    self.set_reference_unit_A(1)

    value = self.read_average(times)


    if self.DEBUG_PRINTING:
        print("Tare A value:", value)

    self.set_offset_A(value)


    # Restore the reference unit, now that we've got our offset.
    self.set_reference_unit_A(backupReferenceUnit)


    return value




def tare_B(self, times=15):
    # Backup REFERENCE_UNIT value
    backupReferenceUnit = self.get_reference_unit_B()
    self.set_reference_unit_B(1)


    # for channel B, we need to set_gain(32)
    backupGain = self.get_gain()
    self.set_gain(32)
```

```
    value = self.read_average(times)


    if self.DEBUG_PRINTING:
        print("Tare B value:", value)

    self.set_offset_B(value)


    # Restore gain/channel/reference unit settings.
    self.set_gain(backupGain)
    self.set_reference_unit_B(backupReferenceUnit)

    return value




def set_reading_format(self, byte_format="LSB", bit_format="MSB"):
    if byte_format == "LSB":
        self.byte_format = byte_format
    elif byte_format == "MSB":
        self.byte_format = byte_format
    else:
        raise ValueError("Unrecognised byte_format: \"%s\"" % byte_format)


    if bit_format == "LSB":
        self.bit_format = bit_format
    elif bit_format == "MSB":
        self.bit_format = bit_format
    else:
        raise ValueError("Unrecognised bitformat: \"%s\"" % bit_format)







# sets offset for channel A for compatibility reasons
def set_offset(self, offset):
    self.set_offset_A(offset)
```

```
    def set_offset_A(self, offset):
        self.OFFSET = offset


    def set_offset_B(self, offset):
        self.OFFSET_B = offset


    def get_offset(self):
        return self.get_offset_A()


    def get_offset_A(self):
        return self.OFFSET


    def get_offset_B(self):
        return self.OFFSET_B




    def set_reference_unit(self, reference_unit):
        self.set_reference_unit_A(reference_unit)



    def set_reference_unit_A(self, reference_unit):
         # Make sure we aren't asked to use an invalid reference unit.
        if reference_unit == 0:
            raise ValueError("HX711::set_reference_unit_A() can't accept 0 as a
reference unit!")
            return


        self.REFERENCE_UNIT = reference_unit



    def set_reference_unit_B(self, reference_unit):
         # Make sure we aren't asked to use an invalid reference unit.
        if reference_unit == 0:
            raise ValueError("HX711::set_reference_unit_A() can't accept 0 as a
reference unit!")
            return
```

```
        self.REFERENCE_UNIT_B = reference_unit



    def get_reference_unit(self):
        return get_reference_unit_A()



    def get_reference_unit_A(self):
        return self.REFERENCE_UNIT



    def get_reference_unit_B(self):
        return self.REFERENCE_UNIT_B


    def power_down(self):
        # Wait for and get the Read Lock, incase another thread is already
        # driving the HX711 serial interface.
        self.readLock.acquire()


        # Cause a rising edge on HX711 Digital Serial Clock (PD_SCK).  We then
        # leave it held up and wait 100 us.  After 60us the HX711 should be
        # powered down.
        GPIO.output(self.PD_SCK, False)
        GPIO.output(self.PD_SCK, True)


        time.sleep(0.0001)


        # Release the Read Lock, now that we've finished driving the HX711
        # serial interface.
        self.readLock.release()



    def power_up(self):
        # Wait for and get the Read Lock, incase another thread is already
```

```
            # driving the HX711 serial interface.
            self.readLock.acquire()


            # Lower the HX711 Digital Serial Clock (PD_SCK) line.
            GPIO.output(self.PD_SCK, False)


            # Wait 100 us for the HX711 to power back up.
            time.sleep(0.0001)


            # Release the Read Lock, now that we've finished driving the HX711
            # serial interface.
            self.readLock.release()


             # HX711 will now be defaulted to Channel A with gain of 128.  If this
             # isn't what client software has requested from us, take a sample and
            # throw it away, so that next sample from the HX711 will be from the
            # correct channel/gain.
            if self.get_gain() != 128:
                self.readRawBytes()



        def reset(self):
            self.power_down()
            self.power_up()



    # EOF - hx711.py
```

CONCLUSION:

Our hypothesis was that distillation would be the best method of purifying water. However, the data from the experiment refuted our hypothesis. We learned that chlorine was most effective in bringing water's pH level to neutrality (7). We took the pH levels of the control and treated water. We then divided the difference between the control and the treated water's pH level by the control's distance from 7. That gave a percentage which we averaged for

each method.

This result does, however, come with a condition: chlorine is a poison. While it may bring the bacteria count in water down, it does not make it safe to drink. There are methods of treating the chlorinated water to make it safe to drink, however.

In our experiment we noticed some flaws in the system that may have hindered our experiment process. We originally planned on using iodine as well as chlorine for chemical treatment. Unfortunately most stores no longer carry the iodine solution to clean water. Other than, our experiment ran smoothly. Some possible errors in the data are the variability of temperature of the water, the pH tester was not meant to be used for scientific research, the safety of the water for drinking was not tested for safety reasons. For a future experiment, we could test more samples of water. We could also measure other facets of the purity of the water such as salinity and chlorine content.