Methamphetamine Detection Using an iPhone

By: Eric Heritage
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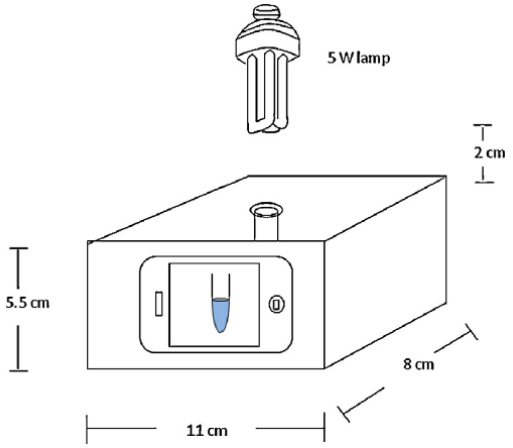
Researchers have developed a field test for methamphetamine that uses colourimetric chemistry, along with an iPhone camera and apps to determine the concentration of the sample.



Quantitative Colourimetric field test kit for methamphetamine detection (Image taken from article)

Law enforcement agencies around the world may soon be able to use iPhone technology to detect methamphetamine, as well as other narcotics, and determine the concentration of a sample. In a joint project between Prince of Songkla University in Thailand and the University of Strathclyde in Scotland, researchers have developed a quantitative colourimetric field test for methamphetamine detection. The basic idea of the field test is the following: A sample is placed in a test tube along with a liquid reagent, which causes the solution to turn blue if methamphetamine is present. A picture of the solution is then taken using an iPhone, and an app installed on the iPhone analyzes the colour of the solution, to determine the concentration of methamphetamine present.

The current field tests for narcotics, which are used by law enforcement agencies, are presumptive colourimetric tests, which are purely qualitative. The officers add a reagent to the sample, and after the reagent reacts with the sample, they compare the colour of the solution to a colour chart, to determine if the drug that was tested for is present. If any further information about the sample is needed, such as the concentration, the sample has to be sent to a forensics lab for further testing. However, in some areas of the world, forensics labs are not always easily accessible. “In many African countries, the closest forensics labs are hundreds of kilometers away, so the only tests that are used by law enforcement agencies in these areas are qualitative field tests. These areas would greatly benefit from having a quantitative field test that could provide more information than just whether or not a particular drug may be present”, says Niamh Nic Daed, a professor at the University of Strathclyde who is involved in the project. But this technology would also benefit law enforcement in more developed countries as well. It would allow them to get more information about the sample on the spot, as opposed to sending the sample to the lab and waiting for the results.

This quantitative colourimetric field test makes use of an app called ColorAssist, which was designed by FTLapps, Inc. What the ColorAssist app does is allow the user to select an area on a digital image and analyze the colour. The app gives the basic red

green blue (RGB) data for the selected area. These RGB values represent the hue of the red, green, or blue colour present. The values range from 0 to 255. For example, R, G, B, values of 0, 0, 0 represent black and values of 255, 255, 255 represent white. With regards to the quantitative test for methamphetamine, the solution turns blue if methamphetamine is present. The higher the concentration of methamphetamine, the "stronger" the blue colour would be. In other words, the ratio of the B value to R and G value in the RGB data would be larger. This, in principle, is how the quantitative colourimetric field test determines the concentration present.

Computer Science students at the University of Strathclyde designed a second iPhone app that takes the RGB values from ColorAssist and determines the concentration of narcotic in the sample. "The app converts these RGB values into intensity values. We developed calibration curves of intensity versus concentration for the three different colours based off known samples, and have programmed these into the app. The user would input what drug is being tested and which reagents are being used, and the app would tell the user the concentration of the sample. The app does all of the calculations behind the scenes", Niamh explains. The app has been applied to a variety of colour tests, such as ones that test for heroin, ecstasy, opiates, and TNT.

A pilot program for these quantitative colourimetric field tests is currently being conducted in Glasgow, Scotland, to allow officers to use the test and provide feedback. It will still take some time, however, before we see these tests being used by law enforcement agencies worldwide. As Niamh points out, "…research definitely needs to be done with regards to standardizing these tests. We need to look at how much climate will affect the reaction with the reagent. It will be slower in colder climates and faster in warmer climates, but we don't know by how much. Therefore, the protocols for running these tests, mainly the time between adding the reagent and taking the picture, will likely differ from region to region".

Interview with Niamh Nic Daeid
March 27th, 2014

1. **What field tests, if any, are currently used for methamphetamine detection (or other drugs)? Where are they used (i.e. airports, border security, etc.)?**
   Currently, in all areas of law enforcement, presumptive colour tests are used in the field to detect a variety of different drugs. Officers have kits that they bring to a drug seizure, that contain everything they need for the test. They would take the solid material, put it in a test tube and add a liquid reagent. After the reagent reacts with the sample, they compare the colour of the solution to a colour chart to determine if the substance is indeed a narcotic. Different reagents are used to test for different drugs, and these tests can only indicate the presence or absence of the drug.
2. **How long would it be until quantitative colourimetric field tests could be used by these agencies? What research would have to be done before this happens?**
   We got a lot of information from the United Nations Office on Drugs and Crime (UNODC). In many African countries, the closest forensics labs are hundreds of kilometers away, so the only tests that are used by law enforcement agencies in these areas are qualitative field tests. These areas would greatly benefit from having a quantitative field test, which could provide more information than just whether or not a particular drug may be present. This was part of the motivation for this research. Currently in Glasgow, we have a pilot program in place where these quantitative field tests are being used. Another interesting aspect of using iPhone technology for these field tests is that the iPhone records the geographic location whenever it takes a picture, so you can later analyse the geographic locations of where drug seizures have taken place.
3. **Are there other substances that would produce a false positive for this test?**
   There are absolutely substances that could produce false positive results for these colourimetric tests. One good example of this would be the test for heroin, because any opiate would produce a positive result. In this case, the test would indicate the classification of the drug, as opposed to telling you what the drug is specifically. However, in the case of methamphetamine, the test that is used is very specific to meth, so a false positive less likely in this case.
4. **How would having a different amount of light, say if you used the camera flash or placed the lamp closer or farther from the sample, change the results of the test (RGB data)?**
   Changing the amount of light does have the potential to distort the colour and therefore give you different results. One way to minimize this error is to zoom in on the part of the picture that you want to analyze, before you take your RGB reading. Another potential way to reduce error is to make standardized kits for law enforcement agencies, with the same light source.

5. **Could this app be applied to quantitative tests for other narcotics? Is this something you and your colleagues are looking into?**
   Computer Science students at our University designed the app specifically for use in quantitative colourimetric tests. We have applied the app to a variety of colour tests, such as colour tests that are used for heroin, ecstasy, opiates, and TNT. We are taking old chemistry knowledge (these colour tests have been well understood for many years) and applying modern technology to get a new result.
6. **What are the RGB values that the app gives you? Are they intensity values or do you have to convert them into intensities?**
   The RGB values that the app measures are the hues of red, green, and blue, present in the image. The app converts these RGB values into intensity values. We developed calibration curves of intensity versus concentration for the three different colours, based off known samples, and have programmed these into the app. The user would input what drug is being tested and which reagents are being used, and the app would tell the user the concentration of the sample. The app does all of the calculations behind the scenes.
7. **You mention that two minutes after the addition of the reagent is the optimal time for digital image capture. How sensitive are the results relative to when you take the picture? If you took the picture, say fifteen seconds earlier or later, how would this affect the measured methamphetamine concentration?**
   Yes, this could affect the results. In the pilot project, several pictures are taken to ensure that at least one of the pictures captures the sample when it has its optimum colour. But research definitely needs to be done with regards to standardizing these tests. We need to look at to what extent climate will affect the reaction with the reagent. It will be slower in colder climates and faster in warmer climates, but we don't know by how much. Therefore, the protocols for running these tests, mainly the time between adding the reagent and taking the picture, will likely differ from region to region.