This instrucable is about building a webcam that could be placed outdoors anywhere in the World where is accessible mobile phone network. It could be used to observe birds, animals, woods, mountains, rivers or lakes. Or it can be placed in the city to monitor traffic jams, construction sites, or weather, or in the country house to keep an eye on it in the absence.

My dream was to have a webcam in winter near the lake to check that it is possible to play ice hockey, or in summer to see that someone is playing football on the field or doing skateboarding. The phone should take a picture, send it away and then sleep until it is time to take the next picture. In this manner phone can be quite power conserving.

It might be illegal to place unauthorized webcams in public places. It looks like old time prejudice. Now everyone has a phone with camera. Consider this instructable as hobby technology exploration – what is possible with today's techniques.

OVERVIEW OF EXISTING SOLUTIONS

Commercial GSM webcam solutions exist, but are expensive:
http://www.hiddencamera.com.au/solar-construction-cam-with-gsm.html

www.automonitor.net/ has a great idea to connect LAN IP camera to 3G modem. This allows to connect to camera directly and besides video also get a sound stream. Sound stream is not trivial in Linux. Only few cameras support that, for example Foscam.

An alternative would be to build a GSM camera interface based on Quecktel M33 GSM module
http://www.quectel.com/ distributed in Europe by SOS-Electronics http://www.soselectronic.com
but it is a quite hard SMD project and would not make HD pictures. That might be good for some mechanical sensors like a GSM automated alarm or post box on the countryside. However for that an old phone can be used.

Now it has become possible to make a GSM webcam using a free software MobileWebcam developed by Michael Haar and a low-cost Android phone, for example, Samsung Galaxy i5500 costs below 100 EUR.

Phone does not need to be rooted.
(Needs to be routed for if want to use autoshutdown function. Can use "Super one click root tool") .
Also Android 2.2. can be flashed, but is not necessary as 2.1 also works.

Then MobileWebCam.apk can be installed from the market.
https://play.google.com/store/apps/details?id=com.dngames.mobilewebcam&feature=search_result#?t=W251bGwsMSwyLDEsImNvbS5kbmdhbWVzLm1vYmlsZXdlYmNhbSJd

Sometimes older versions are preferable and run more stable.
MobileWebcam has a superb support by it's developer Michael Haar
http://forum.xda-developers.com/showthread.php?t=950933

GSM in Germany I use in 2012 is AldiTalk. 4 EUR/months. 500 MB. 1 pic/10 min.
http://barbara320.gotdns.com/webcammob/old/index.php

Second alternative I used in 2012, was O2 for 15 EUR/month. 1 GB/month.

Android phone as a mobile Webcam

Phone used: Samsung i5500 Android 2.1 or 2.2. Cost on Ebay 50-100 EUR.
Temperature sensor resolution 5 degrees.
Plastic box to transmit mobile phone radio waves.
Hermetic. Attachable to lamp post.
Camera hole covered with a microscope cover glass. Reasonably good optical quality.
Mobile Webcam apk.
Batteries in parallel to Samsung battery. LiPo 4Ah x 4pieces. 16Ah x 4V=64Wh

WEATHERPROOF ENCLOSURE

Weatherproof plastic box has outside dimensions are 160x80x55(60) mm. Plastic box is necessary to transmit radio waves. 1mm thick steel plate is screwed to the bottom of it. It can be attached to a street-lamp post with cable ties or strong magnets. When placing the box in open public space it is necessary to mask it, so that it is not stolen. For a non-professional, the box looks like some electric part belonging to a lamp post. Alternative is to make a fake bird house and put it up in a tree.

Microscope cover slide is used for window. And hole is painted black to minimize scattered light. Microscope cover glass provides quite good optical quality but an antireflection-coated plate from eye doctor store would be something even better.
Phone is fixed inside the cover with some drops of hot-melt glue.
Noticed that phone set up in the sun gets quite hot. I think batteries tolerate up to ca +65 deg. C.

EXTRA BATTERY POWER

The biggest problem for autonomous use is power consumption.
When the display is running the power consumption by phone is 2.5W. MobileWebCam App allows to put the phone in sleep mode between taking pictures and wake it up when necessary. In sleep mode there is still connection to GSM. With MobileWebcam app uploading picture every 10 min via GSM the phone runs from its own battery of 800 mAh for 50 hours. So the current consumption is ca 16 mA.

The biggest battery waster is wifi, need to switch it off. (WiFi can be used instead of GSM. Power consumption is comparable to GSM.) Then come background data that Google is synchronizing. Also needs to be off.

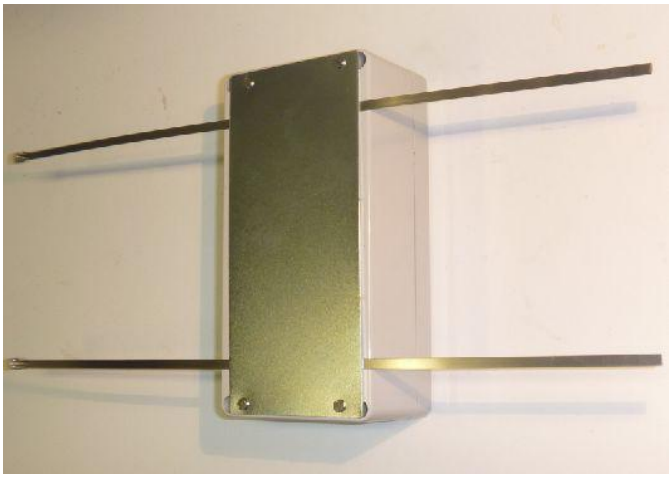
To extend running time a larger LiPo pack is used. It is made from 4 LiPo cells in parallel, 4000mAh each.
This battery pack is connected in parallel to the phone battery. I soldered wires directly to a phone battery.

Can also use LiPos from an old notebooks. Usually only 1-2 cells are completely dead, but other are keeping voltage around 3 V meaning they are OK. Disassemble enclosure. Check every cell. Good cells have voltage of ca 2-3 V. And solder them all in parallel.

LiPo cell should never be charged above 4.2 V as it might self ignite:
http://www.youtube.com/watch?v=YCWdnjLqVWw

- This big capacity battery can be charged via the phone but will take long time. Charging via USB – not recommended as phone forgets about power economy.
- For faster charging I actually disconnect the extra LiPos and charge them via RC-model LiPo charger. It still took ca 50 hours.
- An alternative is to make a 4.2 V stabilized power supply. Nice example is here: http://shdesigns.org/lionchg.html
- Charging can be done also with a laboratory type power supply set at 4.2 V.

MOUNTING OUTDOORS



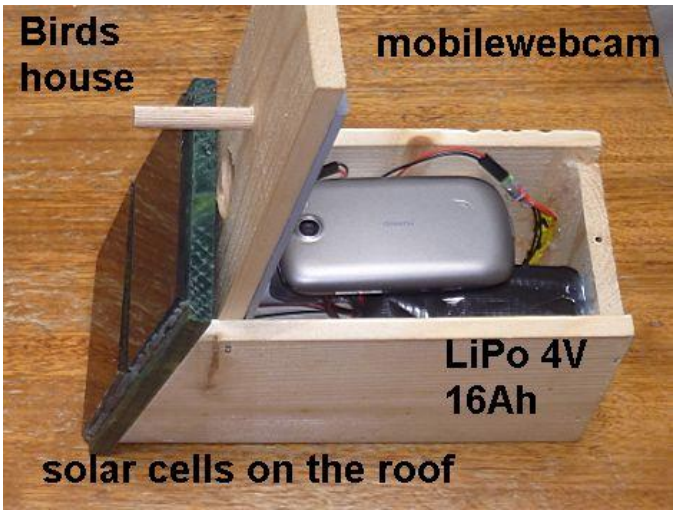
Please have a look at my cameras uploading pictures here, when in operation, of course.
http://barbara320.gotdns.com/

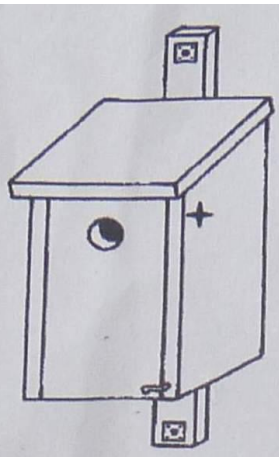
Box in skatepark survived without recharging 3 months attached to a street sign post and one day was removed by street workers. Time lapse video in Youtube:
http://youtu.be/ANkwv9SdvN8

Example setup of the first Samsung i5500 box
And sample image.

FAKE BIRD HOUSE

Phone used: **Huawei U8180** bought for 70 EUR on Ebay . It is similar to Samsung, but temperature sensor resolution is better 1 degree.
When placing the box in open public space it is necessary to mask it, so that it is not stolen. An alternative is to make a fake bird house and put it up in a tree. There are some complications. You want to climb tree some 4 m height. There it should not have branches that shadow the camera, but it is not possible to climb without branches. For climbing might need a ladder or tree-climbing harness. Branches make shadow, so solar charging does not really work. Inside the bird house should be waterproof enclosure/plastic bag because of water condensation in nights. Insects might occupy box after some time. Wooden bird's house is put on the tree with glass on entrance hole and some silicon for rain protection.
Box is packed full with 30 LiPo cells from old notebooks. Charging takes ca > 1 day with a RC model LiPo charger. Autonomous running time ca 3 months in summer, or >1 month in winter because LiPo capacity goes down in cold. There is a solar panel on the roof, but it is too small to sustain continuous operation in shaddow.

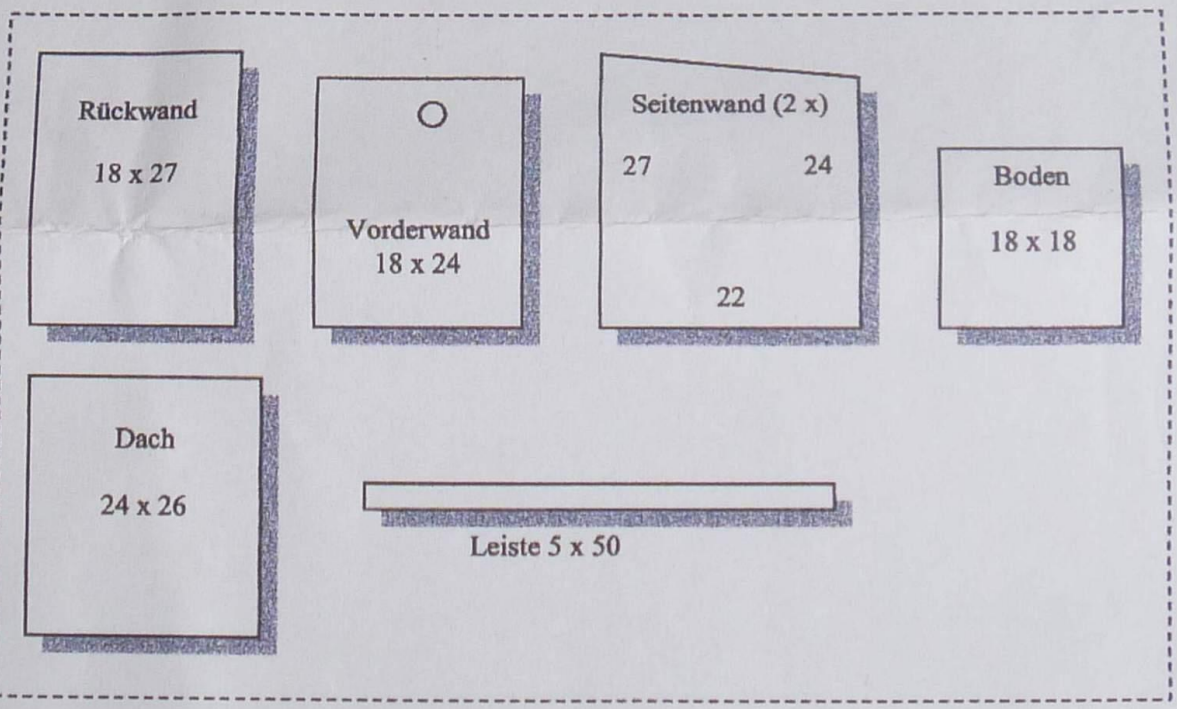




je nach Lochgröße für unterschiedliche Arten geeignet:

- Blau-, Tannen-, Hauben-, Sumpfmeise, Sperling (26 – 28 mm)
- Kohlmeise, Wendehals, Trauer- und Halsbandschnäpper, Gartenrotschwanz (32 – 34 mm)

Die Bauteile (Brettstärke 2 cm, Zahlenangaben in cm)



Der Boden erhält drei Löcher zu 5 mm damit Nässe abfließen kann. Erst wird die Rückwand an den Boden genagelt, dann die Seitenwände. Anschließend wird das Dach befestigt. Die Vorderwand wird oben zwischen zwei Nägeln befestigt die als Drehachse fungieren, die Seitenwände werden hierzu vorher im Durchmesser des Nagels durchbohrt (etwa an der Stelle die mit + markiert ist). Zur Fixierung der Vorderwand wird ein Reiber verwendet, oder ähnliche Haken – siehe obiges Bild unten rechts. Der Kasten wird mit der Leiste verschraubt. Aufgehängt wird er von der Wetterseite abgewandt und nicht in der prallen Sonne.

Viel Spaß beim Bauen und mit den Kastenbewohnern wünscht Ihnen der LBV!

www.lbv.de

Eisvogelweg 1, 91161 Hilpoltstein, Tel.: 089174/4775-0, Email: info@lbv.de

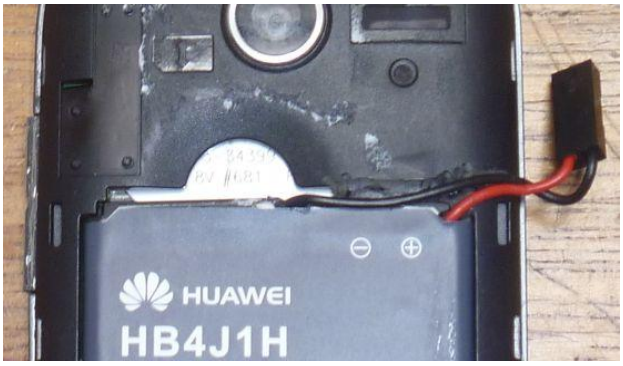
SOLDERING WIRES TO THE PHONE BATTERY

Charging via USB makes phone forget about energy saving.
Wires are soldered directly to the LiPo cell bypassing charging circuit. Need to be careful with charging. Never go above 4.2 V, will make fire. As charging circuit does not see current going in it does not report battery charging from empty state to 100%.

I soldered directly to the cell, bypassing protection circuit that has 3 contacts.

Phone battery case is opened and extension wires are soldered directly to the cell connectors so that battery charging and monitoring circuit is bypassed. A dremel tool grinder is used to cut out plastic so that the battery wires can be taken outside the phone case.

First, I unwrapped the sticky tape, then removed plastic cover and then found with multimeter the "- "and the "+" of the battery. I had to scratch the place with a needle before could solder thin wires to it. In the plastic cover of the battery plastic drilled holes for wires to come out. The wires have 2 pin sockets on it from old PC. Then assembled battery back again. In phone plastic enclosure made a trench for wires using a dremel tool, so that phone cover can be put back on.



SOLAR POWER - *Iphone solar chargers*

Solar charging is a step towards truly autonomous operation.

Noticed that when charging through the USB connector the phone forgets about energy saving. This is important if a solar panel would be used for charging. For efficient use of solar panel power it would be optimal to charge the LiPo directly.

Ordered solar phone chargers from Ebay and will try them when they arrive:
http://www.ebay.de/itm/300608080547?ssPageName=STRK:MEWNX:IT&_trksid=p3984.m1497.l2649
and
http://www.ebay.de/itm/250680007199?ssPageName=STRK:MEWNX:IT&_trksid=p3984.m1497.l2648

Phone charging can not be done via USB. Got very deep LiPo discharge during a cloudy day as phone thinks it gets charged but current is too little. Phone does not save energy and in the evening as the solar charge can not supply enough current the phone drains its battery empty.

I noticed that when phone is charged via USB it somehow does not care much about power consumption, sometimes display goes on for no reason. So it is better to solder wires to the LiPo directly.

Bought from Ebay several cheap Iphone solar charger packs and disassembled. They proved to be quite inefficient. They give 8V. Short circuit current 20 mA. I put 3.7 V Zener diode + (Shotky) diode in series to limit max voltage to 4.2V. Correct solution would be step-down LiPo single cell charger.
LiPo battery voltage should not exceed 4.2 V. at 6 V. That is not enough to sustain phone running forever. Need at least 4 such panels.

Generally get enough voltage from 7 or 8 solar cells in series.
One should solder voltage limiting Zener diode for 4.2 V across the solar panel to prevent overcharging. It could probably be possible to use only 2 cells in series and a switching voltage boost circuit.

Solar panel has low resistance when there is no light. Panel should not discharge the battery in the night. A Schottky diode in series is needed.

SOLAR POWER - *10Wp panel*

10 W peak panel is optimal. Thinking about cloudy days, shade and winter. Usually in cloudy days the output is only 1/10 of the peak power.
Now use a 20V solar panel and switching step-down regulator to 5 V followed by LiPo charger chip Max1811 (free sample) connected directly to the LiPo. The disadvantage is that phone does not show battery level correctly, if it was 50% it will stay like that even if LiPo is charged full. I have an autonomous system running for ca 1 month from 10 W panel and phone did not have extra battery. It's battery gets drained to 70 % in the night and charges fully back during day.

Compared several step-down regulators to 5 V regulators :

* Traco-Power draws 25 mA when idle. That is quite much.
* The one with the smallest idle current of 5.5 mA was found from PowerTrends 78 SR 105 VC with specs 30 V in, 5V 1.5A out. Conrad.de price 30 EUR.
* Probably could use also car 12V -> 5V adapter.
* The LTC3652 (http://www.linear.com/product/LT3652) is ideal step-down LiPo charger.

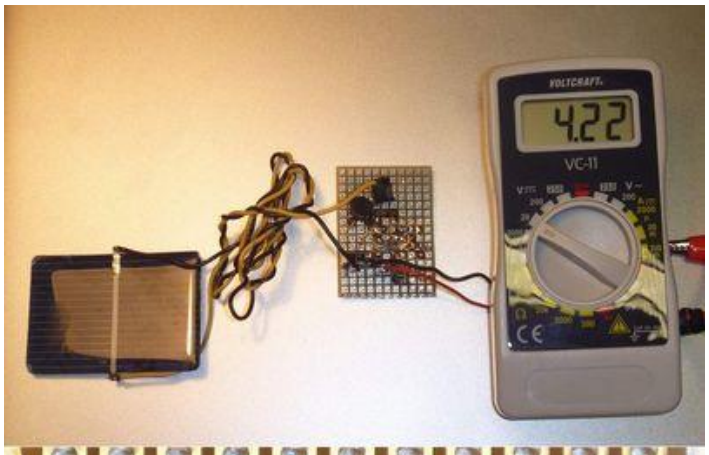
If solar panel is large and you are not concerned about efficiency then would use Lipo charger with LM311 voltage regulator http://www.shdesigns.org/lionchg.html

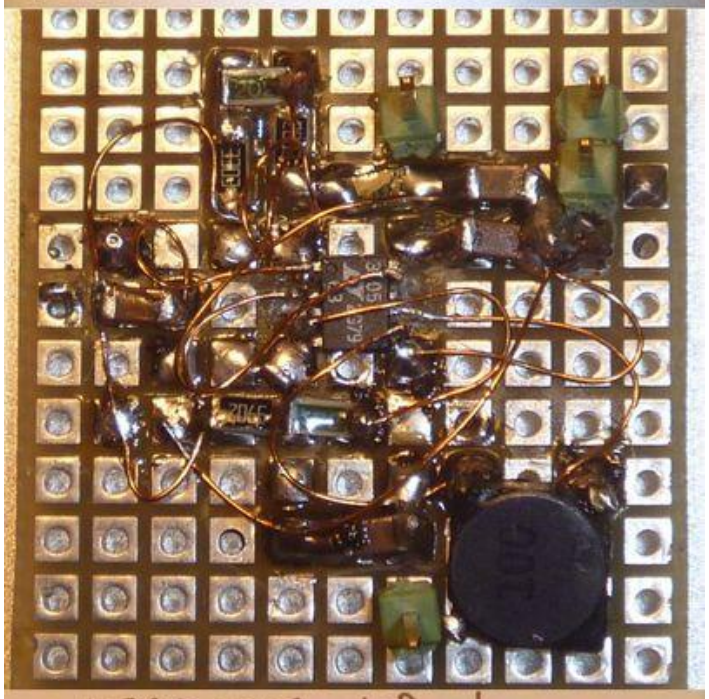
The picture below is misleading and should not be used. In the twilights phone will think that it is being charged, but not enough current will come and phone battery will get drained.

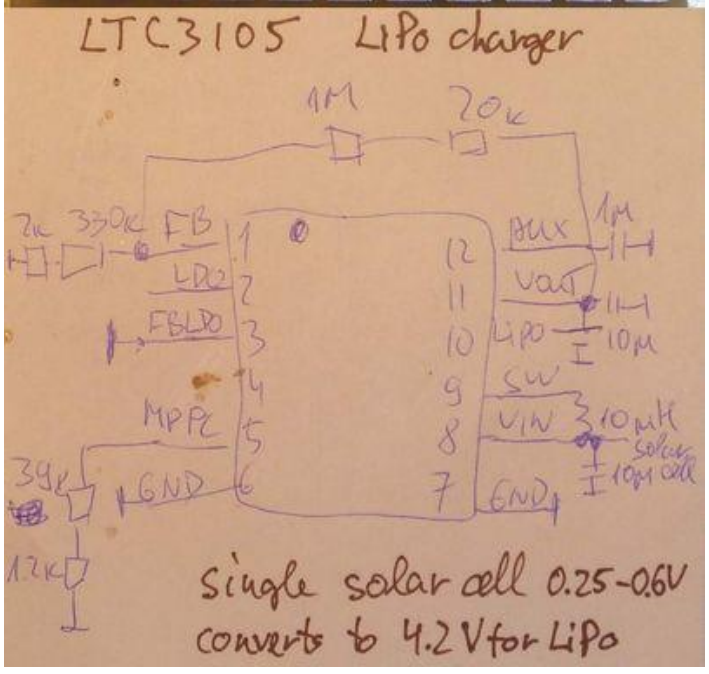
SOLAR POWER - ***Single cell step-up regulator***

LTC3105 - 400mA Step-Up DC/DC Converter with Maximum Power Point Control and 250mV Start-Up MPPT maximum power tracking built in.

Energy harvesting chip that can charge LiPo from a single 0.6 V solar cell! It is favorable for places with shadow where part of solar cell is in shadow.
Very low self use current. Ordered chip as a free sample. Assembled using 0.2 mm thin enameled wire routing. Wire end iis held at the tip of soldering iron for ca 10 s and enamel burns off and it can be soldered very nicely. Some people even assemble microcontroller circuits in this way.







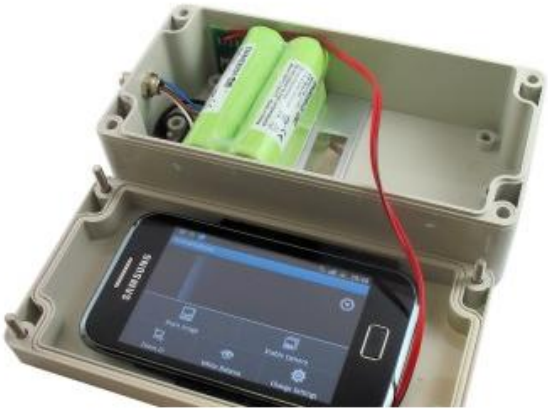
PIR MOTION DETECTION

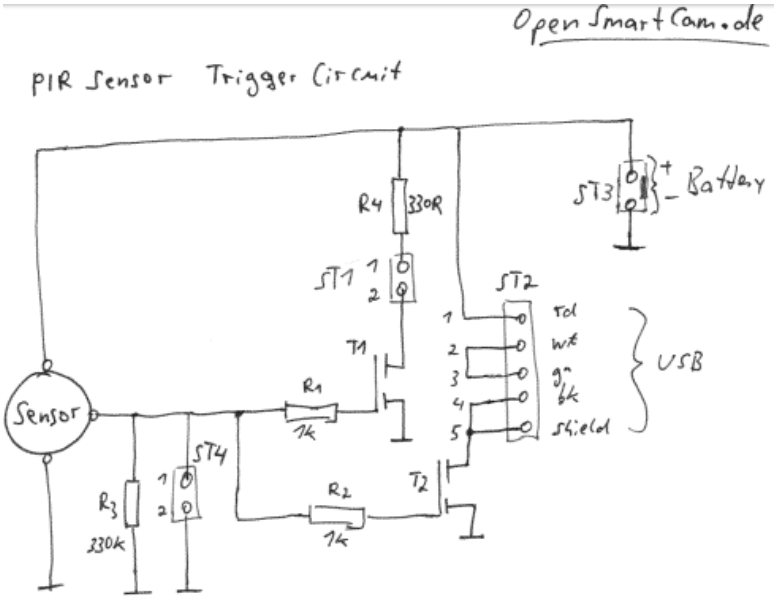
http://opensmartcam.de/

Uses the same free mobilewebcam software, PIR motion detection activated by phone charging wakeup.

So the phone takes a photo when the screen light up it when gets power on the charging connector.

In the spring 2012 the software was not stable enough. PIR motion detection can connect power to the USB charging adapter, phone will wake up from sleep and take photo. Samsung i5500 did not go to sleep afterwards.
In October 2012 Version 2.54 works OK with Samsung i5500.





Sensor: EKMC1603111, Panasonic

T1, T2: MMBF170

ST3: Connector, RM2,54, 2-pole, Type 734166 BKL-Electronic