Designing Appropriate Computing Technologies for Rural Development

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University of Washington

Job Talk - Spring 2007

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3 billion people in the rural developing world need the same information we do

- ✔ Business: new opportunities
- ✔ Finance: capital to invest
- ✔ Government: services & programs
- ✔ Health: informed, consistent care
- ✔ Education: personal advancement

3 billion people in the rural developing world have different limitations and capabilities

- ✗ Money: to buy technology
- ✗ Education: to use technology
- ✗ Infrastructure: power, connectivity
- ✔ Time: lots of available labor
- ✔ Community: lots of relations

Overview & Methodology

Understand Context

A highly 'embedded' approach to designing, developing and evaluating technology

Build Solution

CAM: a mobile phone toolkit for distributed data collection in the rural developing world, and several applications using it

Evaluate Result

Microfinance – actively used in India

Agriculture – tested in Guatemala and India

Supply Chains – tested in India

Step 1: Understand

2002-3

Financial Services to the Poor

Microfinance: Global Movement

- Grameen Bank & Muhammad Yunus – 2006 Nobel Prize

Self-Help Groups (SHGs) - ROSCAs, ASCAs, Village Bank, etc.

- Collect savings during meetings
- Use capital for small loans
- Business, livestock, education, health care, etc.
- Repayment based on peer pressure

Decentralize financial service provision

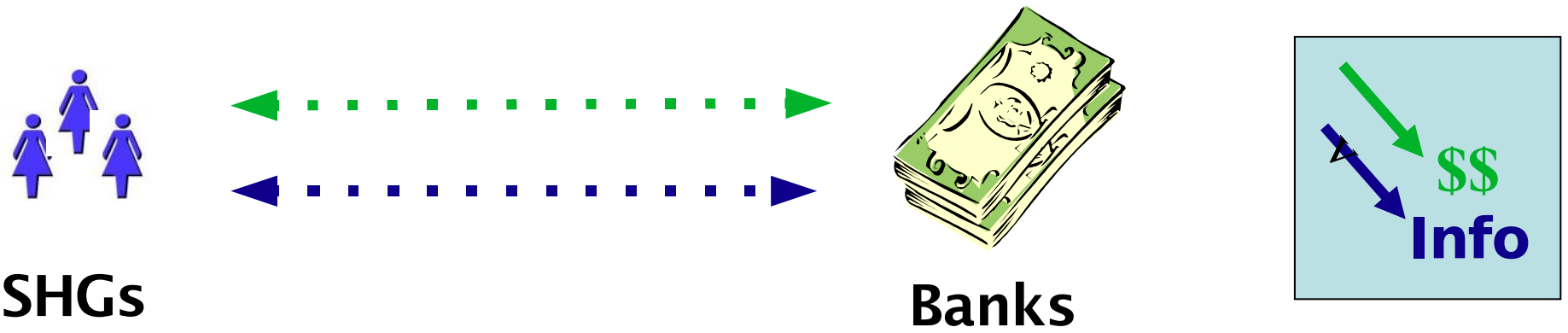
Linking Formal and Informal

SHGs are being linked to banks

- ✔ Access more credit at better rates
- ✔ Other services (insurance, investment, savings, etc.)
- ✔ Local intermediation can reduce cost of service
- ✔ Excellent repayment performance (90-98%)

However, many obstacles **Parikh - ICTD 2006**

- ✗ Spread across remote rural areas
- ✗ Expensive to collect information and money
- ✗ Documentation practices are inconsistent
- ✗ Difficult to assess credit risk and make decisions



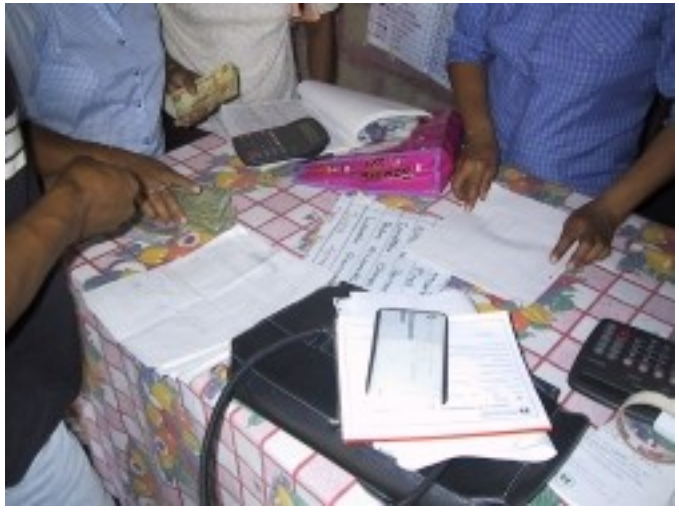
Information can be the Bridge

Information can bridge the divide

- Connect the formal and the informal
- Provide oversight and understanding for SHGs
- Provide credit ratings and risk analysis for banks
- Result: SHGs get better rates for better performance

Can we design a system for SHGs to aggregate data?

- Accessible to users
- Accurate and efficient
- Intermittent power, connectivity
- Generalizes to other applications



Design for Rural Users

Investigate interface design space for rural users
- SHG members and supporting staff
- Some may be semi-literate or illiterate
- Use SHG data collection as sample application

Only previous work was Grisedale et al., CHI 1997
- Data collection for rural health care workers in Rajasthan
- Using Apple Newton

We used laptop / PC for maximum flexibility
- Not considering real deployment issues

contextual study

Weekly by Cluster Monthly MIS for Mahakalam payment

SNo. வரிசை எண்	Member Name உறுப்பினர் பெயர்	No. Saving Subscription வரவினம் Receipts						கடன் நிலுவை	வட்டி நிலுவை	மொத்தம்	செலவினம்		
		ரசீது எண்	சந்தா வரவு	கடன் வரவு	வட்டி வரவு	நிர்வாக நிதி	இதர வரவு				வவுச்சர் எண்	புதிய கடன்	
	ஆரம்ப இருப்பு 'opening balance			Principal loan Repaid	interest payed	Maintenance fund	other receipts	~~Loan due~~ principal due	Interest due	Total due (loan)	Voucher No.	New loan	g
	கையில் ரொக்கம்	cash at hand											
	வங்கி இருப்பு	Bank balance											
	மகாகலச டெபாசிட்	Mahakalam Deposit											
	மகாகலச கூட்டு தொழிலுக்கு		"	"	(enterprise)								
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	மொத்தம்												

கலச ஒருங்கிணைப்பாளர் கையொப்பம் ~~Kasta~~ coordinator cluster incharge

எழுதுபவர் கையொப்பம் Accounts

கையிருப்பு who for

prototype testing

design iteration

தர்ந்தெடுக்கப்பட்ட ள்ளார்
தேதி : 12/10/02

1	விஜயா	50	50
2	பாரதிதாசன்	50	50
3	கார்த்திக்	50	0
4	பிரியா	50	☐
5	மீனா	50	
6	லல்லி	50	
7	சித்ரா	50	
8	சத்யானந்தன	50	
9	சகுந்தலா	50	
10	வி'வகானந்தன்	50	
11	கார்த்திக்	50	

4 பிரியா

50

12.10.02	50	✓
05.10.02	50	✓
22.09.02	50	✓
15.09.02	0	✗
03.09.02	50	✓
26.08.02	50	✓

ஆரம்ப இருப்பு 12.10.02

குழுவின் மொத்த சேமிப் 1080

Group Investments

கையிருப்பு 1600

Bank balance 6850

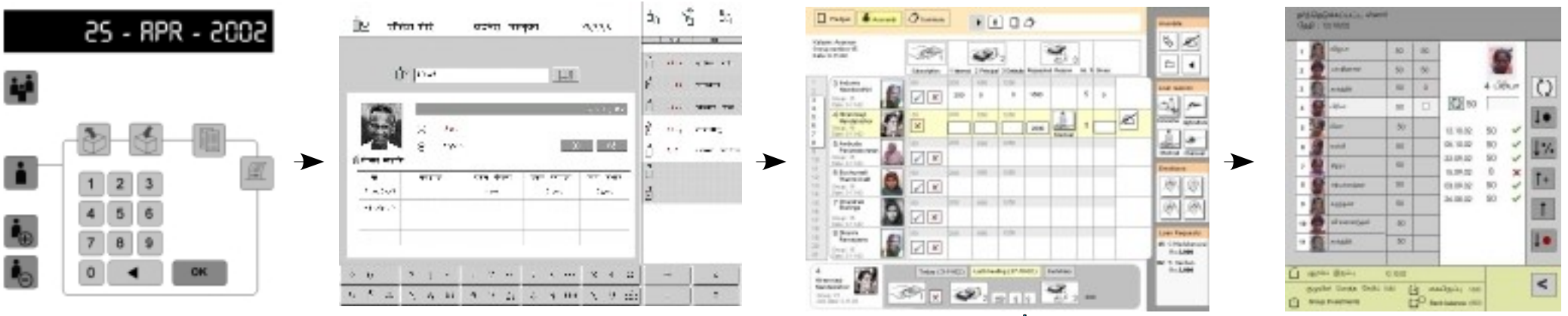
Design Guidelines for Rural Users

Parikh et al. - ACM CHI 2003, ACM CUU 2003 (Best Paper)

Two-month iterative design study conducted in a village

32 rural users - farm laborers (10 semi or illiterate)

- ✔ Paper formats are important
- ✔ Local language audio builds trust
- ✔ Numeric input/output is accessible
- ✔ Guide the user through the task
- ✔ Realistic icons are better



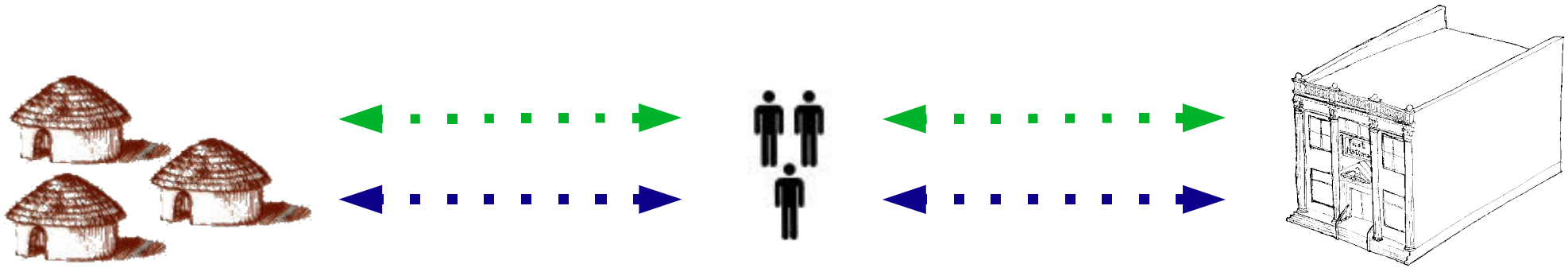
Step 2: Build

2004-5

1) Agents - Rural Service Providers

Agent Model: Provide services through local intermediaries

- Employ underemployed youth and women
- Convenient for users / clients (travel is hard!)
- Common motif for many services
  - Primary health care
  - Retail supply chains
  - Agriculture
  - Communications, etc.
- In microfinance, {bank, NGO} field staff collect info, repayments & deliver reports



2) Mobile Phones

Mobile phones are the perfect client device

- Exponential growth across developing world
- Numeric Keypad, Speakers & Microphone
- Intermittent network, Battery-operated, Low-cost
- Supports Agent-based service model

Problems and Limitations

- Small screen: adapted WIMP metaphor
- Numeric keypad: text entry is difficult
- Difficult to program applications

source: grameen-info.org

3) Paper User Interfaces

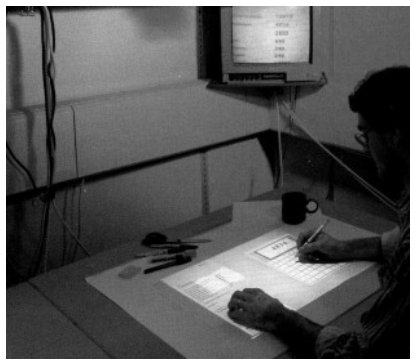
Leverage affordances of paper in digital UIs

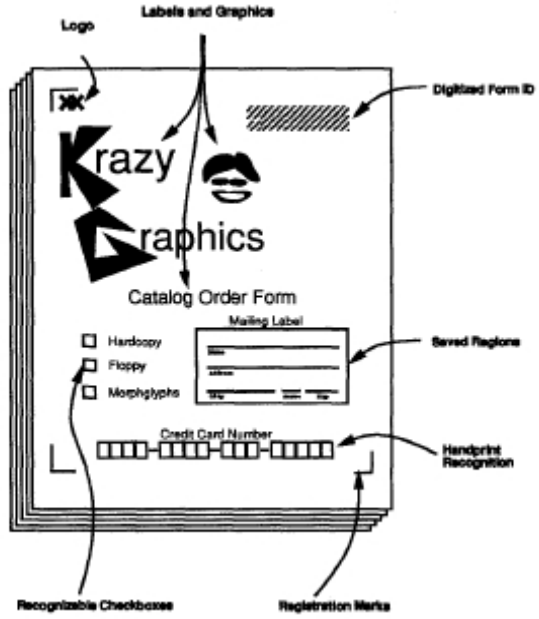
- XAX, Digital Desk, A-Book, Paper PDA, Cooltown, Books with Voices, etc.

However, thus far these approaches have had limited impact

Rural developing world could be the killer application

- Familiarity with paper formats
- Offset high technology cost by performing some operations on paper “client”



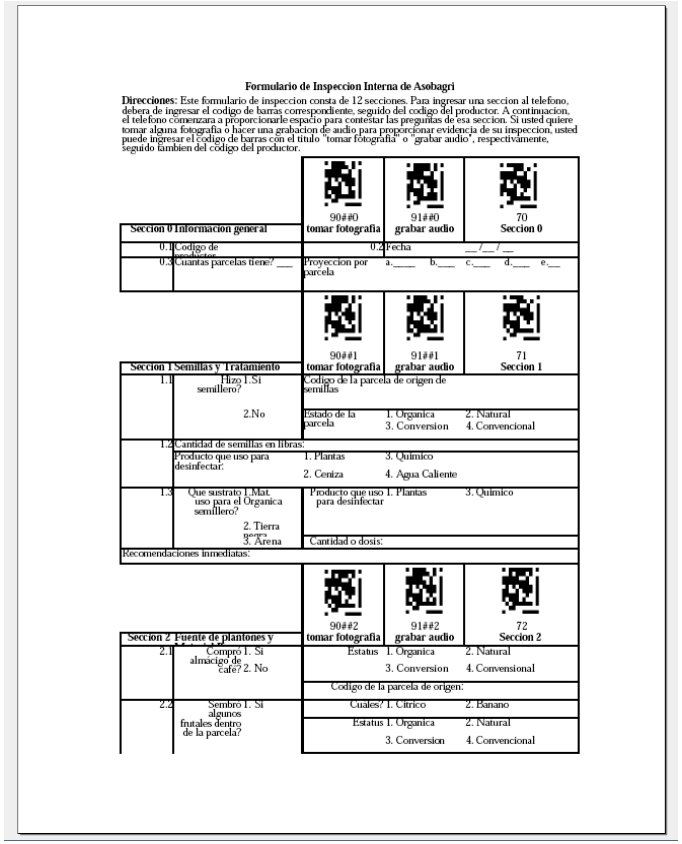


CAM: Application Toolkit for Mobile Phones

Parikh et al. - IEEE Pervasive 2005, WWW 2006

CAMForms

interactive paper forms



Formulario de Inspeccion Interna de Asobagri

Direcciones: Este formulario de inspeccion consta de 12 secciones. Para ingresar una seccion al telefono, debera de ingresar el codigo de barras correspondiente, seguido del codigo del productor. A continuacion, el telefono comenzara a proporcionarle espacio para contestar las preguntas de esa seccion. Si usted quiere tomar alguna fotografia o hacer una grabacion de audio para proporcionar evidencia de su inspeccion, usted puede ingresar el codigo de barras con el titulo "tomar fotografia" o "grabar audio", respectivamente, seguido tambien del codigo del productor.

Seccion 0 Informacion general		90##0 **tomar fotografia**	91##0 **grabar audio**	70 **Seccion 0**
0.1	Codigo de productor	0.2 Fecha		__/__/__
0.3	Cuantas parcelas tiene? __	Proyeccion por parcela	a.___ b.___ c.___ d.___ e.__	
Seccion 1 Semillas y Tratamiento		90##1 **tomar fotografia**	91##1 **grabar audio**	71 **Seccion 1**
1.1	Hizo 1. Si semillero? 2.No	Codigo de la parcela de origen de semillas		
		Estado de la parcela	1. Organica 2. Natural 3. Conversion 4. Convencional	
1.2	Cantidad de semillas en libras:			
	Producto que uso para desinfectar:	1. Plantas 2. Ceniza	3. Quimico 4. Agua Caliente	
1.3	Que sustrato 1.Mat. uso para el Organica semillero? 2. Tierra 3. Arena	Producto que uso para desinfectar	1. Plantas 3. Quimico	
		Cantidad o dosis:		
Recomendaciones inmediatas:				
Seccion 2 Fuente de plantones y		90##2 **tomar fotografia**	91##2 **grabar audio**	72 **Seccion 2**
2.1	Compro 1. Si almacigo de cafe? 2. No	Estatus	1. Organica 2. Natural 3. Conversion 4. Convencional	
		Codigo de la parcela de origen:		
2.2	Sembro 1. Si algunos frutales dentro de la parcela?	Cuales? 1. Citrico	2. Banano	
		Estatus 1. Organica	2. Natural 3. Conversion 4. Convencional	

CAMBrowser

mobile phone app
to process forms

```
<function name="a_click">
    d = input_date("Date", "date.wav");
    i = input_int("Interest", "int.wav");
    p = input_int("Principal", "pri.wav");
    if (d & p & i)
      http_put("...");
</function>
```

CAMScript

scripting language
for form interaction

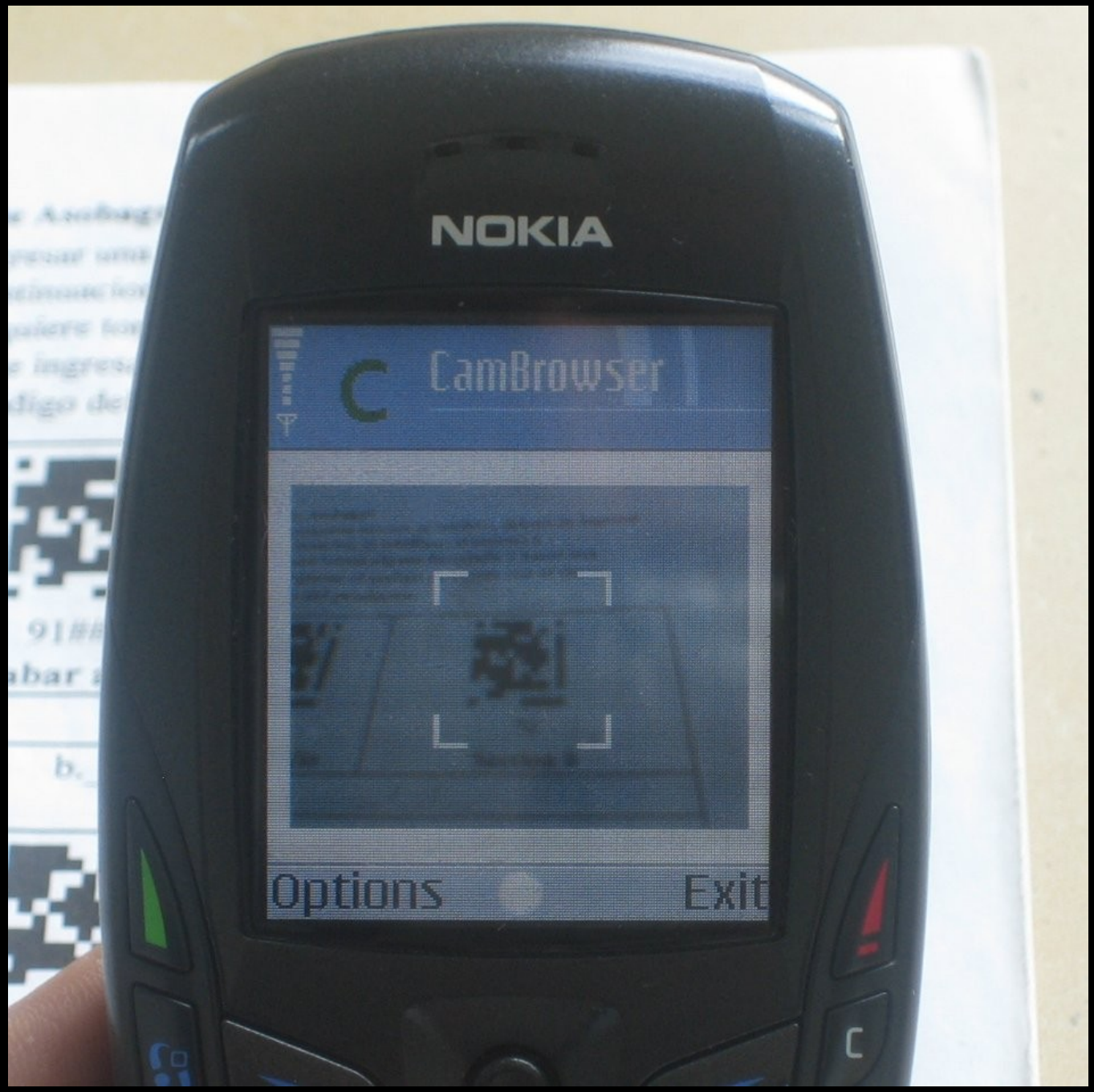
Formulario de Inspeccion Interna de Asobagri

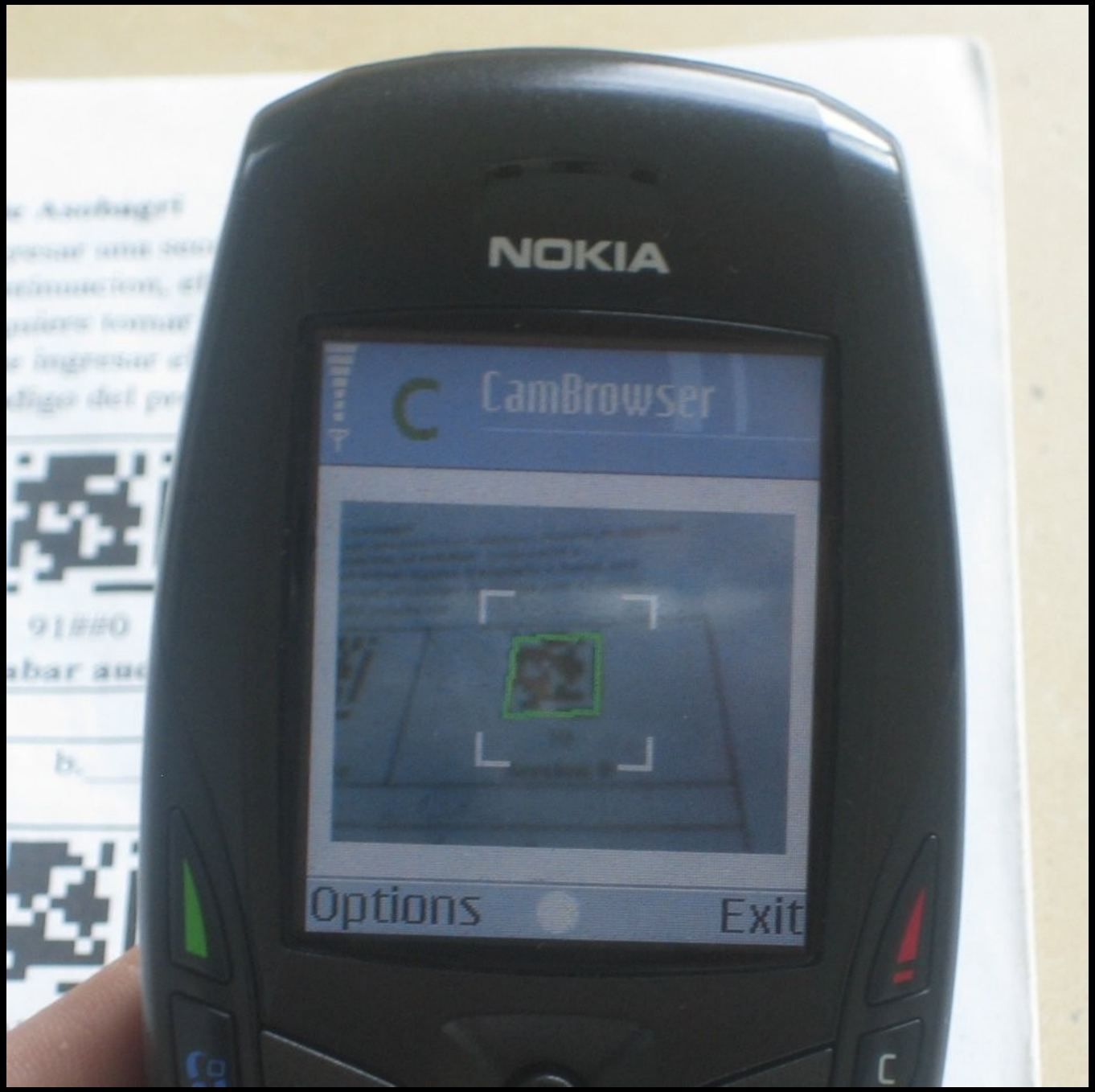
Direcciones: Este formulario de inspeccion consta de 12 secciones. Para ingresar una seccion al telefono, debera de ingresar el codigo de barras correspondiente, seguido del codigo del productor. A continuacion, el telefono comenzara a proporcionarle espacio para contestar las preguntas de esa seccion. Si usted quiere tomar alguna fotografia o hacer una grabacion de audio para proporcionar evidencia de su inspeccion, usted puede ingresar el codigo de barras con el titulo "tomar fotografia" o "grabar audio", respectivamente, seguido tambien del codigo del productor.

Seccion 0 Informacion general	90##0 **tomar fotografia**	91##0 **grabar audio**	70 **Seccion 0**
0.1 Codigo de productor	0.2 Fecha __ /__ / __		
0.3 Cuantas parcelas tiene? ___	Proyeccion por parcela a.____ b.___ c.___ d.___ e.__		

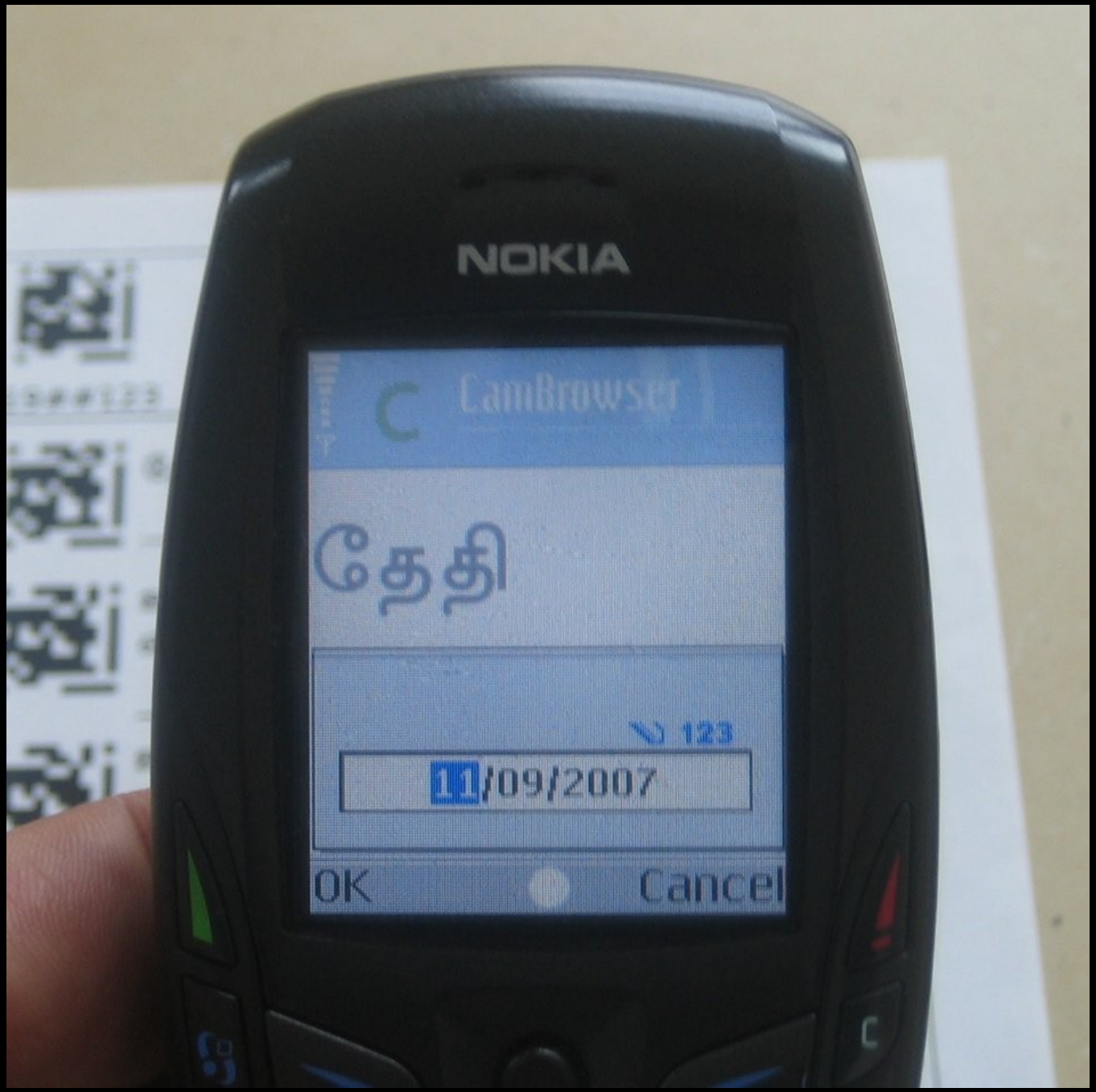
Seccion 1 Semillas y Tratamiento	90##1 **tomar fotografia**	91##1 **grabar audio**	71 **Seccion 1**
1.1 Hizo semillero? 1.Si 2.No	Codigo de la parcela de origen de semillas		
	Estado de la parcela	1. Organica 3. Conversion	2. Natural 4. Convencional
1.2 Cantidad de semillas en libras:			
Producto que uso para desinfectar:	1. Plantas 2. Ceniza	3. Quimico 4. Agua Caliente	
1.3 Que sustrato uso para el semillero? 1.Mat. Organica 2. Tierra 3. Arena	Producto que uso para desinfectar	1. Plantas	3. Quimico
	Cantidad o dosis:		
Recomendaciones inmediatas:			

Seccion 2 Fuente de plantones y	90##2 **tomar fotografia**	91##2 **grabar audio**	72 **Seccion 2**
2.1 Compró almácigo de café? 1. Si 2. No	Estatus	1. Organica 3. Conversion	2. Natural 4. Convensional
	Codigo de la parcela de origen:		
2.2 Sembró algunos frutales dentro de la parcela? 1. Si	Cuáles?	1. Citrico	2. Banano
	Estatus	1. Organica 3. Conversion	2. Natural 4. Convencional


NOKIA
CamBrowser
Options
Exit



Barcode Detection - Rohs 2004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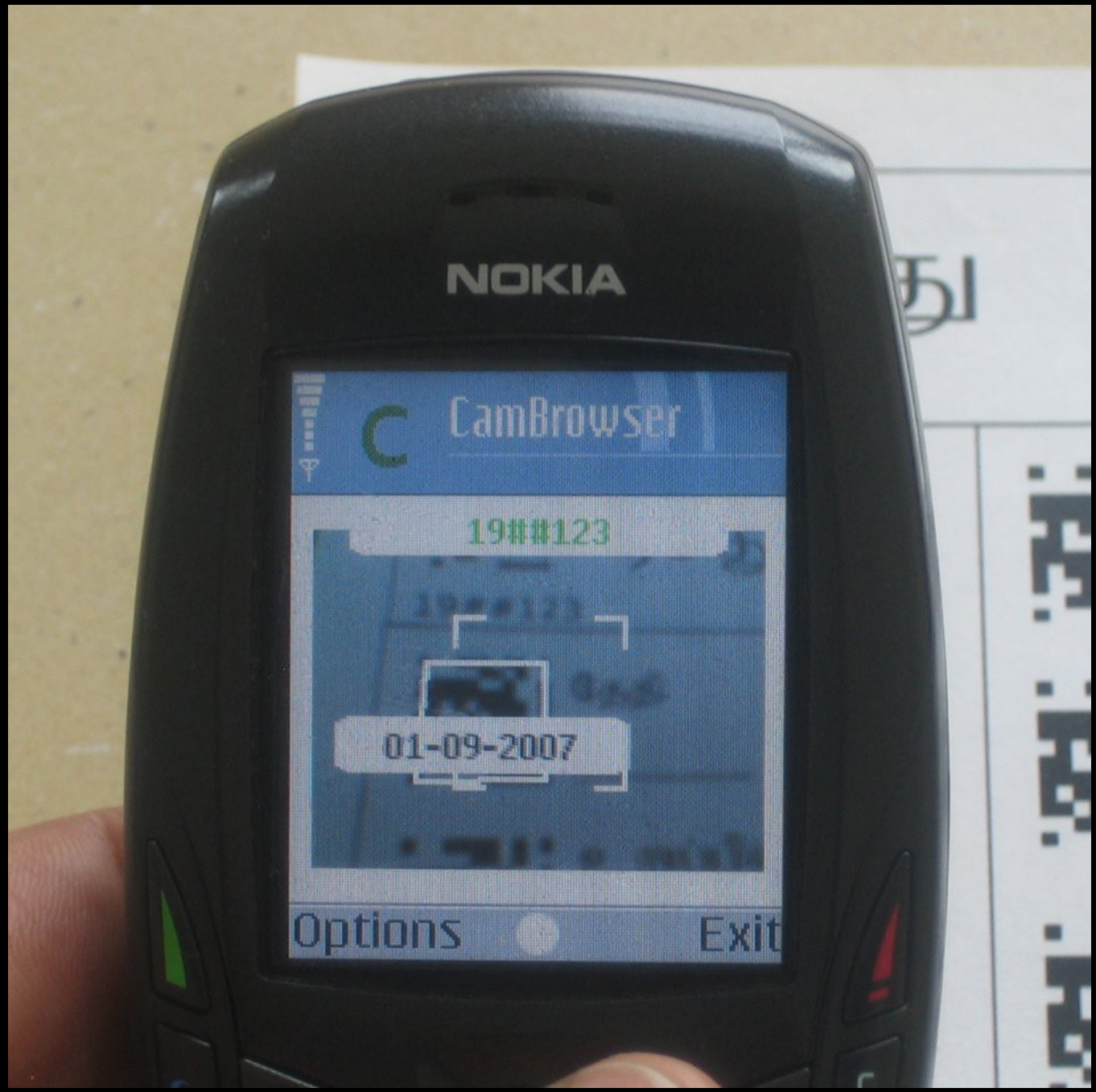
OK
Cancel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19##123
01-09-2007
Options
Exit

CAM: Key Features

Tight linkage to paper practices

- Retain paper as the authoritative local record
- Avoid abstract, menu-driven interaction
- Not optimizing for local labor – don't need OCR!

Simple, scripted programming model

- Easy to program and use

Multimedia Input & Output

- Capture audio and images instead of text

Disconnected Operation

- Transfer data using SMS, MMS, Email (and HTTP)

```
<function name="a_click">
    date = input_date("Enter Date" "date.wav");
    amt = input_int("Enter Amount", "amount.wav");
    message_note("Say your name","sayname.wav");
    record_audio("name.wav");
    email("tap2k@yahoo.com", "a="#amt, "name.wav");
</function>
```

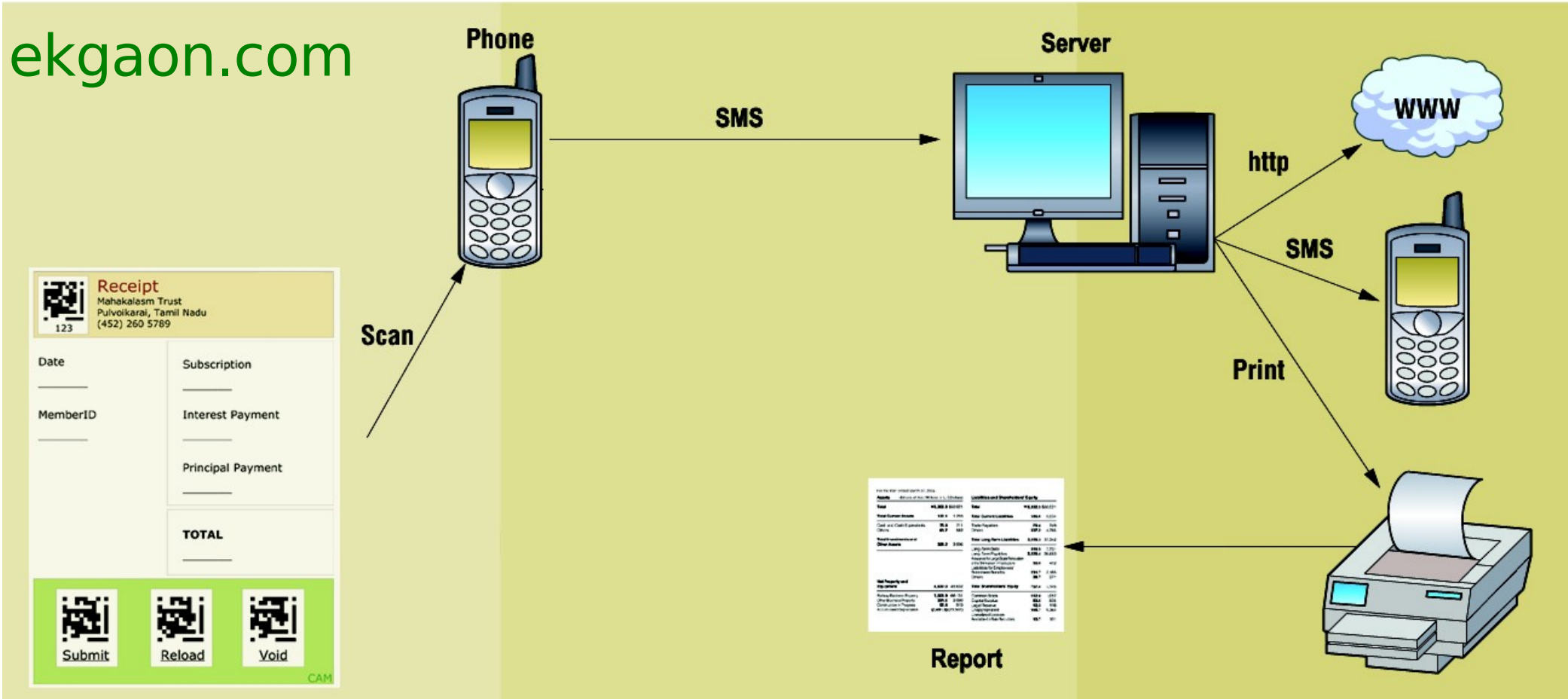
CAM: Dataflow in Microfinance

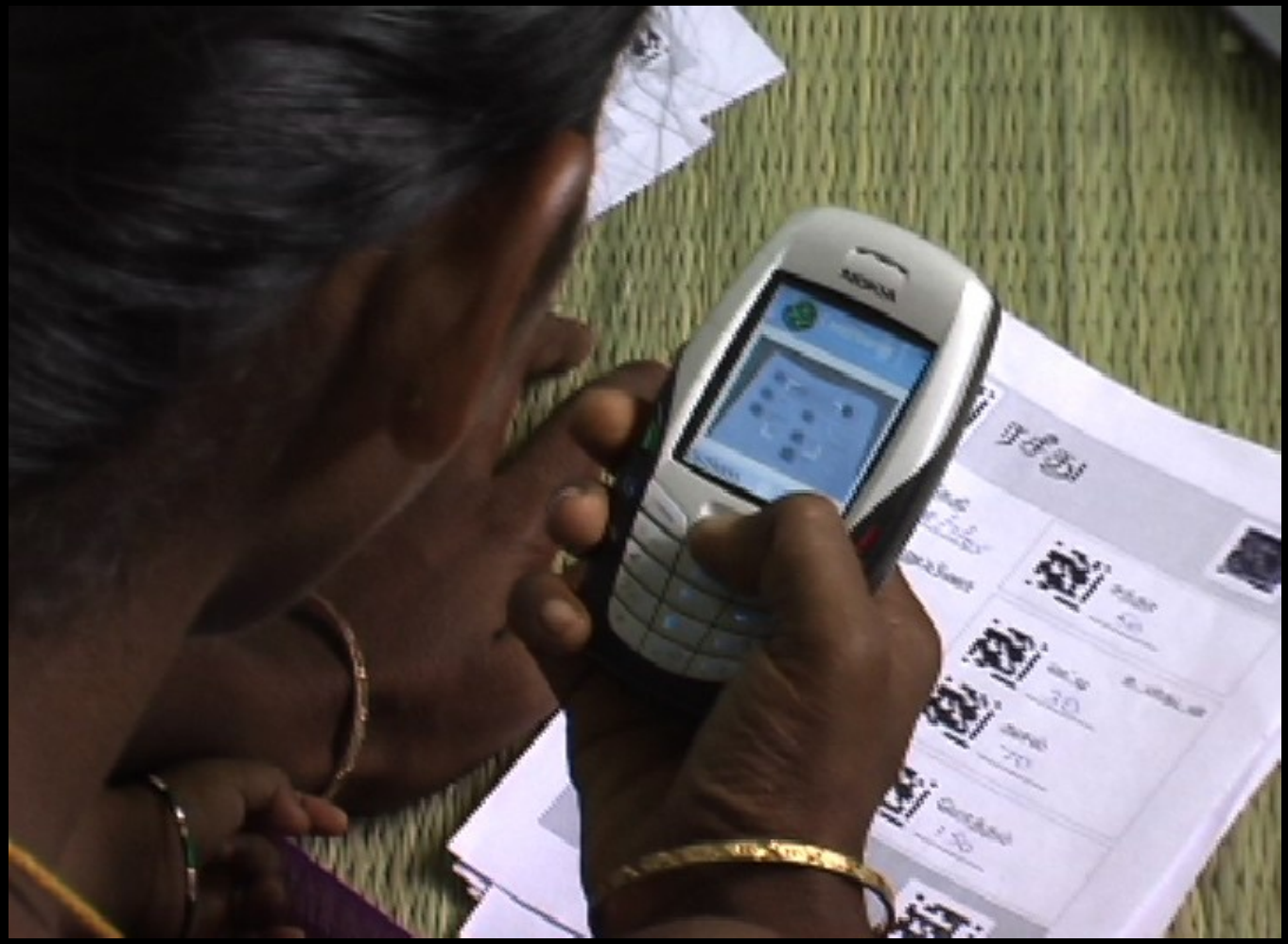
Framework for SHG data collection and reporting

Increased transparency within SHG

Improved documentation when applying for loans

Provide new services to members (e.g. flexible savings)

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Step 3: Evaluate

2006-7

CAM: Usability Evaluation

Parikh et al. - ACM CHI 2006

Task: Record transactions during SHG meetings

- Users: 14 field agents from NGO
- 7th grade to college educated
- Simulated and in situ testing

Results:

- Learnable: Learned within 1-3 sessions
- Efficient: 30 secs per form, 8-10 mins per meeting
- Accurate: Error rate < 1% (0% for in situ tests)
- Users performed significantly better with audio

CAM: Impact in Microfinance

Commercialized by ekgaon technologies pvt.ltd

2 NGOs / 17 agents / 700 SHGs / 10000 members

In active use in Tamil Nadu since October 2006

ekgaon.com

CAM: Beyond Microfinance

RECDATE	RECTIME	SPEED	ROAD_NAME	NRST_LANDM
2/1/2005	00:00:00	0		
2/1/2005	01:00:00	0	METALLED ROAD	Abdulapur
2/1/2005	02:00:00	0		

Supply Chain **Javid and Parikh - ICTD 2006**

- Monitor inventory at rural warehouses
- Track inflows and outflows of goods
- Plan collection & distribution

Health Care **Future Work**

- Collect disease data
- Monitor incidence, transmission
- Monitor treatment compliance

Agriculture **Schwartzman and Parikh - MobEA 2006**

- Monitor cultivation using pictures, audio
- Agricultural extension and certification
- Integrated with various sensors

CAM: Agricultural Monitoring

Working with farmers in Guatemala and India

Extension staff collect geocoded video, images and data

Experts provide feedback and advice via parcel-wise blog

Enable remote certification – organic, bird-friendly, etc.

- Traceability
- Product Differentiation
- Land Use

Understand, Build, Evaluate

Future Work: Support Local Creators

Empower local people to build their own solutions

Physical tools for content creation and application development

Paper formats, visual and tangible programming

Future Work: Trust & Ownership

Rural users may never “own” technology

How do different identification technologies, interaction mediums and social contexts impact trust in computing?

Can we facilitate distant personal / business relationships?

ICTD: An Emerging Area

TIER Group, UC Berkeley
- Long-distance wireless, DTN
- Mobile educational software

Digital Studyhall, Princeton / UW / MSR
- Video for education
- Postmanet – physical networking

Emerging Markets, MSR India
- Design for semi-literate users
- Multiple mice for education

One Laptop Per Child (OLPC)
- Laptops for education

Other Efforts
- MSR funded 17/162 proposals

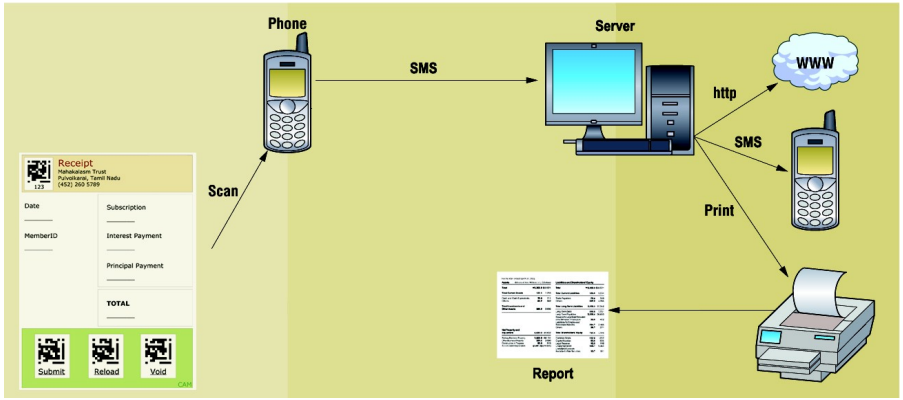
Contributions

Design Lessons for Rural Users

- importance of paper
- local language audio
- numeric i/o

CAM Toolkit

- paper user interface
- multimedia i/o
- scripted & asynchronous



CAM Evaluation

- usability
- generalizability
- real-world impact

Understand Context

ACM CUU 2003
ICTD 2006
IEEE Pervasive

Build Solutions

WWW 2006
IEEE Pervasive
MobEA 2006

Evaluate Results

ACM CHI 2006
ICTD 2006

Long-term Vision

Equitable Economic Development

Environmental Sustainability

Freedom & Political Stability

Information Technology

Decentralization

Final Thoughts

ICTD: an emerging research area

Design for real people & problems

Attracts diverse & energetic students

Impact sustains credibility & collaboration

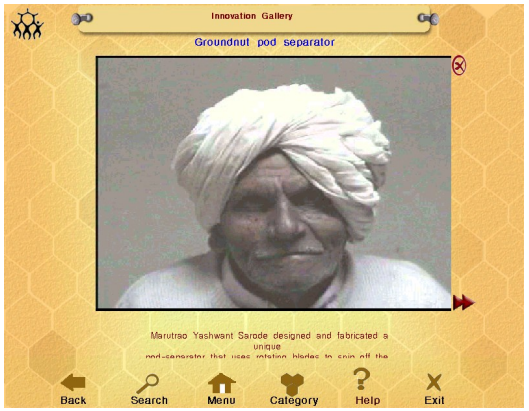
Thanks for all the Fish

Anil Gupta, Vijay Pratap Singh Aditya, Jaimin, Bhavin, Rushabh, Nilesh, Bharat, Kinjal, Kaushik Ghosh, Apala Chavan, Sarit Arora, Puneet Syal, K. Sasikumar, Paul Javid, Yael Schwartzman, S. Olaganathan, John, Bala, Swami, Muthu Velayutham, Edward Lazowska, David Notkin, James Landay, Gaetano Borriello, Richard Anderson, Ken Fishkin, Scott Klemmer, Kentaro Toyama, Eric Brewer, Greg Wolff, Batya Friedman, SRISTI, IIM-A, CCD, Mahakalasm, SEWA, Asobagri, Jataan, HLFPPT, Media Lab Asia, HFI, UW CSE, VSD Lab, UW MLC, Intel, MSR India, Ricoh Innovations, David Bonderman, SEEP, IDRC, ekgaon and everyone else I've had the pleasure to work with.

Knownet-Grin

Knowledge Network for Grassroot Innovators: A Honey Bee Project

- Honey Bee shares grassroots knowledge and innovation
- Publishes 7 regional magazines about agricultural practices and other innovations
- Interested in new ways to share content and facilitate communication
- Developed multi-media distributed database and communications application
- Networked using asynchronous CD-based updates
- Implemented at kiosks in Gujarat, Madhya Pradesh, Maharashtra and Tamil Nadu



ekgaon technologies

ekgaon was founded in 2002 and works in providing technical, managerial and strategic support to community-led initiatives around India and the world. Currently we are based in New Delhi with a field office in Madurai, Tamil Nadu.

http://www.ekgaon.com

Other Partners and Supporters

Covenant Centre for Development
Mahakalasm SHG Federations
CARE India
Deutsche Gesellschaft for Technische Zusammenarbeit (GTZ)
Small Enterprise Education and Promotion Network (SEEP)
International Development Research Centre (IDRC)
Sarai New Media Initiative
Ricoh Innovations
Microsoft Research
Intel Education Program

E-Z Rural Computing

Easy to Use: Max outreach

Easy to Teach: Word of mouth

Easy to Access: Travel is hard

Easy to Share: Amortize high costs

Easy to Create: Local ownership

Easy to Adapt: Localization essential

Outline

1 Background: Microfinance

2 Contextual Design for Rural Users

3 CAM: Data Collection for Mobile Phones

4 Evaluation: Usability, Breadth, Impact

5 Future Work

6 Conclusions

Problems with Mobile UIs

User Interface

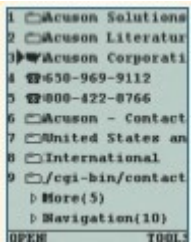
- Adapted point-and-click metaphor
- Text entry is difficult; limited use of other media

Mobile UI research has largely focused on improving display of web content on small screens

- WEST, PowerBrowser, Wingman, Digestor, AppLens, Summary Thumbnails, Collapse-to-zoom, etc.

Programming Model

- Proprietary APIs and programming environments
- Web-based applications require online connection



paper prototyping